Chapter 6

Telecommunications, the Internet, and Wireless Technology

Video Cases:
Case 1 Cisco Telepresence: Meeting without Traveling
Case 2 Virtual Collaboration for Lotus Sametime

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?

STUDENT LEARNING OBJECTIVES

- 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?

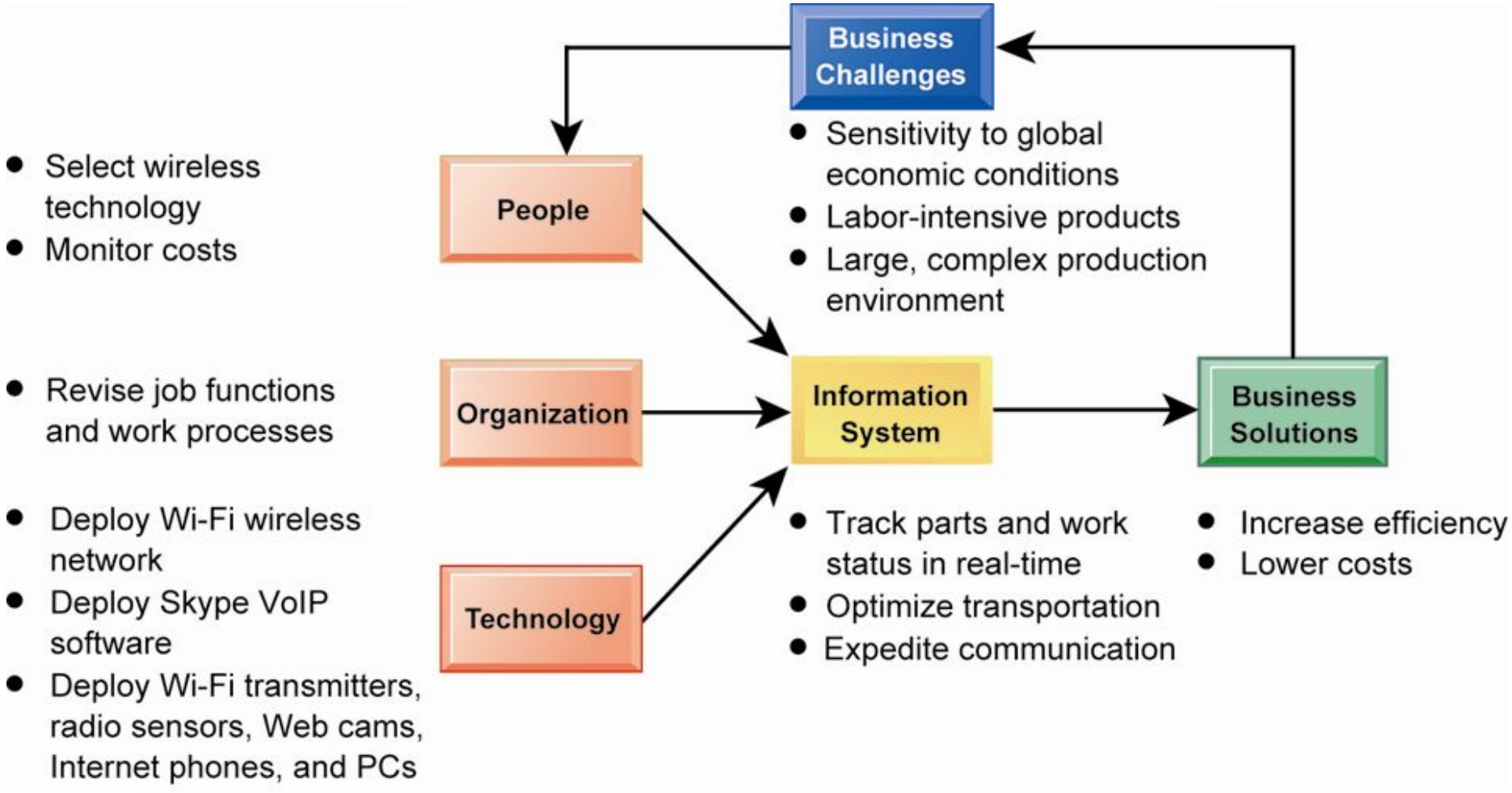
Hyundai Heavy Industries Creates a Wireless Shipyard

