Mobile, Wireless, and Pervasive Computing

CHAPTER 6

Chapter Preview

The traditional computing environment that requires users to come to a wired computer may be ineffective or inefficient in many situations. The solution is to make computers small enough that they are easy to carry or even to wear. Such mobile devices can communicate with traditional systems and infrastructure via wireline or, even better, wireless networks. The ability to communicate and collaborate any time and from anywhere provides organizations with strategic advantage by increasing productivity, speed, and customer service.

Mobile and wireless computing provide the infrastructure for mobile commerce—conducting e-commerce wirelessly, any time and from any place. They enable location-based e-commerce, which is based on knowing where people are at any given time and on the ability to communicate with them. Mobile and wireless computing are changing how IT is deployed and are creating the foundations of the futuristic computing environment called pervasive computing. All of these topics are explored in this chapter.

Chapter Outline

Learning Objectives

1. Discuss the characteristics, attributes, and drivers of mobile computing and m-commerce.
2. Describe the emergence of Wi-Fi and voice portals.
3. Describe personal service applications of m-commerce.
4. Discuss m-commerce applications in financial services.
5. Describe m-commerce applications in shopping, advertising, and customer service.
6. Describe the use of m-commerce in intrabusiness applications.
7. Discuss the use of mobile computing in enterprise and supply chain applications.
8. Describe location-based commerce (l-commerce).
9. Discuss the key characteristics and current uses of pervasive computing.
10. Describe the major inhibitors and barriers of mobile computing and m-commerce.

NEXTBUS: A SUPERB CUSTOMER SERVICE

THE BUSINESS PROBLEM

Buses in certain parts of San Francisco have difficulty keeping up with the posted schedule, especially in rush hours. The scheduled times become meaningless, and passengers are angry because they waste time waiting for late buses.

THE IT SOLUTION

San Francisco bus riders carrying an Internet-enabled wireless device, such as a cell phone or PDA, can quickly find out in *real time* when a bus is most likely to arrive at a particular bus stop. Similar systems have been used successfully in several other cities around the United States and in several other countries.

Figure 6.1 shows how the NextBus system works. The core of the system is a GPS satellite that lets the NextBus information center know where a specific bus is at any given time. Based on a bus's location, traffic patterns, and weather conditions, dispatchers can calculate the arrival time at each stop. Users can access that information from their cell phones or PCs. NextBus schedules are also posted in real time on bus shelter signs.

Currently, NextBus is an ad-free customer service, but in the near future advertising may be added. Because the system knows exactly where you are when you request information and how much time you have until your next bus, it could send you to the nearest Starbucks for a cup of coffee, giving you an electronic coupon for a discount on a cup of coffee as you wait.

THE RESULTS

Passengers in San Francisco are happy with the system; worries about missing the bus are diminished. In rural areas in Finland, where a similar system is used, buses are infrequent and winters are very cold; passengers can stay in a warm coffeehouse not far

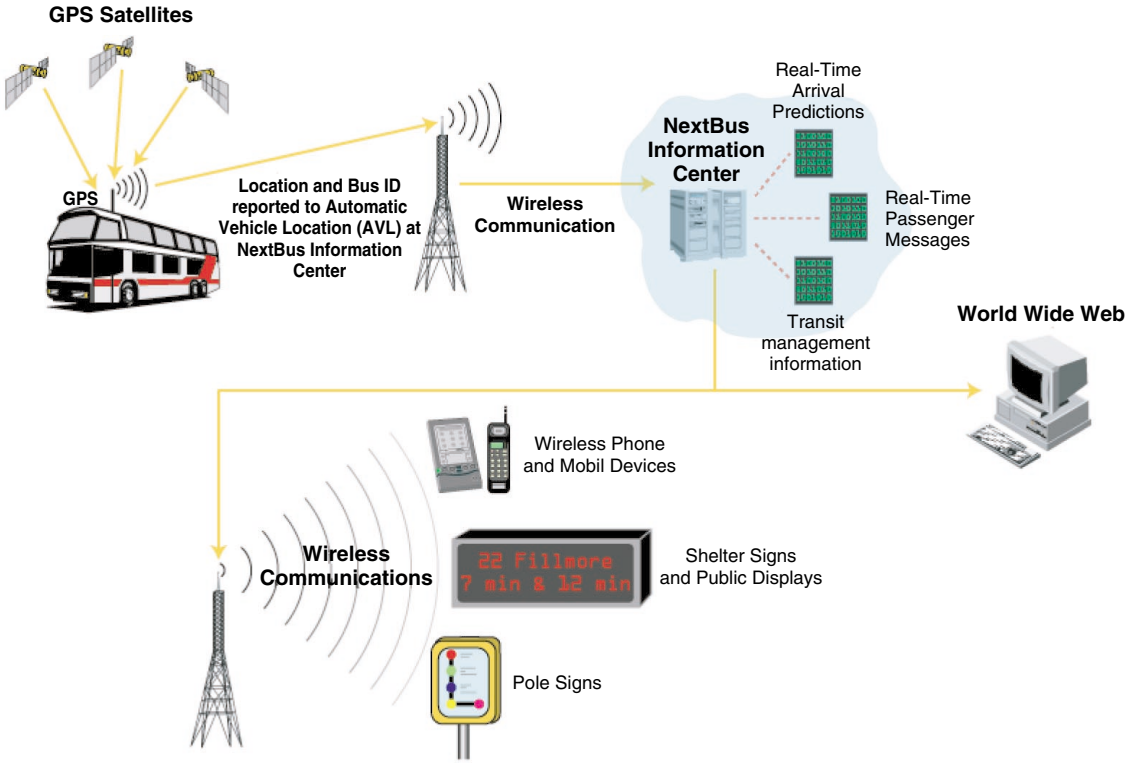

Figure 6.1 *NextBus operational model.*
[Source: NextBus.com/corporate/works/index.htm*, 2002. Used with permission of NextBus Information Systems.]*

from the bus stop rather than wait in the cold for a bus that may be an hour late. Also, using such a system, a bus company can do better scheduling, arrange for extra buses when needed, and improve its operations.

Sources: Compiled from P. Murphy, "Running Late? Take the NextBus," *Environmental News Network*, September 7, 1999, *enn.com/enn-features-archive/1999/09/090799/nextbus_4692.asp* (accessed June 2003); *nextbus.com* (accessed September 2003); and ITS America, "NextBus Expands Real-Time Transit Information in the Bay Area With AC Transit," August 9, 2001, *itsa.org/ITSNEWS.NSF/0/34c13fd8352c4c3f85256aa400497aad?OpenDocument* (accessed June 2003).

WHAT WE LEARNED FROM THIS CASE

This opening vignette is an example of *location-based e-commerce,* which is an application *mobile commerce,* in which EC services are provided to customers wherever they are located at the time they need them. This capability, which is not available in regular EC, may change many things in our lives. The vignette also exemplifies *pervasive computing,* in which services are seamlessly blended into the environment without the user being aware of the technology behind them. This application is a part of *mobile computing,* a type of computing designed for employees who travel outside the boundaries of their organizations or for travelers of any kind.

Mobile computing and commerce are spreading rapidly, replacing or supplementing wired computing. The wireless infrastructure upon which mobile computing is built may reshape the entire IT field. The technologies, applications, and limitations of mobile computing and mobile commerce are the main focus of this chapter. Late in the chapter, we look briefly at futuristic applications of *pervasive computing*.

6.1 MOBILE COMPUTING AND COMMERCE: OVERVIEW, BENEFITS, AND DRIVERS

The Mobile Computing Landscape

In the traditional computing environment users come to a computer, which is connected to other computers, to networks, and to servers with wires. The need to be linked by wires limits the use of computers and makes it difficult or impossible for people on the move to use them. In particular, salespeople, repair people, service employees, law enforcement agents, and utility workers can be more effective if they can use information technology while at their jobs in the field or in transit. Mobile vacationers also may wish to be connected with home or office. Thus, **mobile computing** was designed for workers who travel outside the boundaries of their organizations or for any people traveling outside their homes. One can work with a mobile device as long as the battery is working.

mobile computing *A computing model designed for workers who travel outside the boundaries of their organizations or for people traveling outside their homes.*

The first solution to the need for mobile computing was to make computers small enough so that they could be easily carried about. First, the laptop computer was invented; later, smaller and smaller computers, such as PDAs (personal digital assistants) and other handhelds, appeared. Carriable computers, from laptops to PDAs and other portables, are called **mobile devices**. They have become lighter with time and more powerful as far as processing speed and storage. At the end of the workday, mobile workers can download (or upload) information from or to a regular desktop computer in a process known as *synchronization*. To speed up the "sync," special connecting cradles (docking stations) were created (see IT's About Business 6.1 later in this chapter).

mobile devices *Portable computers such as PDAs and other handhelds.*

EXAMPLE ***Millstone Coffee Goes Mobile.*** Millstone Coffee equipped its 300 drivers with handheld devices and mobile applications for use while they are on the road selling roasted coffee beans to 13,000 stores in the United States. Using the devices, the drivers can track inventory, generate invoices, and capture detailed sales and marketing data at each store. The drivers synchronize ("sync") their

handhelds with the company's main system at the end of the day, a process that takes only 2 minutes. This strategy has proven to be cheaper for Millstone than going wireless, at least with the 2002 technology when the decision to implement the new system was made.

The second solution to the need for mobile computing was to replace wires with *wireless communication media.* Wireless systems have been in use in radio, TV, and telephones for a long time. So it was natural to adopt them to the computing environment.

wireless mobile computing *The combination of mobile devices used in a wireless environment.*

The third solution was a combination of the first two, namely to use mobile devices in a wireless environment. Referred to as **wireless mobile computing**, this combination enables a real-time connection between a mobile device and other computing environments, such as the Internet or an intranet. This innovation is revolutionizing how people use computers. It is spreading at work and at home. It is also used in education, health care, entertainment, and much more. This new computing model is basically leading to *ubiquity*—meaning that computing is available anywhere, at any time. Note that since many mobile applications now go wireless, the term *mobile computing* today is often used generally to describe wireless mobile computing.

Due to some current technical limitations, we cannot (yet) do with mobile computing all the things that we do with regular computing. On the other hand, we can do things in mobile computing that we cannot do in the regular computing environment. A major boost to mobile computing was provided in 2003 by Intel with its Centrino chip. This chip, which will be a standard feature in most laptops by 2005, includes three important capabilities: (1) a connection device to a wireless local area network, (2) low usage of electricity, enabling users to do more work on a single battery charge, and (3) a high level of security. The Centrino is expected to make mobile computing the common computing environment.

A second driving development of mobile computing is the introduction of the third- and fourth-generation wireless environments known as 3G and 4G. These are described in Online File W6.1.

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Mobile Commerce

mobile commerce (m-commerce, m-business) *Any e-commerce done in a wireless environment, especially via the Internet.*

While the impact of mobile computing on our lives will be very significant, a similar impact is already occurring in the way we conduct business. This impact is described as **mobile commerce** (also known as **m-commerce** and **m-business**), which is basically any e-commerce or e-business done in a wireless environment, especially via the Internet. Like regular EC applications, m-commerce can be done via the Internet, private communication lines, smart cards, or other infrastructures.

M-commerce is not merely a variation on existing Internet services; it is a natural extension of e-business. Mobile devices create an opportunity to deliver new services to existing customers and to attract new ones. (A classification of applications by industry is provided at *mobile.commerce.net.* Also see *mobiforum.org*.)

Mobile Computing Basic Terminology

Let's build a foundation for further discussion by defining some common mobile computing terms:

- ***Global positioning system (GPS):*** a satellite-based tracking system that enables the determination of a GPS device's location. (See Section 6.6 for more on GPS.)

personal digital assistant (PDA) *A handheld wireless computer.*

- ***Personal digital assistant (PDA):*** a small handheld wireless computer, such as the family of Palm handhelds and the Pocket PC devices from companies like HP.

short messaging service (SMS) *Technology that allows for sending of short text messages on some cell phones.*

- ***Short message service (SMS):*** a technology, in existence since 1991 that allows for the sending of short text messages (up to 160 characters in 2004) on certain cell phones. SMS messages can be sent or received concurrently, even during a voice or data call. Used by hundreds of millions of users, SMS is known as the e-mail of m-commerce.

- ***Bluetooth:*** a chip technology wireless standard that enables temporary, short-range connection (data and voice) between mobile devices and/or other devices (see *bluetooth.com*). It uses low-power, digital, two-way radio frequency.
- ***Wireless Application Protocol (WAP):*** a set of communications protocols that enable different kinds of wireless devices to talk to a server installed on a mobile network, so users can access the Internet. WAP offers secured Internet browsing (see Online File W6.2).
- ***Smartphones:*** Internet-enabled cell phones that can support mobile applications. These "phones with a brain" are becoming standard devices. They include WAP microprocessors for Internet access and the capabilities of PDAs as well.
- ***WLAN (wireless local area network):*** basically, a wireless version of the Ethernet networking standard. (For discussion of the Ethernet standard, see Technology Guide 4.)
- ***Wi-Fi (short for Wireless Fidelity):*** refers to the 802.11b standard on which most of the wireless local area networks (WLANs) run.

With these terms in mind, we can now look more deeply at the attributes and drivers of mobile computing.

Bluetooth *Chip technology that enables temporary, short-range connection (data and voice) between wireless devices.*

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Wireless Application Protocol (WAP) *A set of communications protocols designed to enable different kinds of wireless devices to talk to a server installed on a mobile network, so users can access the Internet.*

smartphone *Internet-enabled cell phone that can support mobile applications.*

The Attributes and Drivers of Mobile Computing

Generally speaking, many of the EC applications described in Chapter 5 can be done in m-commerce. However, several *new* applications are possible only in the mobile environment. To understand why this is so, let's examine the major attributes and capabilities of mobile computing and m-commerce.

The Specific Attributes of Mobile Computing and M-Commerce. Mobile computing has two major characteristics that differentiate it from other forms of computing: mobility and broad reach.

Mobility implies portability. Mobile computing is based on the fact that users carry a mobile device with them and can initiate a real-time contact with other systems from wherever they happen to be if they can connect to a wireless network.

Broad reach refers to the fact that in mobile computing people can be reached at any time. Of course, users can block certain hours or certain messages, but when users carry an open mobile device, they can be reached instantly.

These two characteristics, mobility and broad reach, create five value-added attributes that break the barriers of geography and time: ubiquity, convenience, instant connectivity, personalization, and localization of products and services. A mobile terminal can fill the need for real-time information and communication, independent of the user's location (*ubiquity*). With an Internet-enabled mobile device, it is easy and fast to access the Web, intranets, and other mobile devices without booting up a PC or placing a call via a modem (*convenience* and *instant connectivity*). Information can be customized and sent to individual consumers as an SMS (*customization*). And knowing where a user is physically at any particular moment is key to offering relevant products and services (*localization*).

Vendors and telecommunication carriers can *differentiate themselves* in the competitive marketplace by offering new, exciting, and useful services based on these attributes. Such services will help vendors attract and keep customers and increase revenues.

Drivers of Mobile Computing and M-Commerce. In addition to the value-added attributes just discussed, the development of mobile computing and m-commerce is driven by the following factors.

Widespread Availability of Mobile Devices. The number of cell phones throughout the world exceeded 1.3 billion in 2003 (*cellular.co.za/stats/stats-main.htm*). It is estimated that within a few years about 70 percent of cell phones in the developed countries

will have Internet access. Thus, a potential mass market is developing for mobile computing and m-commerce. Cell phones are also spreading quickly in developing countries. In 2002, for example, the number of cell phones in China exceeded 200 million, virtually equally the number of fixed line phones in that country. This growth enables developing countries to leap-frog to m-commerce.

