

CHAPTER 10



Wireless, Mobile Computing,
and Mobile Commerce

CHAPTER OUTLINE

1. Wireless Technologies
2. Wireless Computer Networks and Internet Access
3. Mobile Computing and Mobile Commerce
4. The Internet of Things



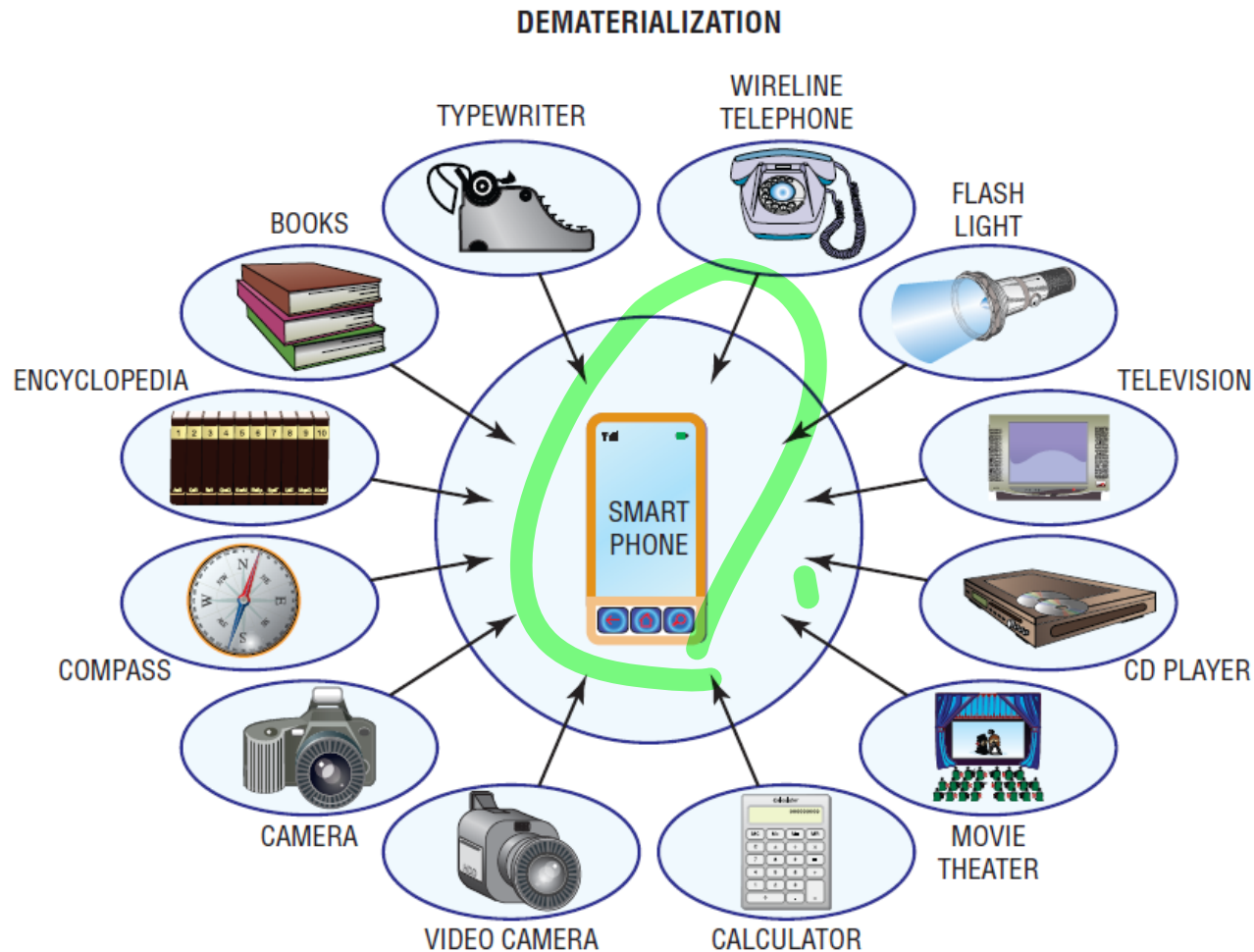
LEARNING OBJECTIVES

1. Identify advantages and disadvantages of each of the four main types of wireless transmission media.
 2. Explain how businesses can use short-range, medium-range, and long-range wireless networks.
 3. Provide a specific example of how each of the five major m-commerce applications can benefit a business.
 4. Describe the Internet of Things, along with examples of how organizations can utilize the Internet of Things.
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10.1 Wireless Technologies