- **Problem:** Systems can't track inventory in 4.2 sq mi shipyard in real-time
- **Solution:** High-speed wireless network using radio sensors web cams, and more

Hyundai Heavy Industries Creates a Wireless Shipyard

- KT Corp builds high-speed wireless network using radio sensors, notebooks, mobiles, Web cams, and connected to electric lines in ships to overcome transmission problems cause by ship hulls
- Demonstrates powerful capabilities and solutions offered by contemporary networking technology
- Illustrates use of radio sensor technologies to track inventory

Hyundai Heavy Industries Creates a Wireless Shipyard



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 68% 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

Components of a Simple Computer Network

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.

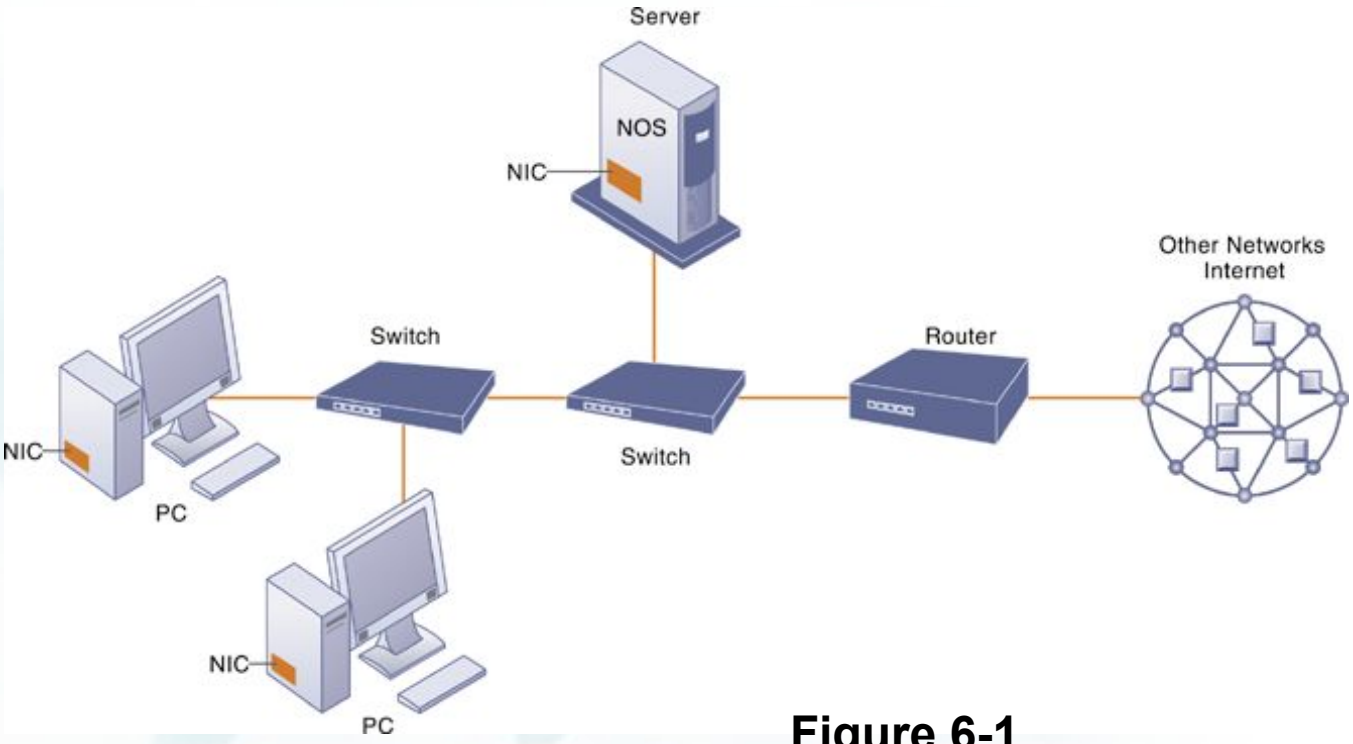


Figure 6-1

Networks in Large Companies

- **Components can include:**
  - Hundreds of local area networks (LANs) linked to firm-wide 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

Corporate Network Infrastructure

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.