No Need for a PC. Because the Internet can be accessed via smartphone or other Internet-enabled wireless device, there is no need for a PC to access the Internet. Even though the cost of a PC that is used primarily for Internet access, such as the Simputer (a "simple computer"), can be as low as $300 (or even less), that amount is still a major expense for the vast majority of people in the world. Smartphones and other wireless devices make it unnecessary to have a PC to reach the Internet.

The "Cell Phone Culture." The widespread use of cell phones is a social phenomenon, especially among the 15-to-25-year-old age group. The use of SMS has been spreading like wildfire in several European and Asian countries. In the Philippines, for example, SMS is a national phenomenon in the youth market. These members of the "cell phone culture" will constitute a major force of online buyers once they begin to make and spend reasonable amounts of money.

Vendor Marketing. Vendors also are pushing m-commerce. Both manufacturers of mobile devices and mobile communication network operators are advertising the many potential applications of mobile computing and m-commerce so that they can sell new technologies, products, and services to buyers.

Declining Prices and Increasing Functionalities. With the passage of time, the price of wireless devices is declining. The per-minute pricing of mobile services is ex-

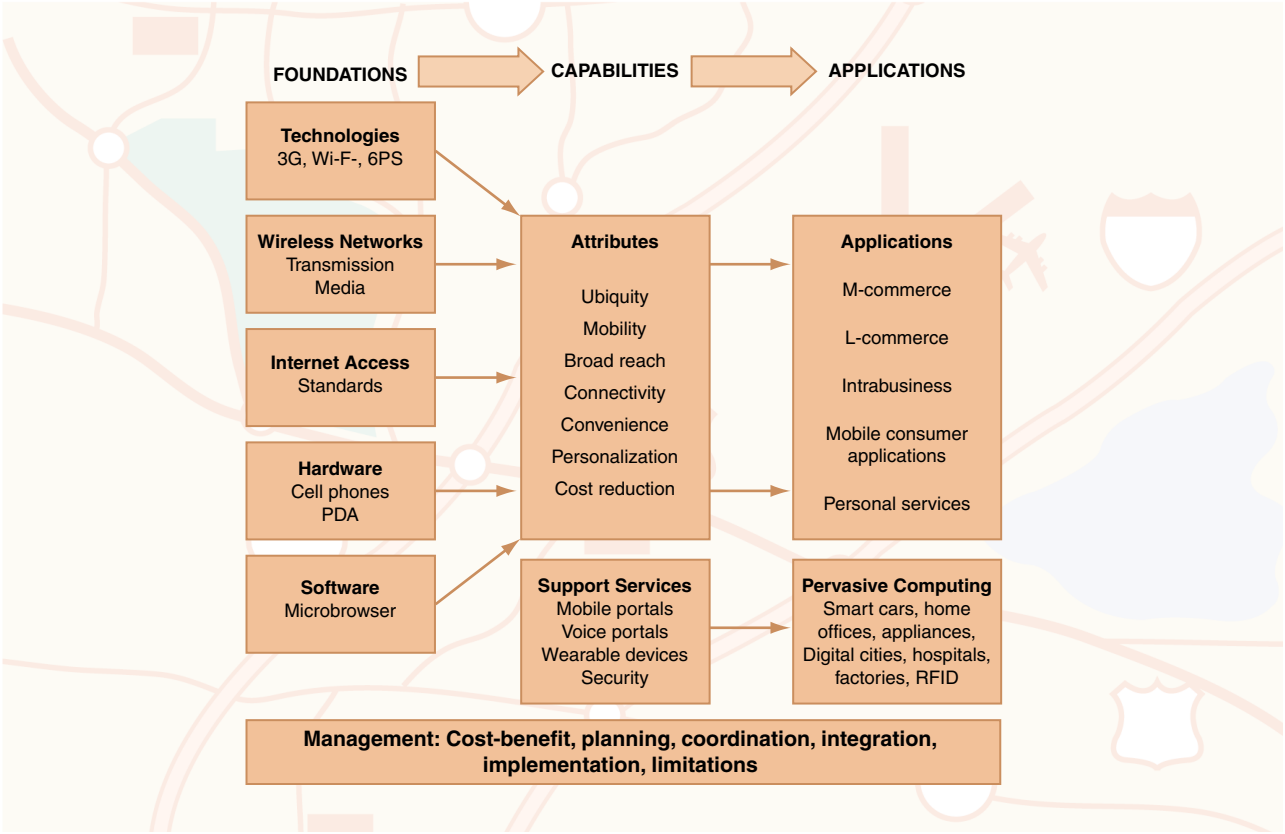


Figure 6.2 *Roadmap: The landscape of mobile computing and commerce.*
[Source: Drawn by E. Turban.]

pected to decline by 50 to 80 percent before 2005. At the same time, functionalities are increasing.

Improvement of Bandwidth. To properly conduct m-commerce, it is necessary to have sufficient bandwidth for transmitting text; bandwidth is also required for voice, video, and multimedia. The 3G (third-generation) technology provides the necessary bandwidth, at a data rate of up to 2 mbps (millions of bits per second). Wi-Fi moves information even faster, at 11 mbps, and new standards will enable even faster speeds.

Mobile computing and m-commerce include many applications. These result from the capabilities of various technologies as shown in Figure 6.2, which also describes the major topics discussed in this chapter.

Before you go on . . .

1. Define mobile computing and m-commerce.
2. Define the following terms: PDA, WAP, SMS, GPS, Wi-Fi, and smartphone.
3. List the value-added attributes of mobile computing.
4. List at least five major drivers of mobile computing.

6.2 WIRELESS LOCAL AREA NETWORKS, WI-FI, AND VOICE PORTALS

WLANs and Wi-Fi

For the past few years, much of the discussion about mobile computing and m-commerce has revolved around WWANs (wireless wide area networks) with cellular technologies, especially the 3G one. Slowly but surely, another technology—wireless local area networks—has been making its way to the forefront, as the market factors impeding its growth are being addressed. As the name implies, a **wireless LAN (WLAN)** is like a wired LAN but without the cables.

wireless LAN (WLAN) *A local area network (LAN) without the cables; used to transmit and receive data over the airwaves.*

In a typical configuration, a transmitter with an antenna, called a **wireless access point**, connects to a wired LAN from a fixed location or to satellite dishes that provide an Internet connection. A wireless access point provides service to a number of users within a small geographical perimeter (up to a couple hundred feet), known as a "hotspot zone" or **hotspot**. (To support larger numbers of users across a larger geographical area, several wireless access points are needed.)

wireless access point *An antenna connecting a mobile device (laptop or PDA) to a wired local area network.*

hotspot *A small geographical perimeter within which a wireless access point provides service to a number of users.*

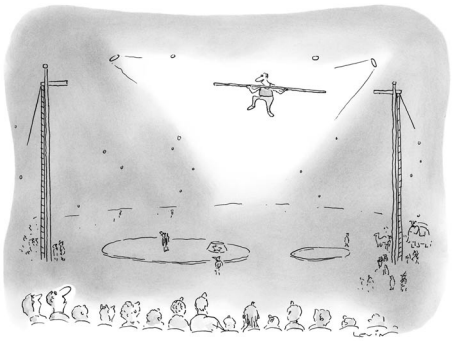
WLANs provide fast and easy Internet or intranet broadband access from public hotspots like airports, hotels, Internet cafes, and conference centers. WLANs are also being used in universities (recall the Dartmouth University case in Chapter 1), offices, and homes, in place of the traditional wired LANs. In this way, users are free to roam with computing capabilities across the campus, office, or throughout their homes (see *weca.net*).

End users can access a WLAN with their laptops, desktops, or PDAs by adding a wireless network card. As of 2004, most PC and laptop manufacturers incorporate these cards directly in their PCs (as an option). For how to connect your PC or laptop quickly and securely with no wires, see Stafford and Brandt (2002) and also the Virtual Music Company running case.

Most of today's WLANs run on a standard known as **802.11b**. This standard is also known as **Wi-Fi (wireless fidelity)**. WLANs employing this standard have communication speeds of 11 mbps. While most wired networks run at 100 mbps, 11 mbps is actually sufficient for many applications. Two other new standards, 802.11a and 802.11g, support data transmissions at 54 mbps. The 802.11g standard is beginning to show up in commercial products because it is compatible with the 802.11b standard. While PCs

802.11b *Technical standard, developed by the IEEE, on which most of today's WLANs run; WLANs employing this standard have communication speeds of 11 mbps.*

(Wi-Fi) wireless fidelity *Another name for the 802.11b standard on which most WLANs run.*



"It appears to be some kind of wireless technology."

can take advantage of 54 mbps, today's (2004) PDAs cannot, because their expansion (network) cards are limited to the 11 mbps speed.

The major benefits of Wi-Fi are its lower cost and its ability to provide simple Internet access. It is the greatest facilitator of the *wireless Internet* (the ability to connect to the Internet wirelessly). The Wi-Fi market got a boost at the end of 2002 when AT&T, Intel, and IBM, along with two global investment firms, joined forces to create Cometa Networks, Inc. (*cometa.com*). Cometa works with major retail chains, hotels, universities, and real estate firms to deploy Wi-Fi hotspots throughout the top 50 U.S. metropolitan areas.

Wireless Personal Area Networks (WPANs). A *wireless personal area network* (WPAN) is a kind of WLAN that people have at their homes or home offices. With such a network, one can connect PCs, PDAs, mobile phones, and digital music players that detect each other and can interact. Also, one can also add a digital payment system and personal security technologies. The network maintains constant connectivity among devices (including wearable devices), which is useful in office settings.

Wi-Fi Applications. Each month brings new examples of business that are adding Wi-Fi services. Several examples are presented below.

EXAMPLES ***Wi-Fi in Airports.*** Like a number of airports in the United States, the Minneapolis–St. Paul International airport is served by Wi-Fi. The Northstar Crossing concession area, the Northwest Airlines' World Club lounge, the United Airlines' Red Carpet Club, and many of the main terminal concourses provide wireless Internet access to anyone with a laptop or handheld device and a Wi-Fi network card. The Internet service that is hosting Wi-Fi at the airport charges a fee of $7.95 for unlimited daily access.

EXAMPLE ***Wi-Fi In-flight.*** Lufthansa offers in-flight Wi-Fi service on its long-haul fleet. The hotspots on the aircrafts are connected to the Internet via satellites. A news channel is free; there is a charge of $25 for Wi-Fi use during the flight.

EXAMPLE ***Wi-Fi in Eateries.*** In 2002, T-Mobile installed Wi-Fi networks in approximately 2,000 Starbucks stores in the United States. Starbucks has plans to add Wi-Fi to 70 percent of its 6,000 locations worldwide over the next few years. Panera Bread Company has added hotspots in many of its restaurants in St. Louis, Missouri, where Panera is headquartered. McDonald's piloted a program in April 2003 in which it offered Wi-Fi wireless access in 10 restaurants in New York City (*mcdwireless.com*). If you buy a "value meal" you get one hour of free access. Alternatively, you can pay $3 an hour. McDonald's will eventually offer the program in thousands of its restaurants. (If you have an Internet access via AOL or other ISPs, you will get the services free, even without buying the value meal.)

EXAMPLE ***Wi-Fi at an Amusement Park.*** Using wireless ticketing system, Universal Studios in Hollywood is shortening the waiting lines for tickets at its front gate. The ticket sellers, armed with Wi-Fi–enabled devices and belt-mounted printers, not only sell tickets but also provide information.

EXAMPLE ***Wi-Fi in Stores.*** CVS Corp., the largest retail pharmacy in the United States, uses Wi-Fi–based devices throughout its 4,100 stores. The handheld computers support a variety of in-store applications, including direct store

delivery, price management, inventory control, and receiving. Benefits include faster transfer rates, increasing productivity and performance, reduced cost, and improved customer service.

Two factors are standing in the way of even greater commercial Wi-Fi market growth: cost and security. We look at those factors next.

Cost as a Barrier to Commercial Wi-Fi Growth. First, some people question why anyone would pay $30 a month, $7.95 a day, or any other fee for Wi-Fi access when it is readily available in many locations for free. Because it's relatively inexpensive to set up a wireless access point that is connected to the Internet, a number of businesses offer their customers Wi-Fi access without charging them for the service (e.g., Starbucks, Panera Bread, and Border's Books and Music Stores). In fact, there is an organization, Freenetworks.org, aimed at supporting the creation of free community wireless network projects around the globe.

In areas like San Francisco, where there is a solid core of high-tech professionals, many "gear heads" have set up their own wireless hotspots that give passersby free Internet connections. This is a part of a new culture known as *war chalking* and *war driving*.

War Chalking and War Driving. Free Wi-Fi Internet hubs are marked in some places by symbols on sidewalks and walls to indicate nearby wireless access. This practice is called *war chalking*. It was inspired by the practice of hobos during the Great Depression who used chalkmarks to indicate which homes were friendly to those seeking handouts.

A number of people have also made a hobby or sport out of war driving. *War driving* is the act of locating wireless local area networks while driving around a city or elsewhere (see *wardriving.com*). To war drive, you need a vehicle, a computer or PDA, a wireless card, and some kind of an antenna that can be mounted on top of or positioned inside the car. Because a WLAN may have a range that extends beyond the building in which it is located, an outside user may be able to intrude into the network, obtain a free Internet connection, and possibly gain access to important data and other resources. The term war driving was coined by computer security consultant Peter Shipley. It derives from the term the *war dialing*, a technique in which a hacker programs his or her system to call hundreds of phone numbers in search of poorly protected computer dialups.

Cost as a Barrier to Commercial Wi-Fi Growth. People who engage in war driving highlight the lax security of Wi-Fi hotspots. Security is the second barrier to widespread acceptance of Wi-Fi. Because it uses radio waves, Wi-Fi can be interrupted by walls (resulting in poor quality at times), and it is difficult to protect. Wi-Fi does have a built-in security system, known as *Wireless Encryption Protocol (*WEP*)*, which encrypts the communications between a client machine (laptop or PDA) and a wireless access point. However, WEP provides weak encryption, meaning that it is secured against casual hacking as long as the person setting up the network remembers to turn on the encryption. Unfortunately, many small business owners and homeowners with wireless LANs fail to do just that. For more on mobile security and WEP, see Online File W6.2.

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Voice Systems and Portals in Mobile Computing and M-Commerce

The most natural mode of human communication is voice. Voice communication can now be done on the computer using a microphone and a sound card. Voice systems are improving and voice technology applications are growing.

Voice technologies have various advantages, which make them especially useful in mobile computing: The most obvious one is portability; the hands- and eyes-free operations of voice technologies increase the productivity, safety, and effectiveness of mobile

computer users, ranging from forklift drivers to military pilots. For users in dirty or moving environments, voice terminals operate better than keyboards because they are more rugged. Voice technologies also enable disabled people to tell a computer to perform various tasks. Another advantage is speed: People can communicate about two-and-a-half times faster talking than typing. In most circumstances, speaking also results in fewer data entry errors than does keyboard data entry.

voice portal *A Web site with audio interface, accessed by making a phone call.*

Voice Portals. A **voice portal** is a Web site with an audio interface. Voice portals are not really Web sites in the normal sense because they are also accessed through a standard or a cell telephone. A certain phone number connects you to a participating Web site where you can request information verbally. The system finds the information, translates it into a computer-generated voice reply, and tells you what you want to know. (See the demo at *3imobile.com.*)

An example of this application for mobile computing is the voice-activated 511 travel-information line developed by Tellme.com. It enables callers to request information about weather, local restaurants, current traffic, and other handy information. In addition to retrieving information, some sites provide true interaction. *iPing.com* is a reminder and notification service that allows users to enter information via the Web and receive reminder calls. This service can even call a group of people to notify them of a meeting or conference call.