- **Wireless:** without wires.
 - **Mobile:** something that changes its location over time.
 - **Mobile Computing:** a real-time, wireless connection between a mobile device and other computing environments, such as the Internet or an intranet.
 - **Mobile Commerce (or M-Commerce):** e-commerce (EC) transactions conducted with a mobile device.
 - **Pervasive Computing (or Ubiquitous Computing):** virtually every object has processing power with either wireless or wired connections to a global network.
 - **Dematerialization:** a phenomenon that occurs when the functions of many physical devices are included in one other physical device. Consider that your smartphone includes the functions of digital cameras for images and video, radios, televisions, Internet access via Web browsers, recording studios, editing suites, movie theaters, GPS navigators, word processors, spreadsheets, stereos, flashlights, board games, card games, video games, an entire range of medical devices, maps, atlases, encyclopedias, dictionaries, translators, textbooks, watches, alarm clocks, books, calculators, address books, credit card swipers, magnifying glasses, money and credit cards, car keys, hotel keys, cellular telephony, Wi-Fi, e-mail access, text messaging, a full QWERTY keyboard, and many, many others.
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Figure 10.1: Dematerialization with Smartphones



Wireless Devices

Wireless Devices Provide Three Major Advantages:

1. Small enough to easily carry or wear
 2. Sufficient computing power to perform productive tasks.
 3. Can communicate wirelessly with the Internet and other devices.
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Wireless Transmission Media

- Microwave
- Satellite
 - Types of Orbits
 - Global Positioning Systems
 - Radio

Wireless Transmission Media: **Microwave**

- **Advantages of Microwave**

- High bandwidth
- Relatively inexpensive

- **Disadvantages of Microwave**

- Must have unobstructed line of sight
 - Susceptible to environmental
 - interference
-

Wireless Transmission Media: ~~Satellite~~

- Advantages of Satellite
 - High bandwidth
 - Large coverage area
- Disadvantages of Satellite
 - Expensive
 - Must have unobstructed line of sight
 - Signals experience propagation delay
 - Must use encryption for security