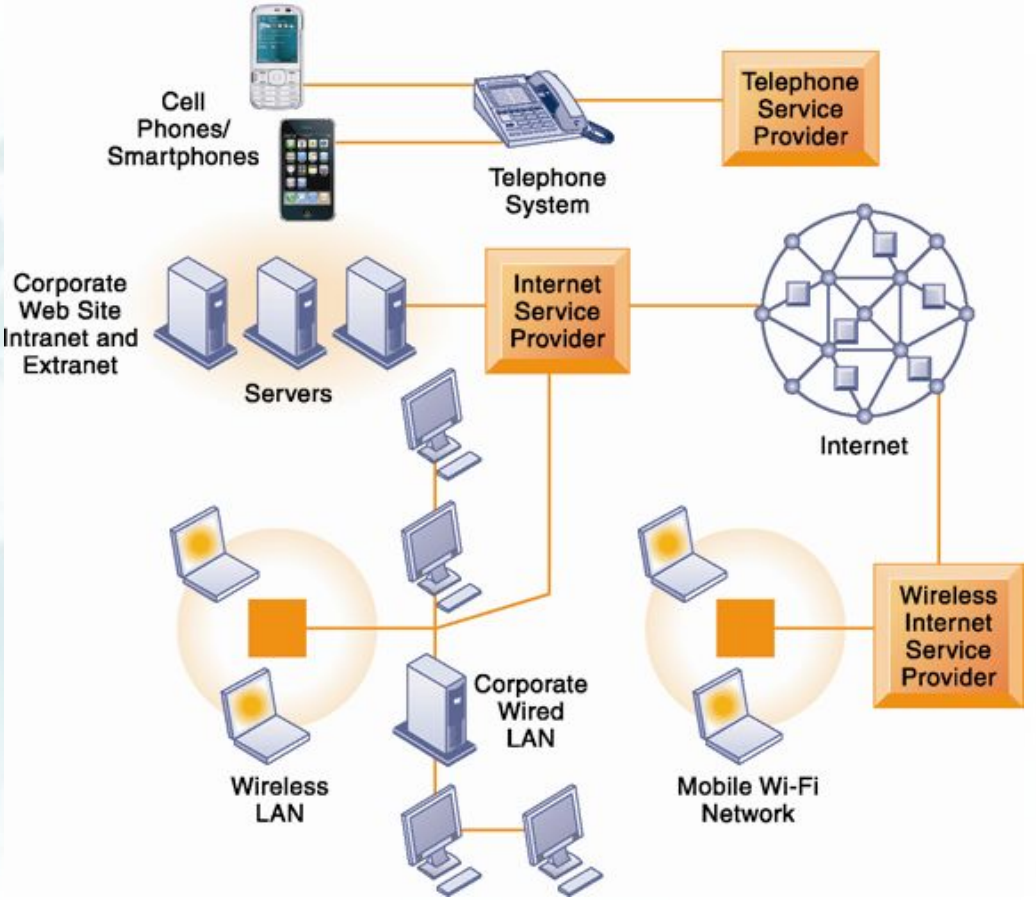


Figure 6-2

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

Packet-Switched Networks and Packet Communications

Data are grouped into small packets, which are transmitted independently over various communications channels and reassembled at their final destination.