The real value for mobile computing is that voice portals can help marketers find new customers. When voice portal services are combined with information about users' locations, they make possible location-based m-commerce, a topic we address later in the chapter.

With the development of technical standards and the continuing growth of wireless technologies, the number of m-commerce applications is growing rapidly. Applications are derived from providing wireless access to existing B2C, intrabusiness, and CRM applications and from creating new location-based and SMS-based applications. In Sections 6.3 through 6.6 of this chapter, we will study m-commerce applications in a number of diverse categories.

Before you go on . . .

1. Define WLANs.
2. Describe Wi-Fi and cite its applications and advantages.
3. What are war chalking and war driving?
4. Describe wireless voice systems and voice portals.

6.3 MOBILE PERSONAL SERVICE APPLICATIONS

A large number of applications exist that provide personal services to consumers. As an example, consider the situation of a person going to an international airport. Tasks such as finding the right check-in desk, checking for delayed flights, waiting for lost luggage, and even finding a place to eat or the nearest restroom can be assisted by mobile devices. Online File W6.3 at the book's Web site lists 12 problem areas in an airport that can be solved using mobile devices. Other personal service areas in which wireless devices can be used are described in the following sections. (See also *attws.com.*)

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Hotel Services Go Wireless

A number of hotels now offer their guests in-room, high-speed, wireline Internet connection. Some of these same hotels are beginning to offer Wi-Fi Internet access in public areas and meeting rooms. One of these is Marriott, which manages 2,500 hotels

worldwide. After a seven-month test, Marriott has partnered with STSN (*stsn.com*), an Internet service provider specializing in hotels, to provide Wi-Fi services in the 400 Marriott hotels that already have in-room broadband Internet access. Other hotels in the United States, India (Taj Group hotels), and England (Holiday Inn and Crowne Plaza hotels) are beginning to offer similar services.

While Wi-Fi provides guests with Internet access, to date it has had minimal impact on other sorts of hotel services (e.g., check-in). However, a few hotels are testing use of the Bluetooth technology. Guests are provided with Bluetooth-enabled phones that can communicate with access points located throughout the hotel. This technology can be used for check-in and checkout, for making purchases from hotel vending machines and stores, for tracking loyalty points (see *tesalocks.com*), and for opening room doors in place of keys. In 2001, Classwave signed a deal with Starwood Hotels & Resorts worldwide to enable Bluetooth solutions within Starwood's hotels.

Wireless Telemedicine

Today there are two different kinds of technology used for *telemedicine* applications: (1) storage of data and transferring of digital images from one location to another, and (2) videoconferencing for real-time consultation between a patient in one location and a medical specialist in another. In most of the real-time consultations, the patient is in a rural area and the specialist is in an urban location.

There are a number of impediments to telemedicine. Some states do not allow physicians to provide medical advice across state lines. The threat of malpractice suits is another issue since there is no "hands-on" interaction between the physician and patient. Also, from a technical standpoint, many telemedicine projects are hindered by poor telecommunications support. However, those who are looking ahead are seeing opportunities to meet some of the needs of the aging population by use of emerging technologies. The new mobile technologies, especially the forthcoming generation, not only offer the possibility of overcoming the hurdles imposed by remote locations but also open a number of novel application opportunities.

EXAMPLES ***Meds by Wireless.*** Typically, physicians write a prescription and you take it to the pharmacy where you wait 15 to 30 minutes for it to be filled. Instead, some new mobile systems allow physicians to enter the patient prescription onto a palm-size device. That information goes by cellular modem (or Wi-Fi) to Med-i-net's (or similar companies') services. There, the information is checked for insurance eligibility and conformity to insurance company regulations. If all checks out, the prescription is transferred electronically to the appropriate pharmacy. For patients who need refills, the system notifies physicians when it is time for the patient to reorder, and the doctor can reissue a prescription with a few clicks.

EXAMPLE ***In-flight Emergencies Aided by Wireless.*** In-flight medical emergencies occur more frequently than one might think. Alaska Airlines, for example, deals with about 10 medical emergencies per day. Mobile communications are already being used to attend to medical emergencies occurring on planes. MedLink, a service of MedAire in Phoenix, provides around-the-clock access to board-certified emergency physicians. These mobile services can also remotely control medical equipment, like defibrillators, located on board the plane.

EXAMPLE ***Remote Surgery.*** The military is involved in developing mobile telesurgery applications that enable surgeons in one location to remotely control robotic arms for surgery in another location. The technology was proven to be particularly useful in battlefield situations during the 2003 Iraq War.

Mobile Portals

mobile portal *A customer interaction channel that aggregates content and services for mobile users.*

A **mobile portal** is a customer channel, optimized for mobility, that aggregates and provides content and services for mobile users. The services provided by mobile portals include news, sports, e-mail, entertainment, and travel information; restaurant and event information; leisure-related services (e.g., games, TV and movie listings); community services; and stock trading. A sizeable percentage of the portals also provide downloads and messaging, music-related services, and health, dating, and job information. Mobile portals frequently charge for their services. For example, you may be asked to pay 50 cents to get a weather report over your mobile phone. Alternatively, you may pay a monthly fee for the portal service and get the report free any time you want it.

Increasingly, the field of mobile portals is being dominated by a few big companies. The world's best-known mobile portal, with over 40 million members, mostly in Japan, is i-mode from DoCoMo. The big players in Europe, for instance, are Vodafone, Orange, O2, and T-Mobile. In the United States the big players are Cingular, Nextel, AT&T wireless, Verizon, and Sprint PCS. Also, mobile-device manufactures offer their own portals (e.g., Club Nokia portal, my Palm portal). And, finally, the traditional portals (such as Yahoo, AOL, and MSN) have mobile portals as well. Examples of the best "pure" mobile portals (those whose only business is to be a mobile portal) are Room 33 (*room33.com*) in Europe and *zed.com* from Sonera in Finland; compared to the large companies that provide various services, these companies are relatively small.

Other Personal Services Mobile-Computing Applications

Many other personal services mobile computer applications exist for consumers, in a variety of categories. One category of other consumer-related mobile applications is on-

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6.1: The Highway 91 Project

Route 91 is a major eight-lane, east–west highway near Los Angeles. Traffic is especially heavy during rush hours. California Private Transportation Company (CPT) built six express toll lanes along a 10-mile stretch in the median of the existing Highway 91. The express lane system has only one entrance and one exit, and it is totally operated with EC technologies. The system works as follows.

Prepaid subscribers receive an automatic vehicle identification (AVI) device that is placed on the rearview mirror of the car. The device, about the size of a thick credit card, includes a microchip, an antenna, and a battery. A large sign over the tollway tells drivers the current fee for cruising the express lanes. In a recent year it varied from $0.50 in slow traffic hours to $3.25 during rush hours.

Sensors in the pavement let the tollway computer know that a car has entered; the car does not need to slow or stop. The AVI makes radio contact with a transceiver installed above the lane. The transceiver relays the car's identity through fiber-optic lines to the control center, where a computer calculates the fee for that day's trip. The system accesses the driver's account and the fare is automatically deducted from the driver's prepaid account. A monthly statement is sent to the subscriber's home.

Surveillance cameras record the license numbers of cars without AVIs. These cars can be stopped by police at the exit or fined by mail. Video cameras along the tollway also enable managers to keep tabs on traffic, for example, sending a tow truck to help a stranded car. Also, through knowledge of the traffic volume, pricing decisions can be made. Raising the price as traffic increases ensures that the tollway will not be jammed.

The system saves commuters between 40 and 90 minutes each day, so it is in high demand. An interesting extension of the system is the use of the same AVIs for other purposes. For example, they can be used in paid parking lots. Someday you may even be recognized when you enter the drive-through lane of McDonald's and a voice asks you, "Mr. Smart, do you want your usual meal today?"

Source: Compiled from *91expresslanes.com* (2002).

QUESTIONS

1. List the benefits of the Highway 91 project to the company that runs it and to its customers.
2. What other applications of such a device can you envision for cars?

line entertainment, as discussed in Online File W6.4. Other examples include online language translations; information about tourist attractions (hours, prices); and emergency services. For other services for consumers, see the case studies at *mobileinfo.com*.

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In addition, non-Internet mobile applications, mainly those using smart cards, have existed since the early 1990s. Active use of the cards is reported in transportation, where millions of "contactless" cards (also called *proximity cards*) are used to pay bus and subway fares and road tolls. Amplified remote-sensing cards that have an RF (radio frequency) of up to 30 meters are used in several countries for toll collection. IT's About Business 6.1 describes the use of proximity cards in a California highway system.

Before you go on . . .

1. Discuss some of the potential applications of Wi-Fi and Bluetooth technologies in hotels.
2. Describe some potential uses of mobile and wireless technologies in providing medical care.
3. Describe mobile portals and the kind of information they provide for consumers.

6.4 MOBILE APPLICATIONS IN FINANCIAL SERVICES

Other popular mobile applications are in financial services. Mobile financial applications include banking, wireless payments and micropayments, wireless wallets, bill-payment services, brokerage services, and money transfers. In this section we will look at some of the most widely used mobile applications in financial services.

Mobile Banking

Throughout many countries in the world, an increasing percentage of banks offer mobile access to financial and account information. Banks in Sweden, the United States, Japan, Scotland, and Mexico offer some form of wireless banking services. A study of banks in Germany, Switzerland, and Austria found that over 60 percent offered some form of mobile financial services (Hornberger and Kehlenbeck, 2002).

Wireless Electronic Payment Systems

Wireless payment systems transform mobile phones into secure, self-contained purchasing tools capable of instantly authorizing payments over the cellular network. In Italy, for example, DPS-Promatic (*dpspro.com*) has designed and installed the first parking meter payable by mobile telephone. In the United States, Cellbucks (*cellbucks.com*) offers a mobile payment service to participating sports stadiums. Any fan who is a member of the Cellbucks Network can dial a toll-free number provided on a menu of choices, enter his or her password and seat location, and then select numbered items from the electronic menu of food, beverages, and merchandise. Once authorized, the purchase is passed on to stadium personnel and is in turn delivered to the fan's seat. An e-mail detailing the transaction is sent to the fan as further confirmation of the order. In Europe and Japan, wireless buying of tickets to movies and other events is popular (Sadeh, 2002).

Micropayments

If you were in Frankfurt, Germany, and took a taxi ride, you could pay the taxi driver using your cell phone. As discussed in Chapter 5, electronic payments for small-purchase amounts (generally less than $10) are called *micropayments*. The demand for wireless micropayments systems is fairly high. An A.T. Kearney study (*cyberatlas.com*)

found that more than 40 percent of mobile phone users surveyed would like to use their mobile phone for small cash transactions such as transit fares or vending machines.

EXAMPLE ***Dialing Up Coca-Cola.*** Coca-Cola faces fierce competition around the world. By using a radical new strategic information system (SIS) that marries "smart" Coke machines with cellular telephone technology, Coca-Cola has a strong competitive advantage in Singapore. As a result of a joint venture between Singapore Telecommunications, Ltd. and F&N Coca Cola Pte. Ltd. of Singapore, subscribers to the SingTel cellular network can buy drinks from vending machines by using their mobile phones. They punch in an ID number and press the call button or send a short mail message. The machine receives the call or mail, identifies the user, and enables the user to then make the desired selection from the machine. The charge is transferred to the user's telephone bill. The telephone company does not collect a commission from Coke, but does make money on the phone call or electronic message sent. Many of the machines in Singapore also accept electronic money cards.

Micropayment technology has wide-ranging applications, such as making payments to parking garages, restaurants, grocery stores, and public transportation. The success of micropayment applications, however, ultimately depends on the costs of the transactions. Transaction costs will be small only if there is a large volume of transactions. Growth in the volume of transactions can be facilitated by wireless e-wallets.

Mobile (Wireless) Wallets

(mobile wallet) m-wallet *A wireless wallet that enables cardholders to make purchases with a single click from their wireless device.*

As discussed in Chapter 5, an *e-wallet* is a piece of software that stores an online shopper's credit card numbers and other personal information so that the shopper does not have to reenter that information for every online purchase. Various companies offer **mobile wallet** (*m-wallet*, also known as *wireless wallet*) technologies that enable

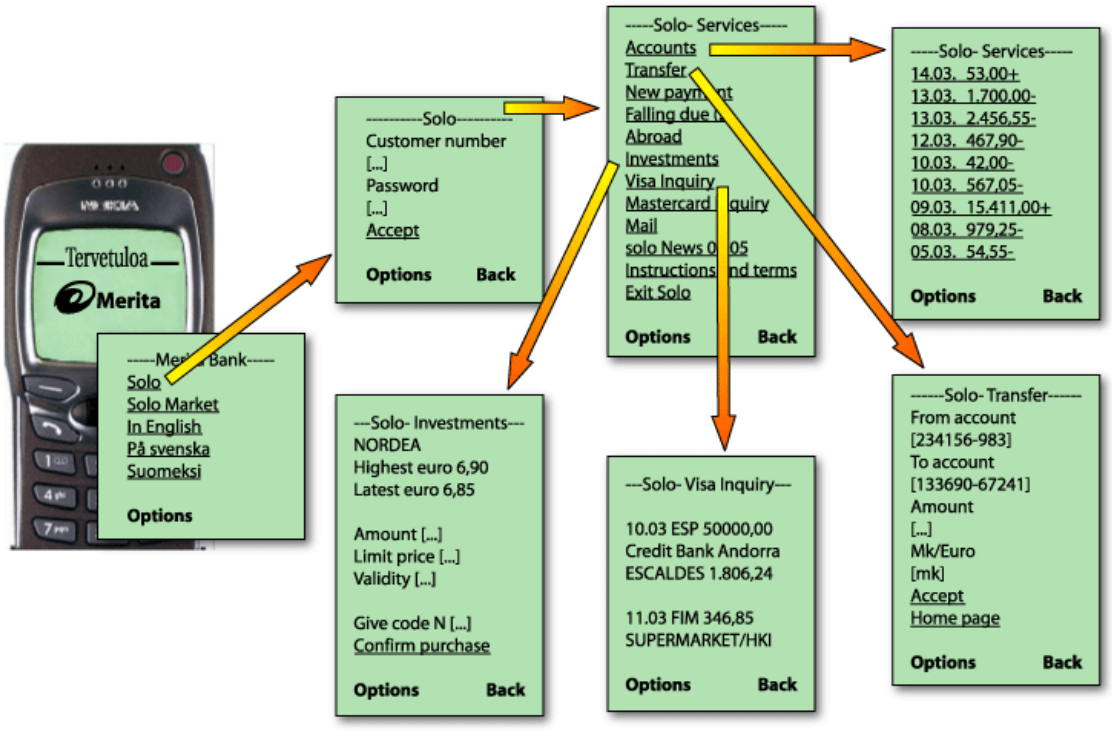

Figure 6.3 *Nordea's WAP Solo Banking Portal.*
[Source: N. Sadeh, M-Commerce *(New York: Wiley, 2002, Fig. 1.4).]*

cardholders to make purchases with a single click from their mobile devices. One example is the Nokia wallet. This application securely stores information (such as credit card numbers) in the customer's Nokia phone for use in making mobile payments. The information also can be used to authenticate transactions by signing them digitally. Microsoft also offers an e-wallet, Passport, for use in a wireless environment.

Wireless Bill Payments

In addition to paying bills through wireline banking or from ATMs, a number of companies are now providing their customers with the option of paying their bills directly from a cell phone. HDFC Bank of India (*hdfcbank.com*), for example, allows customers to pay their utility bills through SMS. An example of how bill payments can be made using a mobile device is shown in Figure 6.3. This service is offered by Nordea, a pioneering provider of wireless banking services in Scandinavia.

Before you go on . . .

1. Describe wireless banking.
2. How can micropayments be made from a mobile device?
3. Describe m-wallets and wireless bill payments.