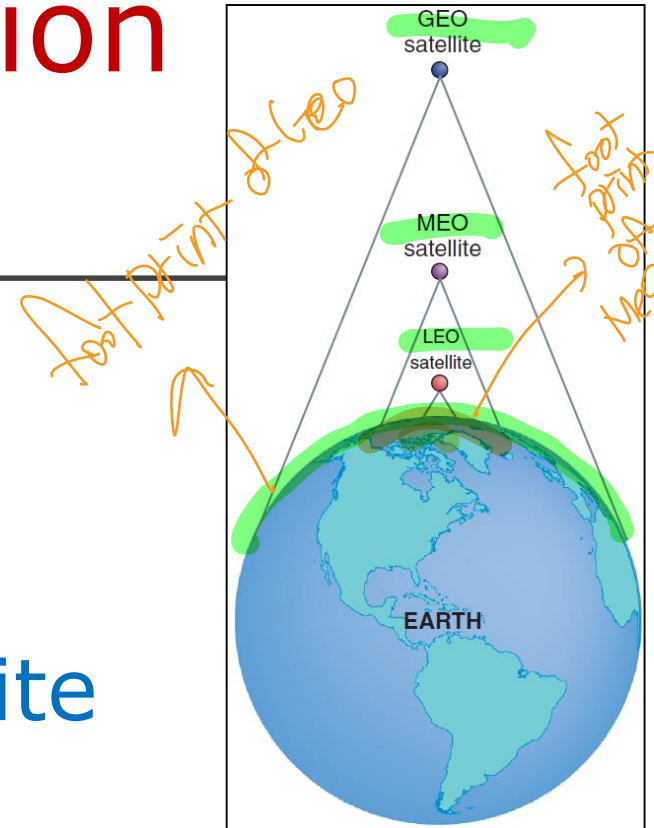


Table 10.1 Advantages & Disadvantages of Wireless Media

Channel	Advantages	Disadvantages
Microwave	High bandwidth Relatively inexpensive	Must have unobstructed line of sight Susceptible to environmental interference
Satellite	High bandwidth Large coverage area	Expensive Must have unobstructed line of sight Signals experience propagation delay Must use encryption for security
Radio	High bandwidth Signals pass through walls Inexpensive and easy to install	Creates electrical interference problems Susceptible to snooping unless encrypted
Infrared	Low to medium bandwidth	Must have unobstructed line of sight Used only for short distances

Satellites


- Three Types of Satellites Circling Earth
 1. Geostationary-Earth-Orbit (GEO)
 2. Medium-Earth-Orbit (MEO)
 3. Low-Earth-Orbit (LEO)
 - **Footprint:** the area of Earth's surface reached by a satellite's transmission overcomes the limitations of microwave data relay stations. The higher a satellite orbits, the larger its footprint.
 - **Propagation Delay:** One major limitation of GEO satellites is that their transmissions take a quarter of a second to send and return from the earth's surface.
 - **Internet Over Satellite (IoS):** in remote parts of the world it is the only option available for Internet connections because installing cables is either too expensive or physically impossible.
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Table 10.2: Three Basic Types of Telecommunications Satellites

Type	Characteristics	Orbit	Number	Use
GEO	<ul style="list-style-type: none">• Satellites stationary relative to point on Earth• Few satellites needed for global coverage• Transmission delay (approximately 0.25 second)• Most expensive to build and launch• Longest orbital life (many years)	22,300 miles	8	TV signal
MEO	<ul style="list-style-type: none">• Satellites move relative to point on Earth• Moderate number needed for global coverage• Requires medium-powered transmitters• Negligible transmission delay• Less expensive to build and launch• Moderate orbital life (6–12 years)	6,434 miles	10–12	GPS
LEO	<ul style="list-style-type: none">• Satellites move rapidly relative to point on Earth• Large number needed for global coverage• Requires only low-power transmitters• Negligible transmission delay• Least expensive to build and launch• Shortest orbital life (as low as 5 years)	400–700 miles	Many	Telephone

Satellites: Geostationary-Earth-Orbit (GEO)

- 22,300 miles above earth
 - Stationary relative to a point on Earth
 - Transmission delay (.25 seconds)
 - Longest orbital life (many years)
 - Few Needed for Global Coverage
 - Used for Television Signals
 - Most Expensive to Build and Launch
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Satellites: Medium-Earth-Orbit (MEO)

- 6,434 miles above earth
 - Satellites moves relative to a point on Earth
 - Negligible transmission delay
 - Moderate orbital life (6-12 years)
 - Moderate number needed for global coverage
 - Used for Global Positioning Systems
 - Less Expensive to Build and Launch
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Satellites: Low-Earth-Orbit (LEO)

- 400-700 miles above earth
 - Move rapidly in relation to a point on Earth
 - Negligible transmission delay
 - Shortest orbital life (low as 5 years)
 - Large Number Needed for Global Coverage
 - Least Expensive to Build and Launch
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Figure 10.3: Obtaining GPS Information in an Automobile



Jeff Chiu/ASSOCIATED PRESS

Wireless Transmission

Media: ~~Radio~~

- **Radio:** uses radio-wave frequencies to send data directly between transmitters and receivers.
 - **Satellite Radio (or digital radio):** offers uninterrupted, near CD-quality transmission that is beamed to your radio, either at home or in your car, from space. In addition, satellite radio offers a broad spectrum of stations, including many types of music, news, and talk.
 - **Advantages of Radio**
 - High bandwidth
 - Signals pass through walls
 - Inexpensive and easy to install
 - **Disadvantages of Radio**
 - Creates electrical interference problems
 - Susceptible to snooping unless encrypted
-



Wireless Security



• Four Major Challenges to Wireless Networks:

– Rogue Access

- an unauthorized access point into a wireless network. The rogue could be someone in your organization who sets up an access point meaning no harm but fails to inform the IT department. In more serious cases, the rogue is an **"evil twin"**—someone who wishes to access a wireless network for malicious purposes.