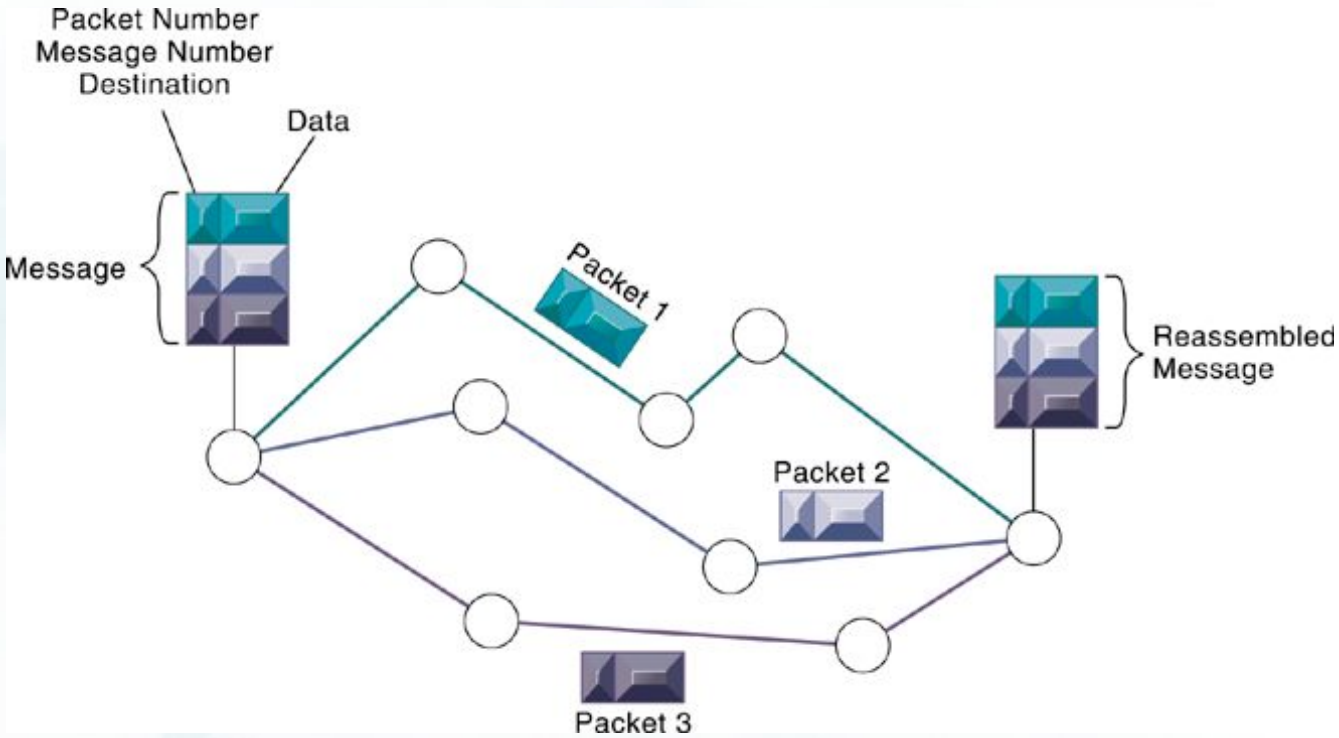


Figure 6-3

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.