6.5 MOBILE SHOPPING, ADVERTISING, AND CUSTOMER SERVICE

As in e-commerce, m-commerce B2C applications are concentrated in three major areas—retail shopping, advertising, and providing customer service.

Shopping from Wireless Devices

An increasing number of online vendors allow customers to shop from wireless devices. For example, customers who use Internet-ready cell phones can shop at certain sites such as *mobile.yahoo.com* or *amazon.com*. Shopping from wireless devices enables customers to perform quick searches, compare prices, order, and view the status of their order using their cell phones or wireless PDAs. Wireless shoppers are supported by services similar to those available for wireline shoppers.

EXAMPLES ***Restaurant Ordering from Wireless Devices.*** A joint venture between Motorola and Food.com provides an infrastructure for restaurant shopping from wireless devices. Restaurants can use the infrastructure to enable consumers to place an order for pickup or delivery virtually any time, anywhere. Donatos Pizzeria was the first chain to implement the system in 2002.

EXAMPLE ***Wireless Auction Shopping.*** Cell phone users can also participate in online auctions. For example, eBay offers "anywhere wireless" services. Account holders at eBay can access their accounts, browse, search, bid, and rebid on items from any Internet-enabled phone or PDA. The same is true for participants in Amazon.com Auctions.

An example of purchasing movie tickets by wireless device is illustrated in Figure 6.4. Notice that the reservation is made directly with the merchant. Then money is transferred from the customer's account to the merchant's account.

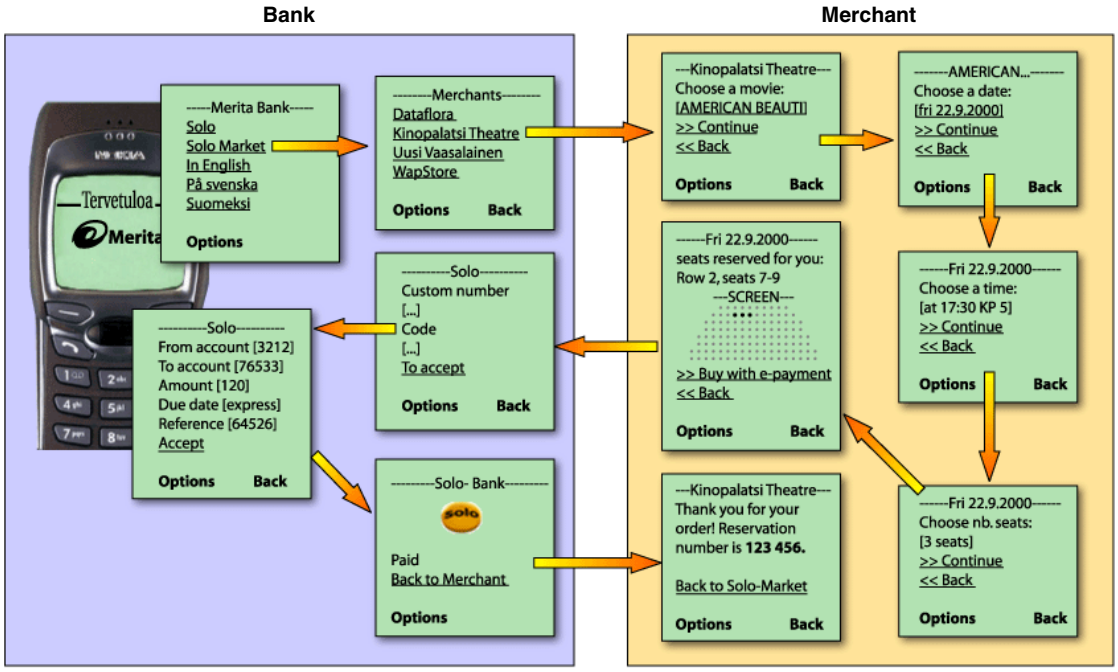

Figure 6.4 *Purchasing Movie Tickets with WAP Solo.*
[Source: N. Sadeh, M-Commerce *(New York: Wiley, 2002, Fig. 1.5).]*

Location-Based Advertising

Imagine that you are walking near a Starbucks store, but you do not even know that one is there. Suddenly your cell phone beeps with a message: "Come inside and get a 15 percent discount." Your wireless device was detected, and similar to the pop-up ads on your PC, advertising was directed your way.

Knowing the current location of mobile users and their preferences or surfing habits, marketers can send user-specific advertising messages to wireless devices about shops, malls, and restaurants close to where a potential buyer is. SMS messages and short paging messages can be used to deliver this type of advertising to cell phones and pagers, respectively. Many companies are capitalizing on targeted wireless advertising, as the examples in Online File W6.5 demonstrate.

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Just as in the wireline world, some people are willing to be exposed to mobile advertising—a practice called *permission marketing*. Advertisers sometimes offer incentives to receive mobile advertising. For example, many people in Singapore are willing to listen to a 10-second ad when they dial their cell phone in exchange for 2 minutes of free long-distance time. You also could use permission marketing to shield yourself from location-based advertising. Using the Starbucks example above, for instance, if the permission marketing system knows that you do not drink coffee, you would not be sent a message from Starbucks.

One method of location-based advertising, already in use in a few places, involves putting ads on the top of taxicabs. The ad changes based on the taxi's location. For example, a taxi cruising in the theater district in New York City might show an ad for a play or a restaurant in that area; when the cab goes to another neighborhood, the ad might be for a restaurant or a business in that other area of the city.

Another (future) use of wireless devices for advertising is dynamic billboards. As described by Raskin (2003), ads can be personalized by a system that knows the likes and preferences of passersby. Here's how dynamic billboards, which are still experimental, are expected to work: Your car would be tracked by a GPS, every 20 seconds. A computer would scan the areas in which billboards are visible, and by cross-referencing information about your location and your likes, a personalized ad could be placed on the billboard so you would see it as you pass. For more on location-based commerce, see Section 6.8.

Mobile Support of Consumers

Many companies are using wireless systems to improve customer service for individual consumers. One example is British Airways, which uses wireless customer support to provide a competitive advantage, as described in Online File W6.6. Another example of a company providing wireless customer service is Expedia, which is using the new technology of Web services as described in IT's About Business 6.2.

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Before you go on . . .

1. Describe how mobile devices can be used to shop.
2. Explain targeted advertising in the wireless environment.
3. How can a wireless system facilitate B2C customer service?

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6.2: How Expedia Is Using Web Services to Provide Customer Service

Expedia.com is a leading online travel service in the United States, with localized versions in the United Kingdom, Canada, and Germany. Expedia operates in a very competitive marketplace with competition from similar services such as Travelocity and Orbitz, ticket discounters such as Priceline and Lastminute.com, traditional travel agencies such as Rosenbluth, and, increasingly, the airlines and hotels themselves. Expedia harnesses the power of Web services to distinguish itself in this market. As described in Chapter 2, Web services are universal, prefabricated business process software modules, delivered over the Internet, that users can select and combine through almost any device, enabling disparate systems to share data and services.

Expedia's competitive strategy is driven by nearly every traveler's need to receive up-to-the-second, diverse information at any time and any place. Expedia actively supplies travelers with dynamic and real-time personalized information, such as flight status. This information is *pushed* to travelers (sent to them from Expedia) as well as *pulled* from the company's portal (accessed by the travelers through specific inquiries). Travelers use desktop computers, cell phones, and other Web-enabled devices to receive or access this information. This multichannel provision of timely travel information is the key for attracting new customers and for keeping existing customers.

To make this happen, Expedia needs to connect to many service providers (airlines, hotels, car renting companies), as well as airports, news services, map services, and more. By using Web services the company solves the integration problem as well as creates device-independent information delivery. This way Expedia can write information only once and then deliver it via whichever method the customer wants—eliminating the need to rewrite the information for each delivery method. Expedia can also tie information into the users' existing "buddy lists" and calendars.

The architecture of the system is flexible enough to work with non-Internet devices. For example, many people with PDAs do not have wireless capabilities. So they can receive information from Expedia by synchronizing the information from a PC to their PDAs and vice versa. By using a system development vendor (Microsoft), Expedia did not have to build services such as authentication, message notification, and calendaring. This enabled the company to be a first-mover in getting these services to market. Using this XML-based service, Expedia adds value to their customers, which provides Expedia with a competitive edge in the travel market.

Sources: Compiled from *expedia.com* and from Microsoft's publicity brochure (2001).

QUESTIONS

1. Identify the customer services provided online.
2. What are the gains to the company?
3. Identify non-Internet mobile computing in this case.

6.6 MOBILE INTRABUSINESS APPLICATIONS

Although B2C m-commerce gets considerable publicity, most of today's applications actually are used *within* organizations. Preliminary research indicates that employees connected to Wi-Fi increase their productivity by up to 22 percent due to better and faster connectivity (Estrada, 2002). In this section we will look at some intrabusiness applications of mobile technologies—at how companies use mobile computing to support their own employees.

Support of Mobile Workers

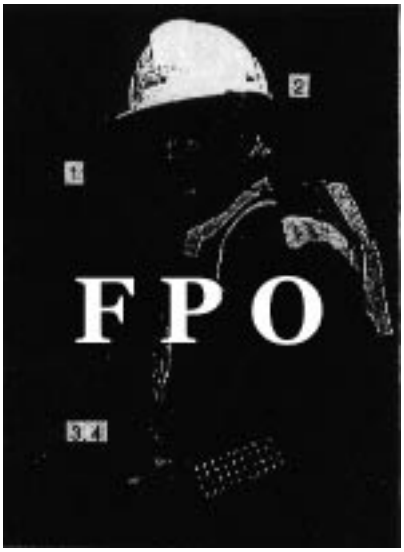
Mobile workers are those working outside the corporate premises. Examples of mobile workers are salespeople in the field, traveling executives, telecommuters, people working in warehouses, and repair or installation employees who work at customers' sites or on utility lines. These mobile workers need the same corporate data available to employees working inside the company's offices. Using wireline devices, even portable ones, may be inconvenient or impossible for mobile workers.

The solution is myriad smaller, simple wireless devices—such as the smartphones and handheld companions carried by mobile workers and the in-vehicle information systems installed in cars. Many of these wireless devices are wearable.

Wearable Devices. Employees who work on buildings, electrical poles, or other difficult-to-climb places may be equipped with a special form of mobile wireless computing devices called **wearable devices**. The following are examples of wearable devices.

wearable devices *Mobile wireless computing devices for employees who work on buildings and other difficult-to-climb places.*

- ***Screen.*** A computer screen is mounted on a safety hat, in front of the wearer's eyes, displaying information to the worker.
- ***Camera.*** A camera is mounted on a safety hat. Workers can take digital photos and videos and transmit them instantly to a portable computer nearby. Photo transmission to a wearable device or computer is made possible via Bluetooth technology.
- ***Touch-panel display.*** In addition to the wrist-mounted keyboard, mobile employees can use a flat-panel screen, attached to the hand, which responds to the tap of a finger or stylus.
- ***Keyboard.*** A wrist-mounted keyboard enables typing by the other hand. (Wearable keyboards are an alternative to voice recognition systems, which are also wireless.)
- ***Speech translator.*** For those mobile employees who do not have their hands free to use a keyboard, a wearable speech translator is handy.



Wearable computers. Item 1: *Computer screen mounted in safety helmet.* Item 2: *Camera mounted in safety helmet.* Item 3: *Touch-panel display, attached to hand.* Item 4: *Wrist-mounted keyboard.*

For an example of wearable devices supporting mobile employees, see IT's About Business 6.3 and *wearable.com.au*.

Like e-mail, short messaging services (SMS) on wireless devices can be used to bolster collaboration. Because of its reach, though, SMS has special applications. According to Kontzer (2003), the following are 10 applications of SMS for mobile workers: (1) alerting mobile technicians to system errors, (2) alerting mobile execs to urgent voice messages, (3) confirming with mobile sales personnel that a faxed order was received, (4) informing traveling employees of delays and changes, (5) enabling contract workers to receive and accept project offers, (6) keeping stock traders up to date on urgent stock activity, (7) reminding data services subscribers about daily updates, (8) alerting doctors to urgent patient situations, (9) enabling mobile sales teams to input daily sales figures into corporate database, and (10) sending mobile sales reps reminders of appointments and other schedule details.

Job Dispatch

Mobile devices are becoming an increasingly integral part of workflow applications. For example, nonvoice mobile services can be used to assist in dispatch functions—to assign jobs to mobile employees, along with detailed information about the task. Tar-

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6.3: Wearable Devices for Bell Canada Workers

For years, mobile employees, especially those who had to climb trees, electric poles, or tall buildings, were unable to enjoy or benefit from new computing technologies. With mobile technologies, that has changed.

On a cold, damp November day in Toronto, Chris Holm-Laursen, a field technician with Bell Canada (*bell.ca*), is out and about as usual, but this time with a difference: A small but powerful computer sits in a pocket of his orange mesh vest, a keyboard is attached to the vest's upper-left side, and a flat-panel display screen hangs by his waist. A video camera attached to his safety hat enables him to take pictures without using his hands and send them immediately to the office. A cell phone is attached as well, connected to the computer. A battery pack to keep everything going sits against his back. (See nearby photo.)

Holm-Laursen and 18 other technicians on this pilot project were equipped like this for 10 weeks during fall 2000. By summer 2003, an increasing number of Bell Canada's employees had been equipped with similar devices. The wearable devices enabled the workers to access work orders and repair manuals wherever they were. The hands-free aspect and the ability to communicate anytime, from anywhere, represent major steps forward for these utility workers. A wide variety of employees in various industries—technicians, medical practitioners, aircraft mechanics, and contractors—are using or testing such devices.

Of course, a practical problem of wearable devices in many countries is the weather: What happens when the temperature is minus 50 degrees or the humidity is 99 percent? Other potential problems also exist: If you are wearing thick gloves, how can you use a keyboard? If it is pouring rain, will the battery short circuit? Various solutions are being developed, such as voice input, tapping on a screen instead of typing, and rainproof electrical systems.

Sources: Compiled from Xybernaut.com, "Xybernaut Mobile Assistant: Productivity Gains in the Telecommunication Field," *xybernaut.com/case_studies/PDFs/Telecommunication_CS.pdf* (accessed January 2004).

QUESTIONS

1. What are some other industrial applications of similar wearable devices?
2. How do you think wearable devices could be used in entertainment?

get areas for mobile delivery and dispatch services include the following: transportation (delivery of food, oil, newspapers, cargo, courier services, tow trucks, and taxis); utilities (gas, electricity, phone, water); field service (computer, office equipment, home repair); health care (visiting nurses, doctors, social services); and security (patrols, alarm installation). Wireless dispatching applications allow improved response with reduced resources, real-time tracking of work orders, increased dispatcher efficiency, and a reduction in administrative work.

EXAMPLE ***AirIQ Shows Its "Smarts" Through Wireless Dispatching.*** AirIQ (*edispatch.com*) offers an interesting dispatching solution. The company's OnLine system combines Internet, wireless, GPS, digital mapping, and intelligent information technologies. The system tracks vital information about a vehicle's direction, speed, and location; those data are provided by a device housed in each of the vehicles being tracked. Managers can view and access information about the fleet on digital maps, monitor on the Internet the location of its vehicles, and maintain top operating condition of their fleet. AirIQ promises savings of about 30 percent in communication costs and increases in workforce efficiency of about 25 percent.

Online File W6.7 provides a detailed description of a job-dispatching system used by U.S. Fleet to benefit both itself and its customers.

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Other Wireless Intrabusiness Applications. A large number of Internet-based wireless applications have been implemented inside enterprises. Three examples of such intrabusiness applications are described below.