• Evil Twin Attack

- attacker is in the vicinity with a Wi-Fi-enabled computer and a separate connection to the Internet.

• Hotspotter

- a device that detects wireless networks and provides information on them (see www.canarywireless.com)—the attacker simulates a wireless access point with the same wireless network name, or SSID, as the one that authorized users expect. If the signal is strong enough, users will connect to the attacker's system instead of the real access point. The attacker can then serve them a Web page asking for them to provide confidential information such as usernames, passwords, and account numbers.

Wireless Security

- Four Major Challenges to Wireless Networks:



- War Driving

- the act of locating WLANs while driving (or walking) around a city or elsewhere.

- Eavesdropping *도청*

- efforts by unauthorized users to access data that are traveling over wireless networks.

- Radio-Frequency (RF) Jamming

- a person or a device intentionally or unintentionally interferes with your wireless network transmissions.

*ex) Airplane
Jamming
↓ dangerous*

10.2 Wireless Computer Networks and Internet Access

- **Short-Range Wireless Networks:** have a range of 100 feet or less (e.g., Bluetooth, ultra-wideband (UWB), and near-field communications (NFC)).
 - **Medium-Range Wireless Networks:** the familiar wireless local area networks (WLANs) and the most common type of Medium-Range network is wireless fidelity (Wi-Fi).
 - **Wide-Area Wireless Networks:** networks that connect users to the Internet over a geographically dispersed territory, they typically operate over the licensed spectrum (government regulation).that is, they use portions of the wireless spectrum that are regulated by the government.
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Short-Range Wireless Networks

- Bluetooth
 - an industry specification used to create small personal area networks.
 - Bluetooth 1.0
 - can link up to eight devices within a 10-meter area (about 30 feet) with a bandwidth of 700 kilobits per second (Kbps) using low-power, radio-based communication.
 - Bluetooth 4.0
 - can transmit up to approximately 25 megabits per second (Mbps) up to 100 meters (roughly 300 feet).
 - Personal Area Network
 - a computer network used for communication among computer devices (e.g., telephones, personal digital assistants, and smartphones) located close to one person
-

Short-Range Wireless Networks

- Ultra-Wideband

- a high-bandwidth wireless technology with transmission speeds in excess of 100 Mbps.
- UWB is a good choice for applications such as streaming multimedia from a personal computer to a television.

- Near-Field Communications

NFC

- has the smallest range of any short-range wireless networks, and is designed to be embedded in mobile devices such as cell phones and credit cards.
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Medium-Range Wireless Networks


- **Medium-Range Wireless Networks:** the familiar wireless local area networks (WLANs) and the most common type of Medium-Range network is wireless fidelity (Wi-Fi).
 - **Wireless Fidelity (Wi-Fi):** a medium-range WLAN.
 - **Wireless Mesh Networks:** networks using multiple Wi-Fi access points to create a wide area network that can be quite large and are essentially a series of interconnected local area networks.
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Figure 10.4: Wireless Access Point



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Wireless Fidelity (Wi-Fi)

- **Wireless Access Point:** a Wi-Fi medium range WLAN and a typical configuration includes a transmitter with an antenna.
 - **Hotspot:** a wireless access point that provides service to a number of users within a small geographical perimeter (up to approximately 300 feet).
 - **Wi-Fi Direct:** enables peer-to-peer communications, so devices can connect directly allowing users to transfer content among devices without having to rely on a wireless antenna. It can connect pairs or groups of devices at Wi-Fi speeds of up to 250 Mbps and at distances of up to 800 feet.
 - **MiFi:** a small, portable wireless device that provides users with a permanent Wi-Fi hotspot wherever they go with a range of about 10 meters (roughly 30 feet).
 - **Super Wi-Fi:** a wireless network proposal that creates long-distance wireless Internet connections which uses the lower-frequency “white spaces” between broadcast TV channels which enable the signal to travel further and penetrate walls better than normal Wi-Fi frequencies.
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IEEE Wi-Fi Standards