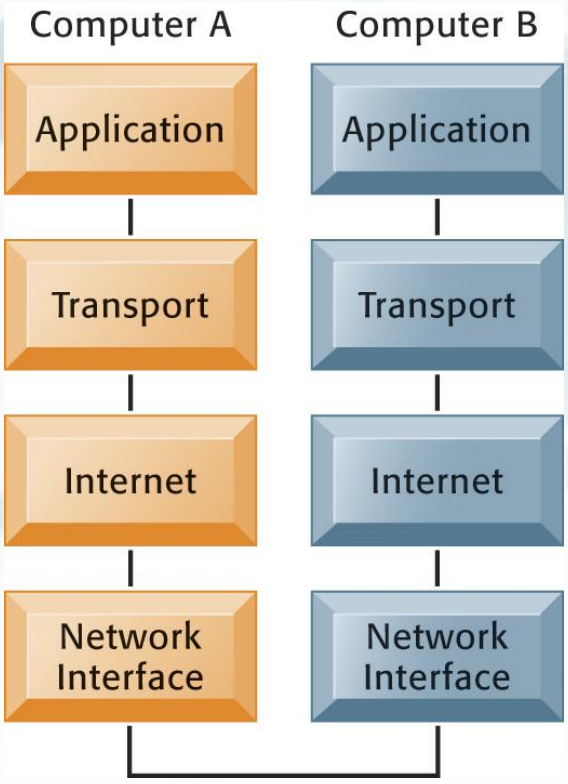


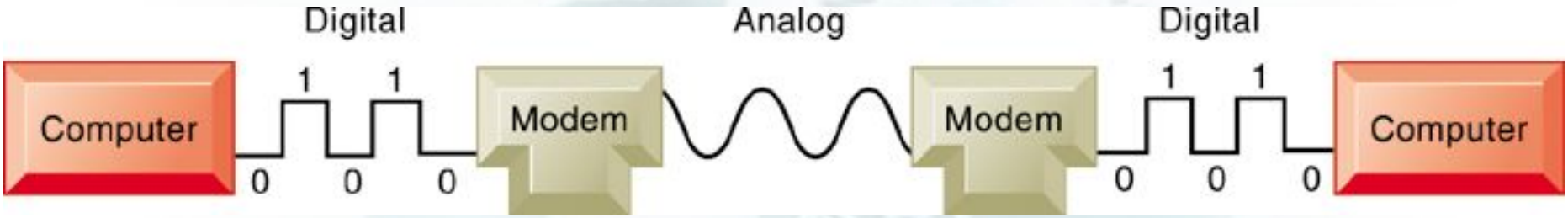
Figure 6-4

Types of Networks

- Signals: digital versus analog
  - Modem: translates digital signals into analog form
- Local-area networks (LANs)
  - Peer-to-peer
  - Client/server
  - Topologies: star, bus, ring
- Metropolitan and wide-area networks
  - Wide-area networks (WANs)
  - Metropolitan-area networks (MANs)

Communications Networks

Functions of the Modem



A modem is a device that translates digital signals into analog form (and vice versa) so that computers can transmit data over analog networks such as telephone and cable networks.

Figure 6-5

Communications Networks

Network Topologies

The three basic network topologies are the bus, star, and ring.