EXAMPLES ***Paying Employees by Cell Phone.*** Employees at Telecom Italia Mobile get their monthly pay slips as SMS messages sent to their mobile phone. The money itself is transferred electronically to a designated bank account. The method is much cheaper for the company and results in less paperwork than the old method of mailing monthly pay slips (Republica IT, 2001).

EXAMPLE ***Photos Sent From the Field.*** Kemper Insurance Company has piloted an application that lets property adjusters report from the scene of an accident. Kemper attached a wireless digital imaging system to a camera that lets property adjusters take pictures in the field and transmit them to a processing center (Henning, 2002; Nelson, 2000). The cameras are linked to Motorola's StarTac data-enabled cellular phone service, which sends the information to a database. These applications eliminate delays in obtaining information and in film processing that exist with conventional methods.

EXAMPLE ***Quality Checkers Report Wirelessly.*** Like many national franchises, Taco Bell employs mystery shoppers who visit restaurants to conduct a survey unknown to the owners. Taco Bell has provided these shoppers with handheld computers so that they can communicate results more quickly to the company's headquarters. The visitors must answer 35 questions, ranging from the speed of service to food quality. Before the devices, mystery shoppers filled out paper forms that were mailed overnight; the information was then scanned into computers for processing. The information flow using the handhelds is both faster and more accurate.

As these examples indicate, a variety of intrabusiness workflow applications are possible. Manager's Checklist 6.1 shows typical intrabusiness workflow applications before and after the introduction of wireless services. Some of these can be delivered on a wireless intranet; some are offered on the Internet. (For details on intrabusiness applications, see *mdsi-advantex.com* and *symbol.com*. The advantages offered by in-

MANAGER'S CHECKLIST 6.1

Intrabusiness Workflow Applications

Before Wireless	With Wireless
Work orders are manually assigned by multiple supervisors and dispatchers.	Work orders are automatically assigned and routed within minutes for maximum efficiency.
Field service technicians commute to dispatch center to pick up paper work orders.	Home-based field service technicians receive first work order via mobile terminal and proceed directly to first assignment.
Manual record keeping of time, work completed, and billing information.	Automated productivity tracking, record keeping, and billing updates.
Field service technicians call for new assignments and often wait because of radio traffic or unavailable dispatcher.	Electronic transmittal of additional work orders with no waiting time.
Completed work orders are dropped off at the dispatch center at the end of the the day for manual entry into the billing tracking system. Uncompleted orders are manually distributed to available technicians. Overtime charges often result.	Technicians close completed work orders from the mobile terminals as they are completed. At the end of the shift, the technicians sign off and go home.

Source: From the publicly distributed brochure, "RALI Mobile," from Smith Advanced Technology, Inc. (2001).

trabusiness wireless solutions can be seen through an examination of workflow applications at *mdsi-advantex.com*.) Also, see Online File W6.8 for examples of the Internet-based intrabusiness wireless applications.

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Non-Internet Intrabusiness Applications. Wireless applications in the non-Internet environment have been around since the early 1990s. Examples include such applications as: wireless networking used to pick items out of storage in warehouses via PCs mounted on forklifts; delivery-status updates, entered on PCs inside distribution trucks; and collection of data such as competitors' inventories in stores and customer orders using a handheld (but not networked) device, from which data were transferred to company headquarters each evening. (See the Maybelline case in Chapter 7, Online File W7.7.) Mobile intrabusiness applications are very popular and are typically easier to implement than interbusiness applications.

Other Types of Mobile Work Support. Wireless devices may support a wide variety of mobile workers. The following example demonstrates one of the varied uses to which mobile computing can be put.

EXAMPLE ***Work on the Farm.*** Tractors equipped with sensors, onboard computers, and a global positioning system (GPS) help farmers save time, effort, and money. GPS determines the precise location of the tractor and can direct its automatic steering. Because the rows of planting resulting from GPS guiding are more exact, farmers save both on seed and on fertilizer, due to minimized overlapping and spillage. The sensors also can instantly notify service people of any machine breakdown, enabling faster repair response and less down time (Scanlon, 2003).

The applications of mobile computing will surely grow as the technology matures and as workers think up new ways to apply the functions of wireless devices to their jobs.

Before you go on . . .

1. Describe wearable devices.
2. Describe wireless job dispatch.
3. List some of the major intrabusiness wireless applications.

6.7 MOBILE ENTERPRISE AND SUPPLY CHAIN APPLICATIONS

Mobile computing solutions are also being applied to B2B and supply chain relationships. This section looks at some applications in these areas.

Support of Customers and Business Partners

Successful companies have applied customer service concepts to the support of business partners as well. Increasingly, companies are looking for ways to meld the interests of various organizational units into enterprisewide systems that support both business customers and business partners. Customer relationship management using mobile technologies is one way to do so.

Customer Relationship Management with Mobile Technologies. Supporting customers is the essence of *customer relationship management (CRM)* systems. Mobile access extends the reach of CRM to both customers and business partners on a 24/7 basis, to wherever recipients are located. According to Eklund

(2002), 12 percent of companies in the United States provided corporate users with mobile access to their CRM systems.

In the large CRM software suites (e.g., Siebel's CRM), the two CRM functions that have attracted the most interest are field service and sales force automation. For example, a field service representative on a service call might need to know current availability of various parts in order to fix a piece of machinery. Or a salesperson might be on a sales call and need to know recent billing history for a particular business customer's account. It is these sorts of situations where mobile access to customer and partner data is invaluable.

Sales force automation (SFA) is a technique of using software to automate the business tasks of sales, including order processing, contact management, information sharing, inventory monitoring and control, order tracking, customer management, sales forecast analysis, and employee performance evaluation. Recently, SFA become interrelated with CRM, since the salespeople constitute the contact point with customers.

Voice portal technology can also be used to provide enhanced customer service. For example, customers who are away from the office could use a vendor's voice portal to check on the status of deliveries to a job site. Similarly, salespeople could check on inventory status during a meeting to help close a sale. There are a wide variety of CRM applications for voice portal technology. The challenge is in learning how to create the navigation and other aspects of interaction that makes customers feel comfortable with voice-access technology.

Supply Chain Applications

Mobile computing solutions also are used to improve supply chain operations. Such solutions enable organizations to respond faster to supply chain disruptions by proactively adjusting plans or by shifting resources related to critical supply chain events as they occur. With the increased interest in collaborative commerce comes the opportunity to use wireless communication to collaborate along the supply chain. For this to take place, integration is needed.

An integrated messaging system is at the center of B2B communications. By integrating the mobile terminal into the supply chain, it is possible to make mobile reservations of goods, check availability of a particular item in the warehouse, order a particular product from the manufacturing department, or provide security access to obtain confidential financial data from a management information system.

Mobile devices can also facilitate collaboration among members of the supply chain. There is no longer any need to call a partner company and ask someone to find certain employees who work with your company. Instead, you can contact these employees directly, on their mobile devices.

By enabling sales force employees to type orders straight into the ERP while at a client's site, companies can reduce clerical mistakes and improve supply chain operations. By allowing them to check production schedules and inventory levels, and to access product configuration and *available-to-promise/capacity-to-promise (ATP/CTP)* functionality to obtain real-time delivery quotes, they empower their sales force to make more competitive and realistic offers to customers. Today's ERP systems tie into broader supply chain management solutions that extend visibility across multiple tiers in the supply chain. Mobile supply chain management (mSCM) empowers the workforce to leverage these broader systems through inventory management and ATP/CTP functionality, which extend across multiple supply chain partners and take into account logistics considerations. IT's About Business 6.4 illustrates the integration of mobile devices to provide customer data to mobile workers, to help improve customer support, and to improve workflow.

Before you go on . . .

1. Discuss how wireless applications can be used to provide customer support.
2. Describe wireless support along the supply chain.

IT'S ABOUT BUSINESS

MKT POM

6.4: PAVECA of Venezuela Uses Wireless

PAVECA, Venezuela's largest paper goods manufacturer and exporter, manufactures toilet paper, paper towels, tissues, and other paper products. The company enjoys a significant amount of market share. Seeking to maintain its lead, PAVECA chose to use some m-commerce technologies to cut operational costs and improve customer service at the same time.

PAVECA implemented a wireless system that enables sales reps to use their wireless PDAs to connect to the Internet while they are in the field. Via the Internet connection, the salespeople can log directly into the company intranet to get all the information they need in real time. Orders can then be entered into the system in real time. When an order is entered into the PDA, it goes into the ERP system (Chapter 8) and follows a predefined automated workflow. The savings produced by the new system as compared to the manual system were dramatic: Order processing time was reduced by 90 percent, order approval time by 86 percent, shipment time by 50 percent, and the time between orders taken and order posting was reduced from three days to 20 seconds. The faster order processing time not only led to faster order approval but also increased the number of daily shipments out of the warehouse.

While the main goal was to improve workflow, there has been another benefit: better customer service. Because of the direct links and integration, customers get their orders faster, and there is less chance of errors occurring. Customers are happier and more loyal, and are more likely to place additional orders with PAVECA in the future.

Sources: Compiled from Paperloop, Inc., "The Profits of Going Wireless," *Paperloop Magazines*, Paper and Pulp International, Inc. (August 2002).

QUESTIONS

1. What are the benefits of PAVECA's new system?
2. What segments of the supply chain are supported?
3. What are the advantages of using wireless systems?

6.8 LOCATION-BASED COMMERCE

As discussed earlier, **location-based commerce (l-commerce)** refers to the localization of products and services. Location-based services are attractive to both consumers and businesses alike. From a user's point of view, l-commerce offers various benefits: convenience (you can locate what is near you without having to consult a directory, payphone, or map), productivity (you can optimize your travel and time by determining points of interest within close proximity), and safety (you can connect to an emergency service with a mobile device and have the service pinpoint your exact location). From a business supplier's point of view, l-commerce offers an opportunity to provide services that meet customers' needs.

location-based commerce (l-commerce) *M-commerce transactions targeted to individuals in specific locations, at specific times.*

The basic l-commerce services revolve around five key areas: (1) *location*—determining the basic position of a person or a thing (e.g., car or boat); (2) *navigation*—plotting a route from one location to another; (3) *tracking*—monitoring the movement of a person or a thing (e.g., a package or vehicle); (4) *mapping*—creating maps of specific geographical locations; (5) *timing*—determining the precise time at a specific location.

L-Commerce Technologies

Providing location-based services requires the following location-based and network technologies:

- ***Position-determining equipment (PDE).*** This equipment identifies the location of the mobile device (either through GPS or by locating the nearest base station). The position information is sent to the mobile positioning center.
- ***Mobile positioning center (MPC).*** The MPC is a server that manages the location information sent from the PDE.
- ***Location-based technology.*** This technology consists of groups of servers that combine the position information with geographic- and location-specific content to

provide an l-commerce service. For instance, location-based technology could present a list of addresses of nearby restaurants based on the position of the caller, local street maps, and a directory of businesses.

- ***Geographic content.*** Geographic content consists of streets, road maps, addresses, routes, landmarks, land usage, Zip codes, and the like. This information must be delivered in compressed form for fast distribution over wireless networks.
- ***Location-specific content.*** Location-specific content is used in conjunction with the geographic content to provide the location of particular services. Yellow Page directories showing the location of specific business and services exemplify this type of content.

Figure 6.5 shows how these technologies are used in conjunction with one another to deliver location-based services.

Underlying these technologies are global positioning and geographical information systems.

global positioning system (GPS) *A wireless system that uses satellites to enable users to determine their position anywhere on the earth.*

Global Positioning System (GPS). As indicated at the start of the chapter, a **global positioning system (GPS)** is a wireless system that uses three satellites to enable users to determine their position anywhere on the earth. GPS equipment has been used extensively for navigation by commercial airlines and ships and for locating trucks and buses (as in the opening case study).

GPS is supported by 24 U.S. government satellites that are shared worldwide. Each satellite orbits the earth once every 12 hours on a precise path, at an altitude of 10,900 miles. Each satellite broadcasts its position and a time signal from its onboard atomic clock, which is accurate to one-billionth of a second. GPS devices also have accurate clocks that are synchronized with those of the satellites. At any point in time, the exact position of each satellite is known, based on the reception of the broadcast satellite data. Knowing the location of the three satellites enables the calculation of the location of the GPS device that receives the satellite's broadcast.

Cell phones that are equipped with a GPS device can be used as standalone units or can be plugged into or embedded in a mobile device. The GPS device calculates its position (location) (or sends the information to be calculated centrally). GPS software then computes the latitude and longitude of the receiver (to within 50 feet). For an online tutorial on GPS see *trimble.com/gps*.

Geographical Information System (GIS). The location provided by GPS is expressed in terms of latitude and longitude. To make that information useful to busi-

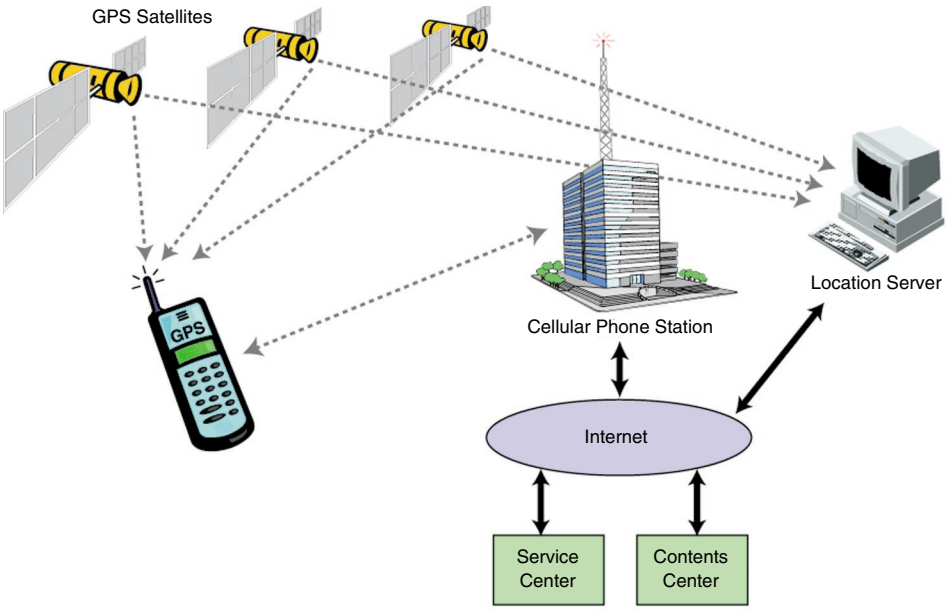

Figure 6.5 *A smartphone with GPS system in l-commerce.*

nesses and consumers it is usually necessary to relate those measures to a certain place or address. This is done by inserting the latitude and longitude onto an electronic map, using software known as a **geographical information system (GIS)**. The GIS data visualization technology integrates GPS data onto digitized map displays. Companies such as *mapinfo.com* provide the GIS core spatial technology, maps, and other data content needed in order to power location-based GPS/GIS services (see Figure 6.6).

geographical information system (GIS) *System that integrates GSP data onto digitized map displays.*

An interesting application of GPS/GIS is now available from several car manufacturers (e.g., Toyota, Cadillac) and car rental companies (e.g., Hertz, Avis). Some cars have a navigation system that indicates how far away the driver is from gas stations, restaurants, and other locations of interest. The GPS knows where the car is at any time, so the application can map the route for the driver to a particular destination. Any GPS application can be classified as *telemetry*, a topic discussed further later on.