- Institute of Electrical and Electronics Engineers (IEEE) WiFi Standards
 - **802.11a:** supports wireless bandwidth up to 54 Mbps; high cost; short range; difficulty penetrating walls.
 - **802.11b:** supports wireless bandwidth up to 11 Mbps; low cost; longer range.
 - **802.11g:** supports wireless bandwidth up to 54 Mbps; high cost; longer range.
 - **802.11n:** supports wireless bandwidth exceeding 600 Mbps; higher cost than 802.11g; longer range than 802.11g.
 - **802.11ac:** will support wireless bandwidth of 1.3 Gbps (1.3 billion bits per second); will provide the ability to fully support a “multimedia home” in which high-definition video can be streamed simultaneously to multiple devices. Essentially, you will be able to wirelessly network your TV, DVR, smartphone, and sound system for complete ondemand access through any Internet-enabled device.
 - **802.11 ad:** supports wireless bandwidth up to 7 Gbps; targeted to the “wireless office” as opposed to the “wireless home.”
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Major Benefits of Wi-Fi

- Low cost
- Ability to provide simple Internet access

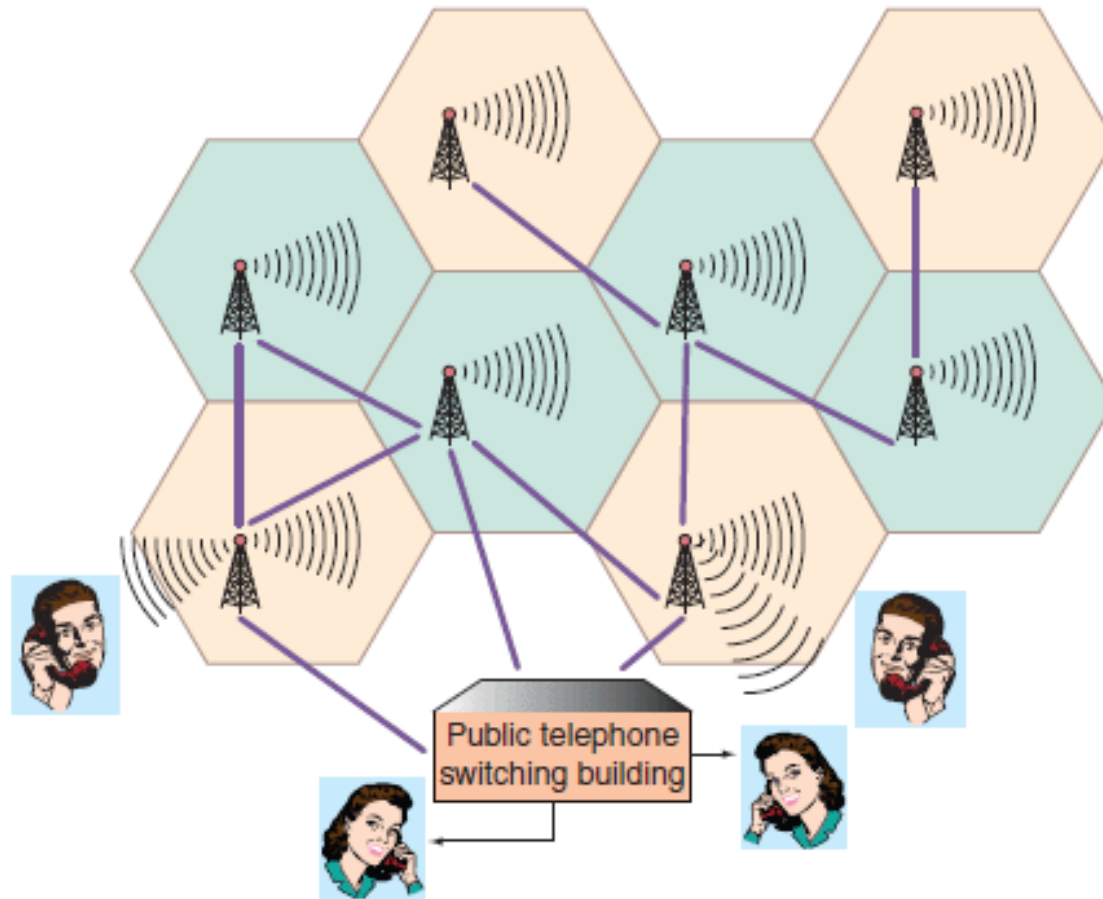
Three Factors Preventing Commercial Wi-Fi Market from Expanding:

- **Roaming:** At this time, users cannot roam from hotspot to hotspot if the hotspots use different Wi-Fi network services. Unless the service is free, users have to log on to separate accounts.
 - **Security:** the second barrier to greater acceptance of Wi-Fi because Wi-Fi uses radio waves, it is difficult to shield from intruders.
 - **Cost:** even though Wi-Fi services are relatively inexpensive, many experts question whether commercial Wi-Fi services can survive when so many free hotspots are available to users.
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Wide-Area Wireless Networks

- **Cellular Radio:** Cellular telephones (cell phones) provide two-way radio communications over a cellular network of base stations with seamless handoffs.
 - **Wireless Broadband or WiMAX:** Worldwide Interoperability for Microwave Access, popularly known as WiMAX, is the name for IEEE Standard 802.16 which has a wireless access range of up to 31 miles and a data transfer rate of up to 75 Mbps. It is a secure system, and it offers features such as voice and video.
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Figure 10.5: Smart Phone & GPS system




Generations of Cellular Technology Evolution

- **First generation (1G):** cellular networks used analog signals and had low bandwidth (capacity).
- **Second generation (2G):** uses digital signals primarily for voice communication; it provides data communication up to 10 Kbps.
- **2.5G:** uses digital signals and provides voice and data communication up to 144 Kbps.
- **Third generation (3G):** uses digital signals and can transmit voice and data up to 384 Kbps when the device is moving at a walking pace, 128 Kbps when it is moving in a car, and up to 2 Mbps when it is in a fixed location. It supports video, Web browsing, and instant messaging.
- **Fourth generation (4G):** is not one defined technology or standard. The International Telecommunications Union (ITU) has specified speed requirements for 4G: 100 Mbps (million bits per second) for high-mobility communications such as cars and trains, and 1 Gbps (billion bits per second) for low-mobility communications such as pedestrians. A 4G system is expected to provide a secure all-IP-based mobile broadband system to all types of mobile devices.
- **Fifth Generation (5G):** 5G networks are predicted to be faster and more intelligent than previous generations of cellular networks. With 5G, wearable computers (e.g., Fitbit), smartphones, tablets, and other devices with sensors that are location- and context-aware will work together with apps and services that you use.

6G

Wireless Broadband or WiMAX

- Worldwide Interoperability for Microwave Access (WiMAX)
 - WiMAX = IEEE Standard 802.16
 - Wireless access range of up to 31 miles
 - Data transfer rate of up to 75 Mbps
 - A secure system offering voice and video
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10.3 Mobile Computing and Mobile Commerce


- **Mobile Computing:** a real-time connection between a mobile device and other computing environments, such as the Internet or an intranet.
 - **Mobility:** means that users carry a device with them and can initiate a real-time contact with other systems from wherever they happen to be.
 - **Broad Reach:** when users carry an open mobile device, they can be reached instantly, even across great distances.
 - **Mobile Commerce**
 - **Mobile Commerce Applications**
-

Mobility and Broad Reach

Mobility and Broad Reach Create Five Value-added Attributes:

1. Ubiquity(regardless of user's location)
 2. Convenience
 3. Instant connectivity
 4. Personalization(customizing information and sending it to individual customers as SMS)
 5. Localization of products and services (by knowing user's physical location)
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Mobile Commerce

- Development of M-Commerce is Driven by:
 - **Widespread availability of mobile devices:** By mid-2014, some 6 billion cell phones were in use throughout the world. Cell phones are spreading more quickly in the developing world than the developed world. Experts estimate that within a few years about 70 percent of cell phones in developed countries will have Internet access. Mobile Internet access in developing countries will increase rapidly as well.
 - **Declining prices:** The price of wireless devices is declining and will continue to decline.
 - **Bandwidth improvement:** To properly conduct m-commerce, you need sufficient bandwidth for transmitting text, voice, video, and multimedia. Wi-Fi, 4G cellular technology, and WiMAX all provide the necessary bandwidth.
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Mobile Commerce Applications