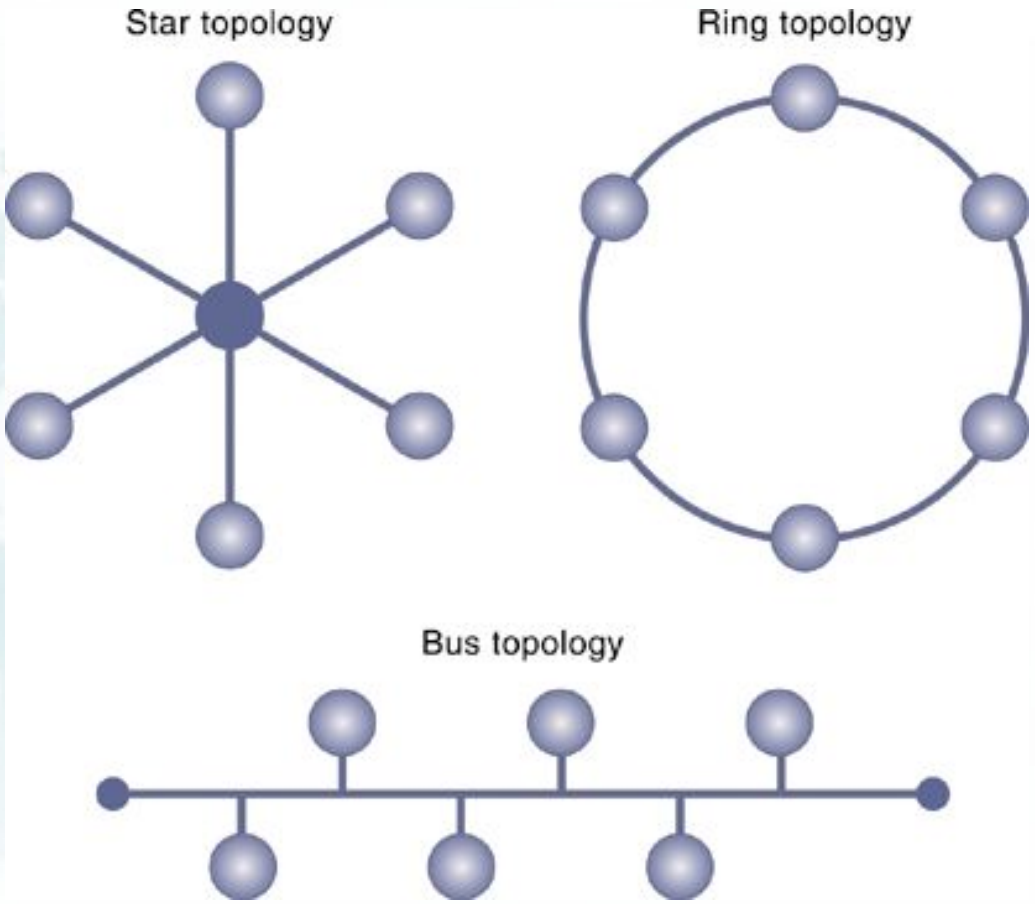


Figure 6-6

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 systems
- Transmission speed (hertz, bandwidth)

BP Amoco's Satellite Transmission System

Communication satellites help BP Amoco transfer seismic data between oil exploration ships and research centers in the United States.

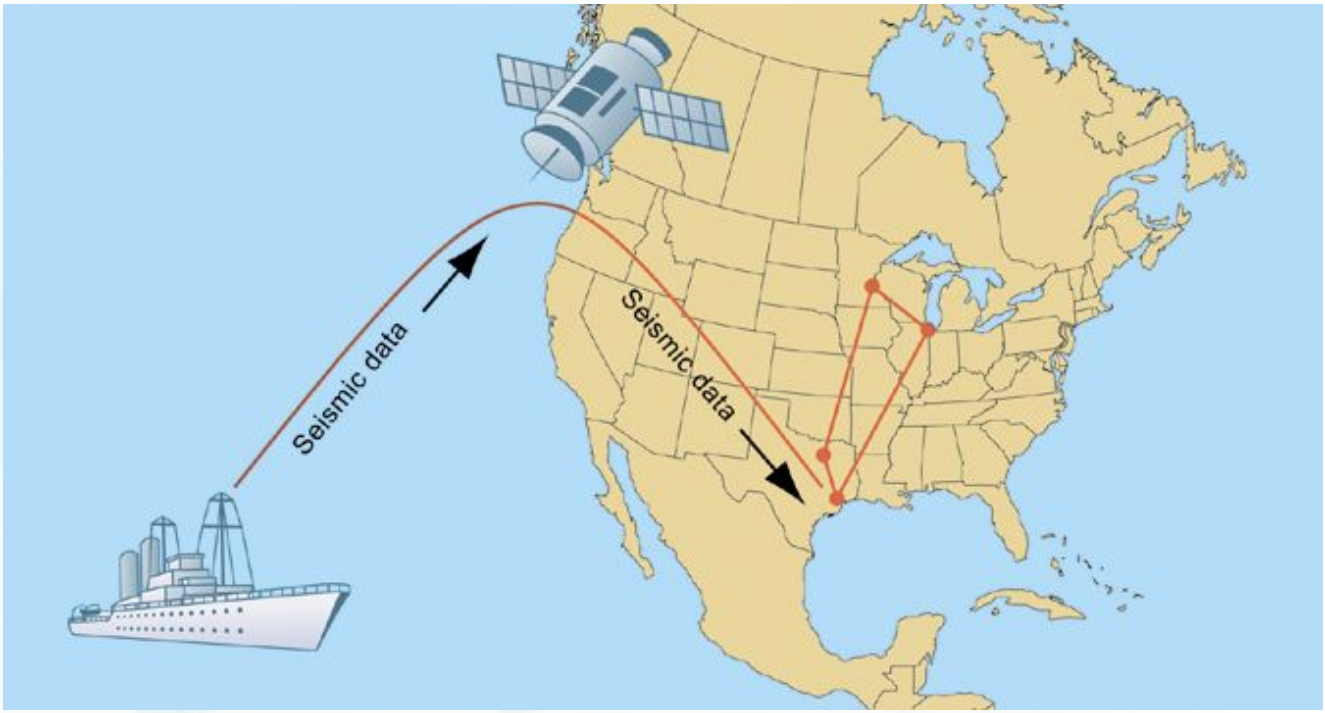


Figure 6-7

What Is the Internet?