E-911 Emergency Cell Phone Calls

If someone dials 911 from a regular wired phone, it is easy for the emergency 911 service to pinpoint the location of the phone. But, what happens if someone places a 911 call from a mobile phone? Can the emergency service locate the caller? A few years ago, the U.S. Federal Communications Commission (FCC) issued a directive to wireless carriers, requiring that they establish services to handle **wireless 911 (e-911)** calls. To give you an idea of the magnitude of this requirement, more than 156,000 wireless 911 calls are made *every day*, representing more than half the 911 calls made daily in the United States. In 2003, 66 million emergency calls were made from cell phones in the United States.

wireless 911 (e-911) *Calls from cellular phones to providers of emergency services; automatic crash notification (ACN).*

The e-911 directive is to take effect in two phases. Phase I requires carriers, upon appropriate request by a local Public Safety Answering Point (PSAP), to report the telephone number of a wireless 911 caller and the location of the cellular antenna that received the call. Phase II, which is being rolled out over a four-year period from October 2002 to December 2005, requires wireless carriers to provide information that will enable the PSAP to locate a caller within 50 meters 67 percent of the time and within 150 meters 95 percent of the time. (The specifics of the phases vary from one wireless carrier—e.g., AT&T, Cingular, Sprint, etc.—to another.) By the end of Phase II, 100 percent of the new cell phones and 95 percent of all cell phones will have these location capabilities. It is expected that many other countries will follow the example of the United States in providing e-911 service.

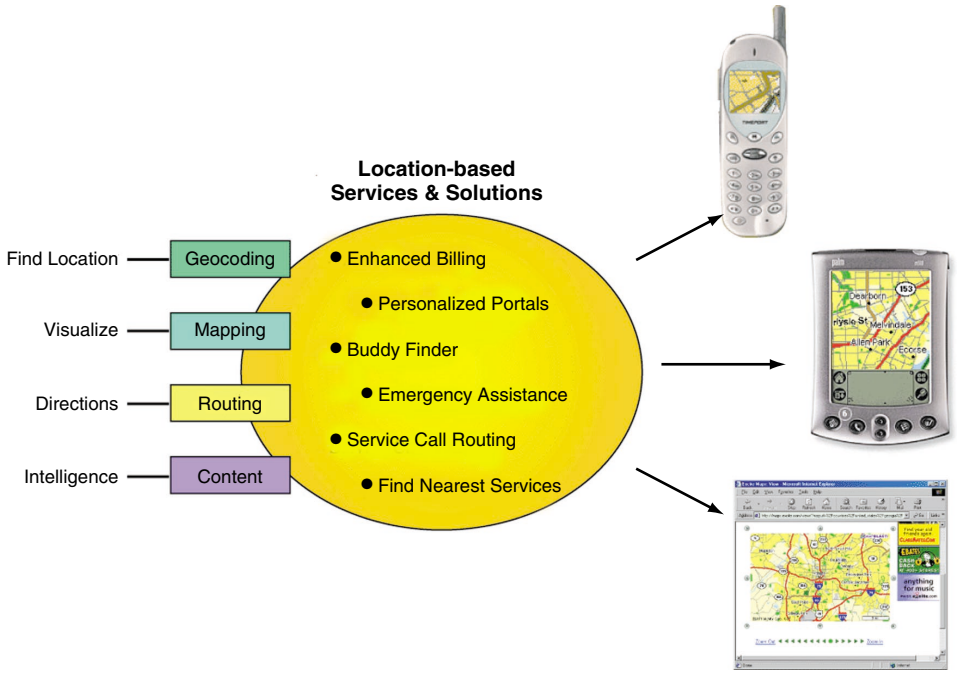

Figure 6.6 *Location-based services involving maps. [Source:* Mapinfo.com, *2001.]*

Telemetry Applications

Telemetry is the science that measures physical remoteness by means of wireless transmission from a remote source (such as a vehicle) to a receiving station. Telemetry has numerous mobile computing applications. Using *mobile telemetry*, technicians can diagnose maintenance problems in equipment. Car manufacturers use the technology for remote vehicle diagnosis and preventive maintenance. Finally, doctors can monitor patients and control medical equipment from a distance.

General Motors Corporation popularized an automotive use of telemetry with its OnStar system (*onstar.com*). Nokia believes that every vehicle will be equipped with at least one Internet Protocol (IP) address by the year 2010. Nokia therefore has set up a business unit called Smart Traffic Products, which is focusing solely on telemetry applications. Smart cars and traffic products are discussed in more detail in Section 6.7.

Barriers to L-Commerce

What is holding back the widespread use of location-based commerce? Several factors come into play:

- ***Accuracy.*** Some of the location technologies are not as accurate as people expect them to be. However, a good GPS provides a location that is accurate up to 15 meters. Less expensive, but less accurate, technologies can be used instead to find an approximate location (within about 500 meters).
- ***The cost-benefit justification.*** For many potential users, the benefits of l-commerce do not justify the cost of the hardware or the inconvenience and time required to utilize the service (Hamblen, 2001). After all, they seem to feel, they can just as easily obtain information the "old-fashioned" way.
- ***The bandwidth of GSM networks.*** GSM bandwidth is currently limited; it will be improved as 3G technology spreads. As bandwidth improves, applications will improve, which will attract more customers.
- ***Invasion of privacy.*** When "always-on" cell phones are a reality, a number of people will be hesitant to have their whereabouts and movements tracked throughout the day, even if they have nothing to hide. This issue will be heightened when our cars, homes, appliances, and all sorts of other consumer goods are connected to the Internet, as discussed in the next section.

Before you go on . . .

1. Describe some of the potential uses of l-commerce.
2. Describe GPS and GIS.
3. List some of the barriers to l-commerce.

6.9 PERVASIVE COMPUTING

Steven Spielberg's sci-fi thriller *Minority Report* depicts the world of 2054. The film immerses the viewer in the consumer-driven world of pervasive computing 50 years from now. Spielberg put together a think tank, headed by Peter Schwartz, president of Global Business Network (*gbn.com*), to produce a realistic view of the future. The think tank projected out from today's marketing and media technologies to create a society where billboards beckon you by name, newspapers are delivered instantly over broadband wireless networks, holographic hosts greet you at retail stores, and cereal boxes broadcast live commercials. While the technologies in the film were beyond the leading edge, none was beyond the realm of the plausible.

A world in which virtually every object has processing power with wireless or wired connections to a global network is the world of **pervasive computing**. The term pervasive computing also goes by the names *ubiquitous computing, embedded computing*, or *augmented computing.*

pervasive computing *Invisible, everywhere computing that is embedded in the objects around us.*

The idea of pervasive computing has been around for years. However, the current version was articulated by Mark Weiser in 1988 at the computer science lab of Xerox PARC. From Weiser's perspective, pervasive computing was the opposite of virtual reality. In virtual reality, the user is immersed in a computer-generated environment. In contrast, pervasive computing is invisible "everywhere computing" that is embedded in the objects around us—the floor, the lights, our cars, the washing machine, our cell phones, our clothes, and so on (Weiser, 2002).

Invisible Computing Everywhere

By "invisible," Weiser did not mean to imply that pervasive computing devices would not be seen. He meant, rather, that these embedded computers would not intrude on our consciousness. Think of a pair of eyeglasses. The wearer does not have to think about using them. He or she simply puts them on and they augment the wearer's ability to see. This is Weiser's vision for pervasive computing. The user doesn't have to think about how to use the processing power in the object; rather, the processing power automatically helps the user perform a task.

Some new embedded technology is already in use at Prada's "epicenter" stores in New York, San Francisco, and Los Angeles. Prada is a high-end fashion retailer (*prada.com*). At these epicenters, the items for sale have an **RFID (radio frequency identification)** tag attached. The tag contains a processor and an antenna. If a customer wants to know about a particular item, she or he can move with the item toward one of the many displays around the store. The display automatically detects the item and provides sketches, video clips of models wearing the item, and information about the item (color, cut, fabric, materials, and availability). If a customer takes a garment into one of the dressing rooms, the tags are automatically scanned and detected via an antenna embedded in the dressing room. Information about the item will be automatically displayed on an interactive touch screen in the dressing room. The dressing rooms also have a video-based "Magic Mirror." When the customer tries on the garment and turns around in front of the mirror, the images will be captured and played back in slow motion. (See Section 6.8 for a related privacy issue).

(RFID) radio frequency identification *Generic term for technologies that use radio waves to automatically identify individual items.*

A device manufactured and sold by Fitsense Technology (*fitsense.com*), a Massachusetts developer of Internet sports and fitness monitors, also offers "invisible" processing power. With this one-ounce device that is clipped to a shoelace, runners are able to capture their speed and the distance they have run. The device transmits the data via a radio signal to a wrist device that can capture and transmit the data wirelessly to a desktop computer for analysis. Along the same lines, Champion Chip (*championchip.com*), headquartered in the Netherlands, has developed a system that keeps track of the tens of thousands of participants in very popular long-distance races.

Active badges can be worn as ID cards by employees who wish to stay in touch at all times while moving around the corporate premises. The clip-on badge contains a microprocessor that transmits its (and its wearer's) location to the building's sensors, which send it to a computer. When someone wants to contact the badge wearer, the phone closest to the person is identified automatically. When badge wearers enter their offices, their badge identifies them and logs them on to their personal computers.

Similarly, *memory buttons* are nickel-sized devices that store a small database relating to whatever it is attached to. These devices are analogous to a barcode, but with far greater informational content and a content that is subject to change. For example, the U.S. Postal Service has placed memory buttons in some residential mailboxes to track and improve delivery schedules.

For a list of the technical foundation of pervasive computing, see Online File W6.9 at the book's Web site.

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Contextual Computing and Context Awareness

context awareness *Capturing a broad range of contextual attributes to better understand what the consumer needs and what products or services might be of interest.*

contextual computing *Active adaptation of the contextual environment for each user, at each point of computing.*

Location can be a significant differentiator in advertising services such as restaurants. However, knowing that the user is at the corner of the street will not tell you what he or she is looking for. For this, we might need to know the time of day or to access our user's calendar or other relevant *contextual attributes*. **Context awareness** refers to capturing a broad range of contextual attributes to better understand what the consumer needs, and what products or services he or she might possibly be interested in.

Context awareness is part of **contextual computing**, which refers to the enhancement of a user's interactions by understanding the user, the context, and the applications and information being used, typically across a wide set of user goals (Pitkow et al., 2002). Contextual computing is about actively adapting the contextual environment for each user, at each point of computing. Such applications are futuristic at the present time. But as shown in IT's About Business 6.5 they already exist in a research university.

Applications of Pervasive Computing

According to Estrin et al. (2000), 98 percent of all processors on the planet are not in traditional desktop computer systems, nor even in laptops. They are in household appliances, vehicles, and machines. Such existing and future applications of pervasive computing are illustrated in Figure 6.7. Notice that all 14 devices can be connected to the Internet. Several of these applications are described in the remainder of this section. We will look at four applications in particular: smart homes, smart appliances, smart cars, and smart things.

Smart Homes

In a *smart home*, your home computer, television, lighting and heating controls, home security system, and many appliances within the home can "talk" to each other via the Internet or a home intranet. These linked systems can be controlled through various devices, including your pager, cellular phone, television, home computer, PDA, or even your automobile. In the United States, tens of thousands of homes are already equipped with home-automation devices, and there are signs that Europe—which has much lower home Internet penetration levels—is also warming to the idea. Some of the tasks and services supported today by home automation systems are described in more detail in Online File W6.10.

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Smart Appliances

One of the key elements of a smart home is the *smart appliance*, an Internet-ready appliance that can be controlled by a small handheld device or desktop computer via a home intranet (wire or wireless) or the public Internet.

One organization that is focused on smart appliances is the Internet Home Alliance (*internethomealliance.com*). The alliance is made up of a number of appliance manufacturers (e.g., Whirlpool and Sunbeam), computer hardware companies (e.g., IBM and Cisco), retailers (e.g., Best Buy), and vendors specializing in home automation (e.g., Lutron Electronics). The mission of the alliance is to accelerate the process of researching, developing, and testing new home products and services that require a broadband or persistent connection to the Internet.

The appliance manufacturers are interested not only in the sale of appliances but also in servicing them. In most cases, the manufacturer loses touch with a purchased appliance unless the customer registers it for warranty purposes. Potentially, a networked appliance could provide a manufacturer with information that could be used to capture or report on its operation, performance, and usage. In addition, the networked appliance could provide information for diagnostic purposes—for monitoring, troubleshooting, repairing, or maintaining the device.

To date, however, consumers have shown little interest in smart appliances. For now, the appliance manufacturers are focusing on improving people's lives by eliminating

IT'S ABOUT BUSINESS SVC

6.5: Context-Aware Environment at Carnegie Mellon University

Carnegie Mellon University (CMU) is known for its advanced science projects including robotics and artificial intelligence. Students participate in a context-awareness experiment in the following manner: Each participating student is equipped with a PDA from which he or she can access Internet services via the campus Wi-Fi network. The students operate in a context-aware environment whose architecture is shown in the attached figure.

A user's content (left of figure) includes the following: calendar information; current location (position), which is regularly updated using location-tracking technology; weather information, indicating whether it is sunny, raining, or snowing, and the current outside temperature (environment); and social context information, including the student's friends and his or her teachers, classmates, and so forth.

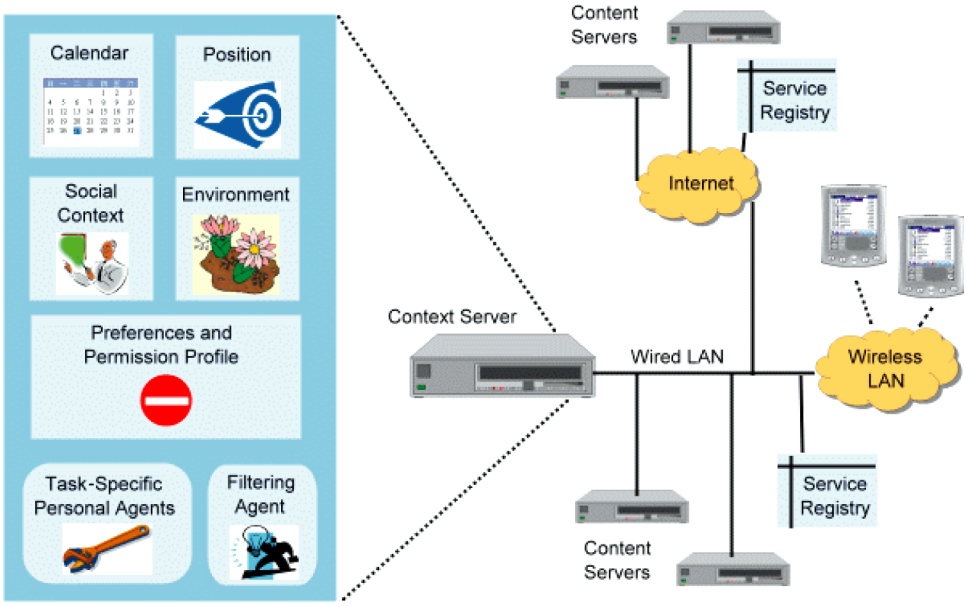
The preferences of each student are solicited and entered into system, as is a personal profile. This is shown as the "preferences and permissions" in the figure. All of the above information helps the system to filter incoming messages, and determine what to show to the students and when. For example, while attending classes the student may block all messages, except from her boyfriend. That is, certain messages will be shown only if the student is in a certain place and/or time; others will not be shown at all.

A user's context information can be accessed by a collection of *personal agents*, each in charge of assisting with different tasks, while locating and invoking relevant Internet services identified through services registries (see the figure). An example of a simple agent is a *restaurant concierge* that gives suggestions to students about places to have lunch, depending on their food preferences, the time they have available before their next class, their location on campus, and the weather. For example, when it is raining, the agent attempts to find a place that does not require going outside of the building where the student is located. The recommendations (usually several choices) appear on the PDA, with an overall rating and a "click for details" possibility.

