Chapter 6

Telecommunications, the Internet, and Wireless Technology
STUDENT LEARNING OBJECTIVES

• What are the principal components of telecommunications networks and key networking technologies?

• What are the main telecommunications transmission media and types of networks?

• How do the Internet and Internet technology work and how do they support communication and e-business?
What are the principal technologies and standards for wireless networking, communication, and Internet access?

Why are radio frequency identification (RFID) and wireless sensor networks valuable for business?
• **Problem:** outdated physical facilities and IT infrastructure.

• **Solutions:** upgrade both facilities and IT by 2013.
Hyatt Regency Osaka Uses Wireless Networking for High-Touch Service

- **LAWA management** is setting up an Ethernet local-area network throughout the airport and will allow smaller airlines access to this technology.
- Demonstrates IT’s role in hastening the communication and flow of information.
- Illustrates digital technology’s role in contemporary networking technology.
Hyatt Regency Osaka Uses Wireless Networking for High-Touch Service

- Design networks
- Monitor service level and costs
- Redesign business processes to take advantage of new network technology
  - Deploy Ethernet LAN
  - Deploy Wi-Fi network
  - Deploy intranet
  - Deploy wireless handhelds

Business Challenges
- Outdated technology
- Outdated physical facilities

People

Organization

Information System
- Provide online services to passengers
- Provide networking services to airlines and airports

Business Solutions
- Increase efficiency
- Lower costs
- Increase customer service
Networking and Communication Trends

• Convergence:
  - Telephone networks and computer networks converging into single digital network using Internet standards
  - Cable companies providing voice service

• Broadband:
  - More than 60 percent U.S. Internet users have broadband access

• Broadband wireless:
  - Voice and data communication as well as Internet access are increasingly taking place over broadband wireless platforms
What Is a Computer Network?

• Two or more connected computers

• Major components in simple network
  • Client computer
  • Server computer
  • Network interfaces (NICs)
  • Connection medium
  • Network operating system
  • Hub or switch

• Routers
  • Device used to route packets of data through different networks, ensuring that data sent gets to the correct address
Illustrated here is a very simple computer network, consisting of computers, a network operating system residing on a dedicated server computer, cabling (wiring) connecting the devices, network interface cards (NIC), switches, and a router.
Networks in Large Companies

- Components can include:
  - Hundreds of local area networks (LANs) linked to firmwide corporate network
  - Various powerful servers
    - Web site
    - Corporate intranet, extranet
    - Backend systems
  - Mobile wireless LANs (Wi-Fi networks)
  - Videoconferencing system
  - Telephone network
  - Wireless cell phones
Today’s corporate network infrastructure is a collection of many different networks from the public switched telephone network, to the Internet, to corporate local area networks linking workgroups, departments, or office floors.

Figure 6-2
Key Digital Networking Technologies

- Client/server computing
  - Distributed computing model
  - Clients linked through network controlled by network server computer
  - Server sets rules of communication for network and provides every client with an address so others can find it on the network
  - Has largely replaced centralized mainframe computing
  - **The Internet:** largest implementation of client/server computing
Key Digital Networking Technologies

• Packet switching
  • Method of slicing digital messages into parcels (packets), sending packets along different communication paths as they become available, and then reassembling packets at destination
  • Previous circuit-switched networks required assembly of complete point-to-point circuit
  • Packet switching more efficient use of network’s communications capacity
Data are grouped into small packets, which are transmitted independently over various communications channels and reassembled at their final destination.

Figure 6-3
Key Digital Networking Technologies

- TCP/IP and connectivity
  - Connectivity between computers enabled by protocols
  - Protocols: rules that govern transmission of information between two points
  - Transmission Control Protocol/Internet Protocol (TCP/IP)
    - Common worldwide standard that is basis for Internet
  - Department of Defense reference model for TCP/IP
    - Four layers
      - Application layer
      - Transport layer
      - Internet layer
      - Network interface layer
The Transmission Control Protocol/Internet Protocol (TCP/IP) Reference Model

This figure illustrates the four layers of the TCP/IP reference model for communications.