- World's most extensive network
- Internet service providers (ISPs) provide connections
  - Digital subscriber line
  - Cable Internet connections
  - T1 lines

The Global Internet

- **Internet addressing and architecture**
  - **IP addresses**
- **The Domain Name System (DNS)** converts IP addresses to domain names
  - **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

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.

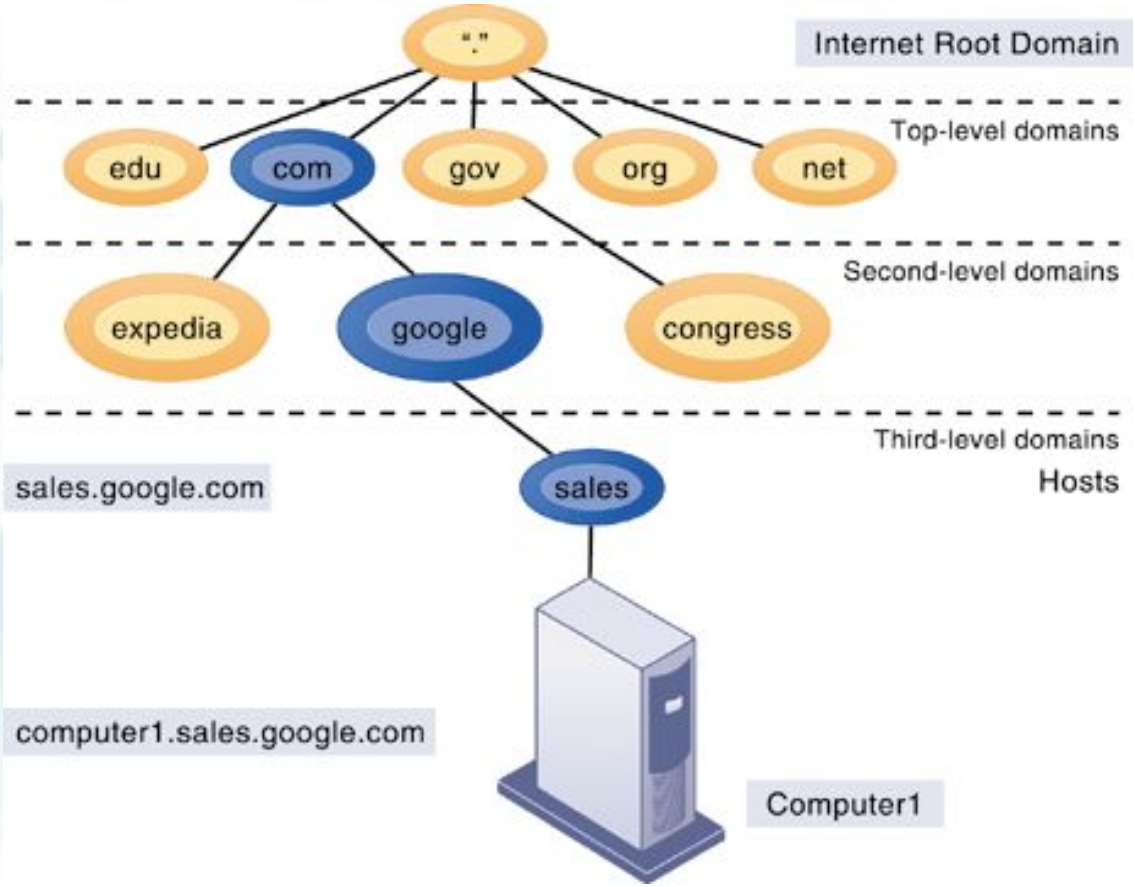


Figure 6-8

Internet Network Architecture

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.