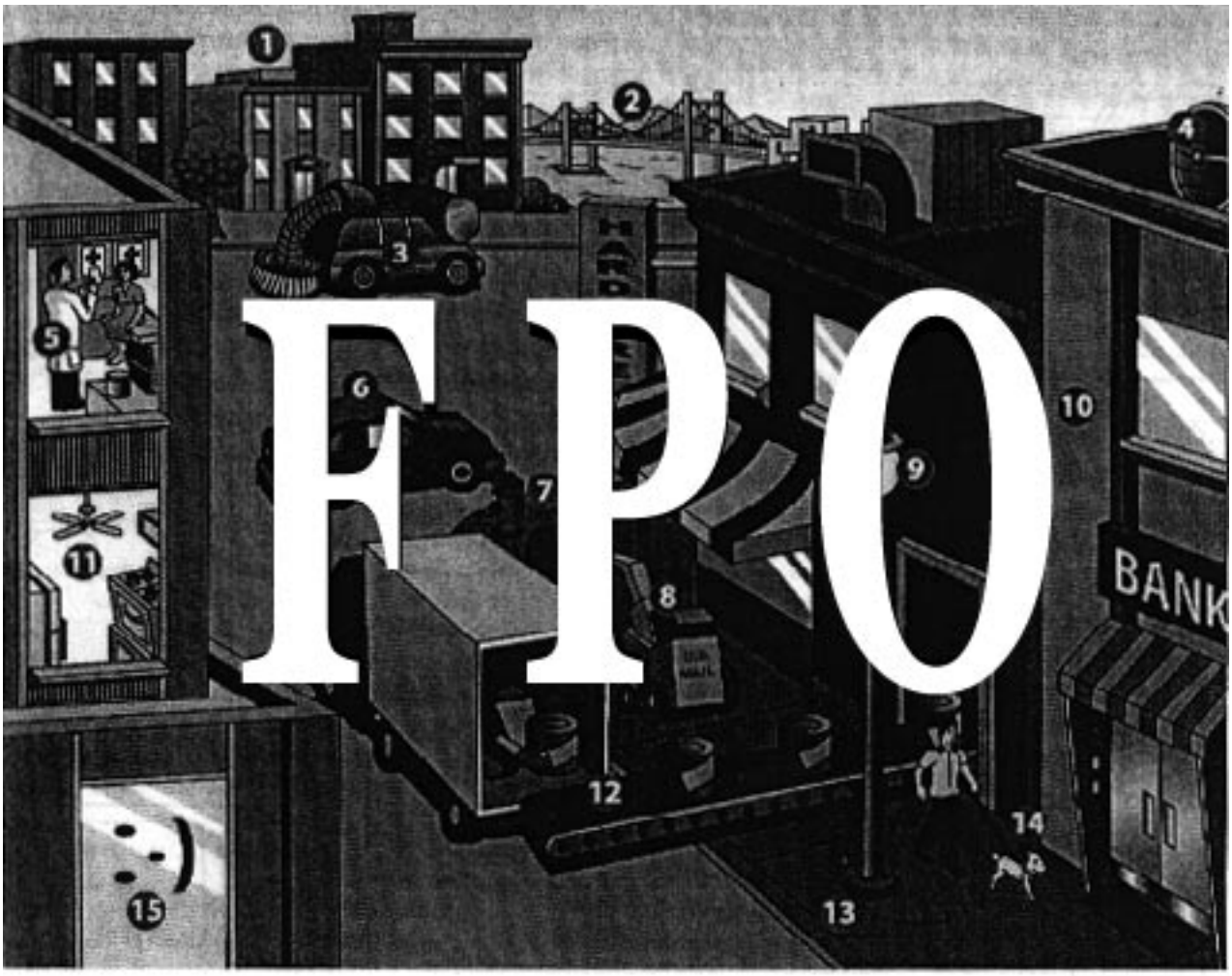
Source: Compiled from N. Sadeh, *M-Commerce* (New York: Wiley, 2002).

QUESTIONS

1. Does the usefulness of such as service justify the need to disclose private preferences?
2. Can such a system be developed for consumers who are not members of a defined community such as a university?



Carnegie Mellon's contextual-computing system.
[Source: N. Sadeh, M-Commerce *(New York: Wiley, 2002).]*



1. Smart building materials:
   - Sense vibrations, temperature, moisture
   - Monitor premises for intruders
   - Cancel street noise
2. Bridge deck erected with smart building materials:
   - Senses, reports traffic, wind loads
   - Monitors structural integrity
3. Autonomous robo-sweeper
4. Wireless communication, including links to GPS satellites, Net access
5. Smart sensor pills:
   - Programmable delivery vehicles for pharmaceuticals
   - Internal sensing applications
6. Embedded automobile devices:
   - Antilock brakes
   - Air bags
   - Evaluate performance
   - Provide Net access
7. Fire hydrant measures water flow, senses heat, offers security mechanisms.
8. Autonomous robo-mailbot performing nominally manual labor.
9. Street light senses foot and motor traffic, polices area.
10. Banking/business:
    - ATM machines, cash registers, bar-code readers, credit card devices
    - Security devices offer personal Ids, but also sense vibrations and (body) heat and motion and monitors premises for intruders.
11. Home networks:
    - Most electrical appliances, including dishwashers, toasters, cable TV set-top boxes, toys, phones, thermostats, PCs
12. Smart building materials:
    - Smart paint
    - smart concrete
    - Smart gels
13. Smart cement detects earthquake activity.
14. Collar on dog for wireless location via GPS link. Clothes on man (personal cybernetics) offer similar abilities. As well as networking and heat sensors.

Figure 6.7 *Embedded computing devices everywhere.*
[Source: D. Estrin, "Embedding the Internet," Communications of the ACM*, May 2000, pp. 38–39.]*

repetitive, nonquality tasks. One example is Sunbeam's corded HLT (Home Linking Technology) products that communicate with one another using an embedded technology called PLC (Power Line Communication). For instance, an HTL alarm clock can coordinate an entire morning's routine: The heating system, the coffeemaker, and the lights in the kids' rooms go on, and the electric blanket goes off.

Smart Cars

Every car today has at least one computer on board to operate the engine, regulate fuel consumption, and control exhaust emissions. The average automobile on the road today has 20 or more microprocessors. They are under the hood, behind the dash, in the door panels, and on the undercarriage. Microprocessors control the radio, decide when your transmission should shift gears, remember your seat position, and adjust the temperature in the passenger cabin. They can make the suspension work better, help you see in the dark, and warn when a tire is low. In the shop, the onboard microprocessors are used to diagnose problems. Car computers often operate independently, but some swap data among themselves—a growing trend. The microprocessors in a car require little maintenance, continuing to operate through extreme temperature, vibration, and humidity.

There is also a growing trend to connect car microprocessors to mobile networks and to the Internet. Emergency assistance, driving directions, and e-mail are some of the services these connections can support. To increase safety, drivers can use voice-activated controls, even to access the Web. GM's OnStar system (*onstar.com*) already supports many of these services.

OnStar is the forerunner of smart cars of the future. The next generation of smart cars is likely to provide even more automated services, especially in emergency situations. Some expect that in the future cars will have a device for *automatic crash notification (ACN)*. This still-experimental device would automatically notify the police of an accident involving an ACN-equipped car and its location. Such systems would determine the speed upon impact, whether the car has rolled over, and whether the driver and passengers were wearing seat belts. Information of this sort might be used by emergency personnel to determine the severity of the accident and what types of services will be needed.

Ideally, smart cars eventually will be able to drive themselves. Known as *autonomous land vehicles (ALVs),* these cars follow GIS maps and use sensors in a wireless environment to identify obstacles. Such vehicles are already on the roads in California, Pennsylvania, and Germany (on an experimental basis, of course).

Smart "Things"

Several other devices and instruments can be made "smart." Some examples are discussed below.

Barcodes. A typical barcode, known as the *Universal Product Code (UPC),* is made up of 12 digits, in various groups. The first two show the country where it was issued, the next four represent the manufacturer, and the remaining six are the product code assigned by the manufacturer. On a package the code is represented by a series of bars and spaces of varying widths.

Barcodes have worked pretty well over the past 25 years. But they have their limitations. First, they require line-of-sight of the scanning device. This is fine in a store but can pose substantial problems in a manufacturing plant, a warehouse, or on a shipping/receiving dock. Second, they are printed on paper, and so can be ripped, soiled, or lost. Third, the barcode identifies the manufacturer and product, not the item. For example, every carton of milk of a given producer has the same barcode, regardless of when it was produced. This makes a barcode useless in determining things like the expiration date. There is an alternative identification method, called Auto-ID, which overcomes the limitations of barcodes.

Auto Identification (Auto-ID) Center *Joint partnership among global companies and research universities to create an "Internet of things."*

Internet of things *A network that connects computers to objects in order to be able to track individual items as they move from factories to store shelves to recycling facilities, providing near-perfect supply chain visibility.*

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Auto-ID. This method has been promoted over the past couple of years by the **Auto Identification (Auto-ID) Center** (*autoidcenter.org*). This organization is a joint partnership among more than 87 global companies and three of the world's leading research universities—MIT in the United States, the University of Cambridge in the UK, and the University of Adelaide in Australia. The companies include manufacturers (e.g., Coca-Cola, Gillette, and Canon), retailers (e.g., Wal-Mart, Tesco in the UK), shippers (e.g., UPS and the U.S. Postal Service), standards bodies (e.g., Uniform Code Council), and government agencies (e.g., the U.S. Department of Defense).

The mission of the Auto-ID Center goes well beyond replacing one code with another. Its stated aim is to create an **Internet of "things,"** a network that connects computers to objects—ranging from boxes of laundry detergent to pairs of jeans to airplane engines. This Internet of things will provide the ability to track *individual* items as they move from factories to store shelves to recycling facilities. This will make possible near-perfect supply chain visibility.

The key technical elements of the Auto-ID system and an explanation of how it will work are provided in Online File W6.11.

RFID: Capabilities and Cost. As discussed earlier, RFID (radio frequency identification) uses radio waves to automatically identify individual items. Typically, a microchip with product information and an antenna are embedded in an RFID tag. The antenna transmits the identification information by radio waves to an RFID reader; the reader passes the information on to computers that can make use of it.

RFID has been around awhile. In World War II, RFIDs were used to identify friendly aircraft. Today, they are used in wireless tollbooth systems, such as E-Z Pass. In Singapore they are used in a system called Electronic Road Pricing, which charges different prices to drive on different roads at different times, encouraging drivers to stay off busy roads at busy times. Every car has an RFID tag that communicates with card readers on the major roads (similar to Highway 91 in California).

Until now the problem with RFID has been the expense. Tags have cost at least 50 cents, which makes them unusable for low-priced items. A California company called Alien Technology (*alientechnology.com*) has invented a way to mass-produce RFID tags for less than 10 cents apiece for large production runs. In January 2003, Gillette placed an order with Alien Technology for 500 million RFID tags (*RFID Journal,* November 15, 2002). Gillette is using the tags in a number of trial programs. In one of the early trials, Gillette attached the tags to Mach 3 razors shipped to Wal-Mart, whose store shelves are equipped with special RFID readers. The overall success of RFID tags in the marketplace will depend on the outcome of trials such as this.

Large-Scale Pervasive Systems

Smart homes, smart appliances, smart cars, and smart things can certainly make our lives more comfortable and efficient. But pervasive computing has the potential to make an even larger contribution to society when many computing devices are linked together, creating massive intelligent systems. These systems include factories, airports, schools, offices, health-care services, and even entire cities.

At the moment, most such systems are experimental and on a relatively small scale. Two examples of large-scale pervasive systems that are already in operation are provided below.

EXAMPLES

Intelligent Elder-Care. Due to the increased age of the population in many countries, more elderly people must be cared for and for longer periods of time. Long-term care facilities, where different patients require different levels of care, bring the problem of how to provide such care efficiently and effectively. An experimental project called Elite-Care has demonstrated the benefits of using pervasive computing in such settings. At Elite-Care's Estates Cluster Residential Care Facility in Milwaukie, Oregon, pervasive computing is being used to increase the autonomy and care level of all of its residents, regardless of their individual needs.

Elite-Care, a family-owned business (*elite-care.com*), has been built from the ground up to provide "high-tech, high-touch" programs. The entire facility is wired with a 30-mile network of (wireline and wireless) of unobtrusive sensors and other devices including: biosensors (e.g., weight sensors) attached to each resident's bed; movement sensors embedded in badges worn by the residents and staff (wearable computers); panic buttons used to call for help; Internet access via touch screens in each room; video conferencing using Webcams; and climate control, lights, and other regulated appliances.

These devices and others allow the staff to monitor patient activity. For example, staff can determine the location of any patient, to tell whether he or she is in an expected area of the facility. Devices that monitor length of absence from bed might alert personnel that the patient has fallen. Medical personnel can watch for weight loss, restlessness at night, and frequency of trips to the bathroom, all of which may indicate certain medical conditions for the elderly. Also, close monitoring of conditions enables staff to give medicine and/or other treatments as needed, rather than at predetermined periods. All of these capabilities enable true one-to-one care, which is both more effective and less expensive.

One of the initial concerns with these monitors was that the privacy of the residents would be unnecessarily invaded. To alleviate these concerns, residents and their families are given the choice of participating or not. Most choose to participate because the families believe that these monitors provide better tracking and care. The monitors also increase the autonomy of all the patients because their use reduces the need for staff to constantly monitor residents in person, especially those with more acute care needs. At the present time such projects are experimental and expensive, but someday they will be affordable to many. (*Source:* Standford, 2000.)

EXAMPLE ***Digital Cities.*** The concept of *digital cities* is to build an area in which people in regional communities can interact and share knowledge, experiences, and mutual interests. Digital cities integrate urban information (both real time and stored) and create public spaces for people living in or visiting the cities. Digital cities are being developed all over the world. In Europe alone there are over 100 projects (e.g., Amsterdam, Helsinki).

In the city of Kyoto, Japan, for example, the digital city complements and corresponds to the physical city (Ishida, 2002). Three layers are constructed: The first is an information layer, where Web archives and real-time sensory data are integrated to provide information anywhere, at any time. The second layer is 2-D and 3-D interfaces, which provide views of car, buses, and pictures that illustrate city services (for attractive and natural presentation). Finally, there is an interactive layer. Extensive use of GIS supports the project. One area of emphasis is a digital tour guide for visitors. Also, the system uses avatars (animated computer characters) that appear on a handheld device and "walk" with visitors around the city in real time.

Another digital-city experiment is the city of Lancaster (UK), where wireless devices are being used for improve services for both visitors and residents. The experimental Lancaster City Guide is based on a network of Wi-Fi context-sensitive and location-aware applications. One area that was developed first is services for tourists. By knowing where the tourist is (using a GPS) and his or her preferences, the system can recommend tourist sites in the same general area. (This application is similar to the Carnegie Mellon application described in IT's About Business 6.3.)

Before you go on . . .

1. Define pervasive computing.
2. What is contextual computing?
3. What applications of pervasive computing interest you the most? Explain why.
4. Explain the benefits of auto-ID and RFID.

6.10 INHIBITORS AND BARRIERS OF MOBILE COMPUTING

Several limitations either are slowing the spread of mobile computing or are leaving many m-commerce customers disappointed or dissatisfied (Islam and Fayad, 2003). We will consider some representative inhibitors and barriers of mobile computing in the following discussion.

The Usability and Other Technical Problems

When mobile Internet users visit mobile Internet sites, the *usability* of the site is critical to attract attention and retain "user stickiness" (the degree to which users stay at a site). There are three dimensions to usability, namely *effectiveness*, *efficiency*, and *satisfaction*. However, users often find current mobile devices to be ineffective, particularly with respect to restricted keyboards and pocket-size screens, limiting their usability. In addition, because of the limited storage capacity and information access speed of most smartphones and PDAs, it is often difficult or impossible to download large files to these devices.