Figure 6-4
Types of Networks

• Signals: digital versus analog
  • Modem: translates digital signals into analog form

• Local-area networks (LANs)
  • Campus-area networks (CANs)
  • Peer-to-peer
  • Topologies: star, bus, ring

• Metropolitan and wide-area networks
  • Wide-area networks (WANs)
  • Metropolitan-area networks (MANs)
A modem is a device that translates digital signals from a computer into analog form so that they can be transmitted over analog telephone lines. The modem also translates analog signals back into digital form for the receiving computer.
The three basic network topologies are the bus, star, and ring.

Figure 6-6
Physical Transmission Media

- Twisted wire (modems)
- Coaxial cable
- Fiber optics and optical networks
  - Dense wavelength division multiplexing (DWDM)
- Wireless transmission media and devices
  - Microwave
  - Satellites
  - Cellular telephones
- Transmission speed (hertz, bandwidth)
Communication satellites help BP Amoco transfer seismic data between oil exploration ships and research centers in the United States.

Figure 6-7
What is the Internet?

Internet addressing and architecture

- The Domain Name System
  - Hierarchical structure
  - Top-level domains

- Internet architecture and governance
  - No formal management: IAB, ICANN, W3C

- The future Internet: IPv6 and Internet2
The Domain Name System is a hierarchical system with a root domain, top-level domains, second-level domains, and host computers at the third level.

Figure 6-8
The Internet backbone connects to regional networks, which in turn provide access to Internet service providers, large firms, and government institutions. Network access points (NAPs) and metropolitan area exchanges (MAEs) are hubs where the backbone intersects regional and local networks and where backbone owners connect with one another.

Figure 6-9
Internet Services

- E-mail
- Chatting and instant messaging
- Newsgroups
- Telnet
- File Transfer Protocol (FTP)
- World Wide Web
- VoIP
- Virtual private network (VPN)
Client/Server Computing on the Internet

Client computers running Web browser and other software can access an array of services on servers over the Internet. These services may all run on a single server or on multiple specialized servers.

**Figure 6-10**
A VoIP phone call digitizes and breaks up a voice message into data packets that may travel along different routes before being reassembled at the final destination. A processor nearest the call’s destination, called a gateway, arranges the packets in the proper order and directs them to the telephone number of the receiver or the IP address of the receiving computer.

Figure 6-11
This VPN is a private network of computers linked using a secure “tunnel” connection over the Internet. It protects data transmitted over the public Internet by encoding the data and “wrapping” them within the Internet Protocol (IP). By adding a wrapper around a network message to hide its content, organizations can create a private connection that travels through the public Internet.
The World Wide Web

- **HTML (Hypertext Markup Language):**
  - Formats documents for display on Web

- **Hypertext Transfer Protocol (HTTP):**
  - Communications standard used for transferring Web pages

- **Uniform resource locators (URLs):**
  - Addresses of Web pages
  - E.g., http://www.megacorp.com/content/features/082602.html

- **Web servers**
  - Software for locating and managing Web pages
The World Wide Web

- **Search engines**
  - Started in early 1990s as relatively simple software programs using keyword indexes
  - Today, major source of Internet advertising revenue via **search engine marketing**, using complex algorithms and page ranking techniques to locate results

- **Shopping bots**
  - Use intelligent agent software for searching Internet for shopping information
The World Wide Web

- **Web 2.0**
  - Second-generation interactive Internet-based services enabling people to collaborate, share information, and create new services online

- **Blogs**: chronological, informal Web sites created by individuals using easy-to-use Weblog publishing tools

- **RSS (Really Simple Syndication)**: syndicates Web content so aggregator software can pull content for use in another setting or viewing later

- **Wikis**: collaborative Web sites where visitors can add, delete, or modify content on the site
The Google search engine is continuously crawling the Web, indexing the content of each page, calculating its popularity, and storing the pages so that it can respond quickly to user requests to see a page. The entire process takes about one-half second.