- **Mobile Wallets:** technology that provides an alternative to swiping a plastic card at the checkout counter, consumers merely wave their phones a few inches above a payment terminal. This process uses a contact-free technology called near-field communications (NFC)
 - **Location-Based Commerce (L-Commerce):** Location-based mobile commerce.
 - **Location-Based Applications and Services:** M-commerce B2C applications include location-based services and location-based applications.
 - **Mobile Advertising:** a form of advertising via cell phones, smartphones, or other mobile devices.
 - **Financial Services**
 - **Intrabusiness Applications**
 - **Accessing Information**
 - Mobile Portal
 - Voice Portal
 - **Telemetry Applications**
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Mobile Wallets

- Softcard
 - Joint venture between AT&T, T-mobile and Verizon. Google acquired its intellectual property.
 - Google Wallet
 - A mobile wallet to use NFC to allow its users to store debit cards, credits cards, loyalty cards and gift cards on their smartphone.
 - Android Pay
 - Not need an app and not have to enter a pin. The wallet functionality is built in the OS.
 - MasterCard's Contactless, American Express's ExpressPay, and Visa's PayWave
 - Apple Pay
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Location-Based Applications and Services

- Location-Based Commerce (L-Commerce)
 - Location-based services provide information that is specific to a given location.
 - Location based advertising
 - Marketers can send user-specific advertising messages concerning nearby shops, malls, and restaurants to consumers' wireless devices.
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Benefits of Location-Based Services for Users:

- Request the nearest business or service, such as an ATM or a restaurant
 - Receive alerts, such as a warning of a traffic jam or an accident
 - Find a friend
 - Locating taxis, service personnel, doctors, and rental equipment
-

Benefits of Location-Based Services for Service Providers


- Schedule fleets
 - Tracking objects such as packages and train boxcars
 - Find information such as navigation, weather, traffic, and room schedules
 - Targeting advertising
 - Automating airport check-ins
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Mobile Commerce Applications: Financial Services

- **Financial Services:** Mobile financial applications including banking, wireless payments and micropayments, money transfers, wireless wallets, and bill payment services.
 - Mobile Banking
 - Micropayments
 - very small purchase amounts (generally less than \$10) are called micropayments.
 - Money Transfers
 - Wireless Mobile Wallets (M-Wallets)
 - enable cardholders to make purchases with a single click from their mobile device
 - Bill Payment Services
 - In China, SmartPay allows people to use their mobile phones to pay their phone bills and utility bills, buy lottery tickets and airline tickets, and make other purchases.
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Intrabusiness Applications

Mobile Computing For Employee Support:

- Workflow Applications
 - Companies can use non-voice mobile services to assist in dispatch functions—that is, to assign jobs to mobile employees, along with detailed information about the job.
 - Dispatch Functions
 - Target areas for mobile delivery and dispatch services include transportation (delivery of food, oil, newspapers, cargo; courier services; tow trucks; taxis), utilities (gas, electricity, phone, water); field service (computers, office equipment, home repair); healthcare (visiting nurses, doctors, social services); and security (patrols, alarm installation).
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Accessing Information

- **Mobile Portal:** portals that aggregates and provides content and services for mobile users. These services include news, sports, and e-mail; entertainment, travel, and restaurant information; community services; and stock trading.
 - **Voice Portal:** a Web site with an audio interface. A phone number connects you to a 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.
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Mobile Computing

Applications: Telemetry

- **Telemetry Applications:** the wireless transmission and receipt of data gathered from remote sensors.
 - Applications:
 - Identify maintenance problems in equipment
 - Monitor medical patients
 - Control medical equipment remotely
 - Remote vehicle diagnosis & preventive maintenance
 - Find My iPhone
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10.4 The Internet of Things



sensor

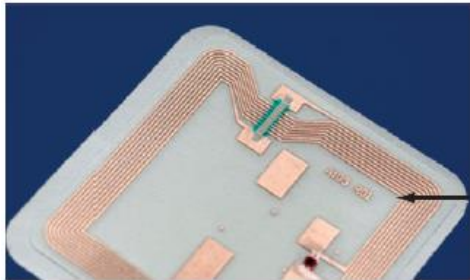
The Internet of Things (IoT): also called the Internet of Everything, the Internet of Anything, the Industrial Internet, and machine-to-machine (M2M) communication, is a system in which any object, natural or manmade, has a unique identity (i.e., its own IP address) and is able to send and receive information over a network (i.e., the Internet) without human interaction.