The major technical and other limitations that have slowed the spread of m-commerce are summarized in Table 6.1.

Ethical and Legal Issues

Several ethical and legal issues are unique to mobile computing. For example, fashion retailer Benetton Group SpA was considering embedding RFID smart tags into the labels in one of its lines of clothing, to help track shipping, inventory, and sales in the company's 5,000 stores worldwide. (Also, the tags could help prevent shoplifting.) Using the tags, the store would know where each piece of clothing is, at any given time. However, privacy groups expressed concern that the tags could also be used to track buyers; some groups even urged that the company's clothing be boycotted. As a result, Benetton backed away from the plan, at least until an impact study could be done.

According to Hunter (2002), privacy is in great danger in the world of ubiquitous computing. Some people fear that the networking of pervasive computing

Table 6.1 Technical and Other Limitations of Mobile Computing

Limitation	Description
Insufficient bandwidth	Sufficient bandwidth is necessary for widespread use and it must be inexpensive. It will take a few years until 3G is in many places. Wi-Fi solves some of the problem.
Security standards	Universal standards were not available in 2003. It may take 3 or more years to have them.
Power consumption	Batteries with long life are needed for mobile computing. Color screens and Wi-Fi consume more electricity, but new chips are solving some of the power-consumption problems.
Transmission interferences	Weather and terrain problems as well as distance-limited connection exist with some technologies. Reception in tunnels and some buildings is poor.
GPS accuracy	GPS may be accurate in a city with tall buildings.
WAP limitations	According to *mofileinfo.com*, in 2002 there were only about 50,000 WAP sites (compared to millions of Web sites). WAP still is a cumbersome process to work with.
Potential health hazards	Potential health damage from cellular radio frequency emission is not known yet. However, more car accidents are related to drivers who were talking (some places bar the use of cell phones while you drive). Also, cell phones may interfere with sensitive medical devices.
Legal issues	Potential legal issues against manufacturers of cell phones and against service providers exist, due to the potential health problems.
Human interface with device	Screens and keyboards are too small and uncomfortable and tedious for many people to use.
Complexity	Too many optional add-ons are available (e.g., battery chargers, external keyboards, headset, microphone, cradles). Storing and using the optional add-ons can be a problem.

devices, which could link individuals, businesses, and government, may jeopardize privacy. The Elite-Care project, for example, raised the issue of protecting information collected by sensors. Also, privacy is difficult to control in other types of context-aware systems. As indicated earlier, security is especially difficult in Wi-Fi systems.

In order for pervasive (ubiquitous) systems to be widely deployed, it is necessary to overcome both the technical and the ethical/legal barriers associated with wireless computing. In addition, vendors will need to find appropriate business models for pervasive computing technologies and to develop experience in deploying ubiquitous systems. Some of this experience is likely to come through trial-and-error.

Failures in Mobile Computing and M-Commerce

As with any other technology, especially a new one, there have been many failures of applications as well as of entire companies in mobile computing and m-commerce. It is important to anticipate and plan for possible failures as well as to learn from them. The case of Northeast Utilities provides some important insights.

EXAMPLE ***Inspectors at Northeast Utilities Go Wireless.*** Northeast Utilities, located in Berlin, Connecticut, supplies energy products and services to 1.2 million customers from Maine to Maryland. The company embarked on a wireless project in 1995 in which its field inspectors used wireless devices to track spills of hazardous material and report them to headquarters in real time. After spending a year and a half and $1 million, the project failed (Hamblen, 2001).

Some of the lessons learned from the failure of the wireless project were the following:

- Do not start without appropriate infrastructure.
- Do not start a full-scale implementation; use a small pilot for experimentation.
- Pick up an appropriate architecture. Some users don't need to be persistently connected, for example.
- Talk with a range of users, some experienced and some not, about usability issues.
- Users must be involved; use biweekly meetings if possible.
- Use wireless experts if you are not one.
- Wireless is a different medium from other forms of communication. Remember that people are not used to the wireless way of doing things.

Having learned from the failure, Northeast made its next wireless endeavor a success. Today, 15 field inspectors carry rugged wireless laptops that are connected to the enterprise intranet and databases. The wireless laptops are used to conduct measurements related to electricity transformers, for example. The laptops transmit the results, in real time, to chemists and people who prepare government reports about hazardous materials spills. All of the information is entered directly into proper fields of electronic forms without having to be transcribed, saving time and ensuring greater accuracy. The new system is so successful that it has given IT workers the confidence to launch other applications such as sending power-outage reports to executives via smartphones and wireless information to crews repairing street lights (Hamblen, 2001).

Before you go on . . .

1. Discuss the role that usability plays in the adoption of m-commerce.
2. List the technical limitations of m-commerce.

WHAT'S IN IT FOR ME?

ACC

FOR THE ACCOUNTING MAJOR

Wireless applications help with inventory counting and auditing. They also assist in expediting the flow of information for cost control. Price management, inventory control, and other accounting-related activities can be improved by use of wireless technologies.

FIN

FOR THE FINANCE MAJOR

Banks and other financial institutions can derive a competitive advantage when providing wireless services. Wireless electronic payments, including micropayments, are made faster and their cost is significantly reduced. Electronic bill payment from mobile devices is becoming more popular, increasing security and accuracy, expediting cycle time, and reducing processing cost.

MKT

FOR THE MARKETING MAJOR

Imagine a whole new world of marketing, advertising, and selling, with the potential to increase sales of products and services by significant amounts. Such is the promise of mobile computing. Of special interest for marketing are location-based advertising and l-commerce as well as the new opportunities resulting from pervasive computing and RFIDs. Finally, wireless also provides new opportunities in sales force automation (SFA), enabling faster and better communications with both customers (CRM) and corporate services.

POM

FOR THE PRODUCTION/ OPERATIONS MANAGEMENT MAJOR

Wireless technologies offer a multitude of opportunities to support mobile employees of all kinds. Wearable computers enable repair personnel working in the field and off-site employees to service customers faster, better, and at less cost. Wireless devices also enable productivity lifts within factories by allowing faster communication and collaboration, and improved managerial planning and control. In addition, mobile computing technologies can decrease risky operations and increase safety by providing quicker warning signs and instant messaging to isolated employees. Finally, using mobile devices, personnel can communicate and collaborate better both internally and externally.

HRM

FOR THE HUMAN RESOURCES MANAGEMENT MAJOR

Mobile computing offers new frontiers in improving HR training and extending it to any place at any time. Payroll notices can be delivered as SMSs. Self-service selection of benefits and updating of personal data can be extended to wireless devices, making these functions even more convenient for employees to handle on their own.

SUMMARY

1. **Discuss the characteristics, attributes, and drivers of mobile computing and m-commerce.** Mobile computing is based on mobility and reach. These characteristics provide ubiquity, convenience, instant connectivity, personalization, and product and service localization. The major drivers of mobile computing are: large numbers of users of mobile devices, especially cell phones; no need for a PC; a developing "cell phone culture"; vendor marketing; declining prices and increasing functionalities; and bandwidth improvement.
2. **Describe the emergence of Wi-Fi and voice portals.** Wi-Fi is a popular emerging standard for wireless local area networks (WLANs). It is fairly fast and inexpensive. It provides service to a number of users within a small transmission area known as a hotspot. Hotspots are available in many public places. Voice portals allow users to access the Internet by voice from a regular or cell telephone.
3. **Describe personal service applications of m-commerce.** M-commerce is being used to provide applications in travel, delivery of medical services, delivery of information (e.g., news, sports, and other information) over wireless devices, and gaming and entertainment. Non-Internet consumer

applications of m-commerce are used mainly in transportation and shopping from vending machines and gas pumps. Such applications typically involve use of various types of smart cards.

4. **Discuss m-commerce applications in financial services.** Many EC applications in the service industries (e.g., banking, travel, and stocks) can be conducted with wireless devices. Applications in financial services are expanding. Mobile banking is popular in many countries. Wireless electronic payment systems and micropayment technology allow purchasing from vending machines any time and place. Wireless m-wallets store the information used to make mobile payments more easily.
5. **Describe m-commerce applications in shopping, advertising, and customer service.** Consumers who shop from wireless devices are supported by services similar to those used by wireline shoppers. In addition, targeted advertising can reach customers in the appropriate place and time. Finally, real-time ubiquitous customer service is provided by m-commerce applications.
6. **Describe the use of m-commerce in intrabusiness applications.** Large numbers of applications of mobile computing are being found in business. Intrabusiness applications such as wearable devices for mobile workers, job dispatching, and more are already evident inside organizations.
7. **Discuss the use of mobile computing in enterprise and supply chain applications.** Enterprise applications in areas such as customer service, CRM, sales force automation, and supply chain management are being used to provide competitive market advantage and to facilitate cooperation between business partners.
8. **Describe location-based commerce (l-commerce).** Location-based commerce is emerging in applications such as calculating arrival time of buses (using GPS) and calling for emergency services (wireless 911). In the future, it will be used to target advertising to individuals based on their location. Other innovative applications also are expected.
9. **Discuss the key characteristics and current uses of pervasive computing.** Pervasive computing is the world of "invisible" computing in which virtually every object has an embedded microprocessor that is connected in a wired and/or wireless fashion to the Internet. In context-aware computing, a computer captures the contextual variables of the user and the environment and then provides, in real time, various services to users. Current uses of pervasive computing include some early applications in homes, appliances, and cars (e.g., On Star). Many more applications are still in the experimental stage. Eventually, an Internet of things—homes, appliances, cars, and any manufactured items—will provide a number of life-enhancing, consumer-centric, and B2B applications.
10. **Describe the major inhibitors and barriers of mobile computing and m-commerce.** The major limitations of mobile computing are: small screens on mobile devices, limited bandwidth, high cost, lack of (or small) keyboards, transmission interferences, unproven security, and possible health hazards. Many of these limitations are expected to diminish over time. The primary legal/ethical limitations of m-commerce relate to privacy issues.

INTERACTIVE LEARNING

DISCUSSION QUESTIONS

1. Discuss how m-commerce can expand the reach of e-business.
2. Discuss why wireless mobile computing may be superior to mobile computing that is *not* wireless.
3. How are GIS and GPS related?
4. List three to four major advantages of wireless commerce to consumers, presented in this chapter, and explain what benefits they provide to consumers.
5. Discuss the ways in which Wi-Fi is being used to support mobile computing and m-commerce. Describe the ways in which Wi-Fi is affecting the use of cellular phones for m-commerce.
6. Describe some m-commerce B2B applications along the supply chain.
7. You can use location-based tools to help you find your car or the closest gas station. However, some people see location-based tools as an invasion of privacy. Discuss the pros and cons of location-based tools.
8. Which of the applications of pervasive computing—smart cars, homes, appliances, consumer products, and other objects—do you think are likely to gain the greatest market acceptance over the next few years? Why?

PROBLEM-SOLVING ACTIVITIES

1. Enter *kyocera-wireless.com*. Take the smart tour and view the demos. What is a smartphone? What are its capabilities? How does it differ from a regular cell phone?
2. Enter *www.i3mobile.com*. Run the Pronto demo. What types of services are provided by Pronto? What types of users would be more likely to use Pronto rather than a smartphone?
3. Using a search engine, try to determine whether there are any commercial Wi-Fi hotspots in your area. Enter *wardriving.com*. Based on information provided at this site, what sorts of equipment and procedures could you use to locate hotspots in your area?

INTERNET ACTIVITIES

1. Explore *nokia.com*. Prepare a summary of the types of mobile services and applications Nokia currently supports and plans to support in the future.
2. Enter *ibm.com*. Search for *wireless e-business*. Research the resulting stories to determine the types of wireless capabilities and applications IBM's software and hardware supports. Describe some of the ways these applications have helped specific businesses and industries.
3. Enter *mapinfo.com* and look for the location-based services demos. Try all the demos. Find all of the wireless services. Summarize your findings.
4. Enter *packetvideo.com* and *microsoft.com/mobile/pocketpc*. Examine their demos and products and list their capabilities.
5. Enter *onstar.com*. What types of *fleet* services does OnStar provide? Are these any different from the services OnStar provides to individual car owners?
6. Enter *mdsi-advantex.com* and review the wireless products for the enterprise. Summarize the advantages of the different products.
7. Enter *zilog.com/about/partners/011600.html* and find information about smart appliances.

TEAM ASSIGNMENTS

1. Each team should examine a major vendor of mobile devices (Nokia, Kyocera, Motorola, Palm, BlackBerry, etc.). Each team will research the capabilities and prices of the devices offered by each company and then make a class presentation, the objective of which is to convince the rest of the class why one should buy that company's products.
2. Each team should explore the commercial applications of m-commerce in one of the following areas: financial services, including banking, stocks, and insurance; marketing and advertising; manufacturing; travel and transportation; human resources management; public services; and health care. Each team will present a report to the class based on their findings. (Start at *mobiforum.org*.)
3. Each team should take one of the following areas—homes, cars, appliances, or other consumer goods like clothing—and investigate how embedded microprocessors are currently being used and will be used in the future to support consumer-centric services. Each team will present a report to the class based on their findings.

REAL-WORLD CASE

HERTZ GOES WIRELESS

The car rental industry is very competitive, and Hertz (*hertz.com*), the world's largest car rental company, competes against hundreds of companies in thousands of locations. The competition focuses on customer acquisition and loyalty.

Hertz has been a "first mover" to information technologies since the 1970s. So it has naturally looked for new technologies to improve its competitive position. Hertz has pioneered the following mobile computing applications:

- ***Quick rentals.*** Upon arrival at the airport, Hertz's curbside attendant greets you if you have a reservation and transmits your name wirelessly to the renting booth. The renting-booth employee advises the curbside attendant about the location of your car. All you need to do is go to the slot where the car is parked and drive away. This system is now part of a national wireless network that can check credit cards, examine your rental history, determine which airline to credit your loyalty mileage to, and more.
- ***Instant returns.*** Pioneered by Hertz in 1987, a handheld device connected to a database via a wireless system expedites the car-return transaction. Right in the parking lot, the lot attendant uses a handheld device to calculate the cost of the rental and print a receipt for the renter. You check out in less than a minute, and you do not have to enter the renting booth at all.
- ***In-car cellular phones.*** Starting in 1988, Hertz began renting cell phones with its cars. Today, of course, this is not the big deal it was in 1988, when it was a major innovation.
- ***NeverLost Onboard.*** Some cars come equipped with an onboard GPS system, which provides route guidance in the form of turn-by-turn directions to many destinations. The information is displayed on a screen with computer-generated voice prompts. An electronic mapping system is combined with the GPS, enabling you to see on the map where you are and where you are going. Also, consumer information about the locations of the nearest hospitals, gas stations, restaurants, and tourist areas is provided.
- ***Additional customer services.*** Hertz's customers can download city guides, Hertz's location guide, emergency telephone numbers, city maps, shopping guides, and even reviews of restaurants, hotels, and entertainment into their PDAs and other wireless devices. Of course, driving directions are provided.
- ***Car locations.*** Hertz is experimenting with a GPS-based car-locating system. This will enable the company to know where a rental car is at any given time, and even how fast it is being driven. Although the company says it wants to collect such information in order to provide discounts based on your usage pattern, this capability is seen by many as an invasion of privacy. On the other hand, some may feel safer knowing that Hertz knows where they are at all times.

Source: hertz.com (2003) and J. A. Martin, "Mobile Computing: Hertz In-Car GPS," *PC World*, March 13, 2003, *pcworld.com/howto/article/0,aid,109560,00.asp* (accessed June 2003).

QUESTIONS

1. Which of these wireless applications are intrabusiness in nature? Which are customer-centered applications?
2. Identify any finance- and marketing-oriented applications.
3. What are the benefits to Hertz of knowing exactly where each of its cars is? As a renter, how do you feel about this capability?