**Figure 6-13**
Google is the most popular search engine on the Web, handling 56 percent of all Web searches.

Figure 6-14
Intranets and Extranets

• **Intranets**
  - Use existing network infrastructure with Internet connectivity standards software developed for the Web.
  - Create networked applications that can run on many types of computers.
  - Protected by firewalls.

• **Extranets**
  - Allow authorized vendors and customers access to an internal intranet.
  - Used for collaboration.
  - Also subject to firewall protection.
The Wireless Revolution

- **Wireless devices**
  - PDAs, BlackBerry, smart phones

- **Cellular systems**
  - Competing standards for cellular service
    - United States: **CDMA**
    - Most of rest of world: **GSM**
  - Third-generation (3G) networks
    - Higher transmission speeds suitable for broadband Internet access
Wireless computer networks and Internet access

- Bluetooth (802.15)
  - Links up to 8 devices in 10-m area using low-power, radio-based communication
  - Useful for personal networking (PANs)

- Wi-Fi (802.11)
  - Set of standard: 802.11a, 802.11b, 802.11g, 802.11n
  - Used for wireless LAN and wireless Internet access
  - Use **access points**: device with radio receiver/transmitter for connecting wireless devices to a wired LAN
Bluetooth enables a variety of devices, including cell phones, PDAs, wireless keyboards and mice, PCs, and printers, to interact wirelessly with each other within a small 30-foot (10-meter) area. In addition to the links shown, Bluetooth can be used to network similar devices to send data from one PC to another, for example.

Figure 6-15
Mobile laptop computers equipped with wireless network interface cards link to the wired LAN by communicating with the access point. The access point uses radio waves to transmit network signals from the wired network to the client adapters, which convert them into data that the mobile device can understand. The client adapter then transmits the data from the mobile device back to the access point, which forward the data to the wired network.

Figure 6-16
Wireless computer networks and Internet access

- **Wi-Fi (cont.)**
  - **Hotspots:** one or more access points in public place to provide maximum wireless coverage for a specific area
  - **Weak security features**
- **WiMax (802.16)**
  - Wireless access range of 31 miles
  - Require WiMax antennas
- **Broadband cellular wireless**
  - Many cell services offer Wi-Fi capabilities for Internet access
Radio frequency identification (RFID)

- Use tiny tags with embedded microchips containing data about an item and location
- Tags transmit radio signals over short distances to special RFID readers, which send data over network to computer for processing
- **Active RFID**: tags have batteries, data can be rewritten, range is hundreds of feet, more expensive
- **Passive RFID**: range is shorter, also smaller, less expensive, powered by radio frequency energy
Radio frequency identification (RFID)

- Common uses:
  - Automated toll-collection
  - Tracking goods in a supply chain
  - Requires companies to have special hardware and software
  - Reduction in cost of tags making RFID viable for many firms
RFID uses low-powered radio transmitters to read data stored in a tag at distances ranging from 1 inch to 100 feet. The reader captures the data from the tag and sends them over a network to a host computer for processing.

Figure 6-17
Wireless sensor networks

- Networks of hundreds or thousands of interconnected wireless devices embedded into physical environment to provide measurements of many points over large spaces
- Used to monitor building security, detect hazardous substances in air, monitor environmental changes, traffic, or military activity
- Devices have built-in processing, storage, and radio frequency sensors and antennas
- Require low-power, long-lasting batteries and ability to endure in the field without maintenance
A Wireless Sensor Network

The small circles represent lower-level nodes and the larger circles represent high-end nodes. Lower-level nodes forward data to each other or to higher-level nodes, which transmit data more rapidly and speed up network performance.

Figure 6-18