Radio-Frequency Identification (RFID): technology that allows manufacturers to attach tags with antennas and computer chips on goods and then track their movement through radio signals. RFID was developed to replace bar codes.

Wireless Sensor Networks (WSNs): networks of interconnected, battery powered, wireless sensors called motes that are placed into the physical environment.

Radio-Frequency Identification (RFID)

- RFID
- Bar Codes
- QR Codes



RFID tag



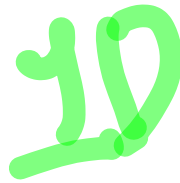
QR code



Barcode

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Media Bakery

Bar Codes



Universal Product Code (UPC): A typical bar code made up of 12 digits that are batched in various groups. The first digit identifies the item type, the next five digits identify the manufacturer, and the next five identify the product. The last digit is a check digit for error detection.

Limitations of Bar Codes:

- Requires line of sight from scanning device
- Pose substantial problems in manufacturing plants, warehouses and shipping/receiving docks
- Paper bar codes are easily damaged
- Identifies the manufacturer and product but not the actual item

QR Codes: 2D


Advantages Over Bar Codes

- **QR code:** a two-dimensional code, readable by dedicated QR readers and camera phones
- Store more information
- Data types stored include numbers, text, URLs, and even Japanese characters.
- Smaller because they store information both horizontally and vertically.
- Read from any direction or angle
- More resistant to damage

QR bar code



RFID

- **Radio-Frequency Identification (RFID):** technology that allows manufacturers to attach tags with antennas and computer chips on goods and then track their movement through radio signals. RFID was developed to replace bar codes.
 - **RFID Systems:** tags have embedded microchips, which contain data, and antennas to transmit radio signals over a short distance to RFID readers including information that uniquely identifies an item (location and when it was made).
 - **Two Basic Types of RFID Tags:**
 - **Active RFID:** tags that use internal batteries for power, and they broadcast radio waves to a reader.
 - **Passive RFID:** tags rely entirely on readers for their power, less expensive than active tags, and can be read only up to 20 feet.
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The Internet of Things (IoT)

- **Internet of Things (IoT):** a scenario in which objects, animals, and people are provided with unique identifiers and the ability to automatically transfer data over a network without requiring human-to-human or human-to-computer interaction.
 - **Examples of IoT Use:**
 - A heart monitor implant
 - A farm animal with a biochip transmitter
 - An automobile tire pressure
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Capabilities of IoT

- Reducing waste, loss, and cost
- Identifying the need for repair, replacement, or recall
- Tracking expiration data on perishable items

Examples of IoT Use

- **Smart Home**
 - your home computer, television, lighting and heating controls, home security system (including smart window and door locks), thermostats, and appliances have embedded sensors and can communicate with one another via a home network
- **Healthcare**
 - Patients with nonlife-threatening conditions can wear sensors, or have them implanted—for example, to monitor blood pressure or glucose levels—that are monitored by medical staff.
- **Automotive**
 - Modern cars have many sensors that monitor functions such as engine operation, tire pressure, fluid levels, and many others.
- **Supply Chain Management**
 - A company can now track, in real time, the movement of raw materials and parts through the manufacturing process to finished products delivered to the customer.

Examples of IoT Use

- **Environmental Monitoring**
 - Sensors monitor air and water quality, atmospheric and soil conditions, and the movements of wildlife.
 - **Energy Management**
 - Sensors will be integrated into all forms of energy-consuming devices; for example, switches, power outlets, light bulbs, and televisions.
 - **Agriculture**
 - Sensors monitor, in real time, air temperature, humidity, soil temperature, soil moisture, leaf wetness, atmospheric pressure, solar radiation, trunk/stem/fruit diameter, wind speed and direction, and rainfall.
 - **Transportation**
 - Sensors placed on complex transportation machines such as jet engines and locomotives can provide critical information on their operations.
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