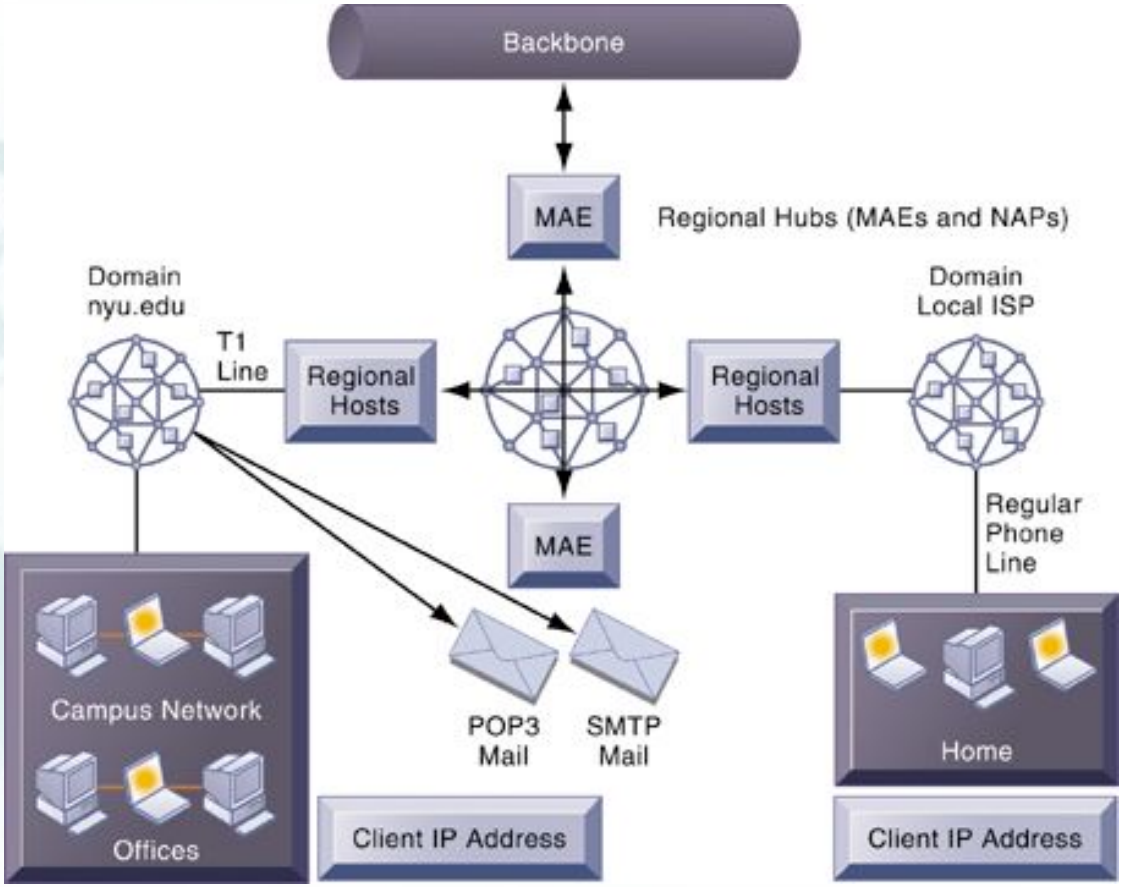


Figure 6-9

Interactive Session: Organizations
The Battle Over Net Neutrality

- **Read the Interactive Session and then discuss the following questions:**
  - **What is network neutrality? Why has the Internet operated under net neutrality up to this point in time?**
  - **Who's in favor of network neutrality? Who's opposed? Why?**
  - **What would be the impacts on individual users, businesses, and government if Internet providers switched to a tiered service model?**
  - **Are you in favor of legislation enforcing network neutrality? Why or why not?**

Internet Services

- Internet services
  - E-mail
  - Chatting and instant messaging
  - Newsgroups
  - Telnet
  - File Transfer Protocol (FTP)
  - World Wide Web
- VoIP
- Unified communications
- Virtual private network (VPN)

The Global Internet

Client/Server Computing on the Internet

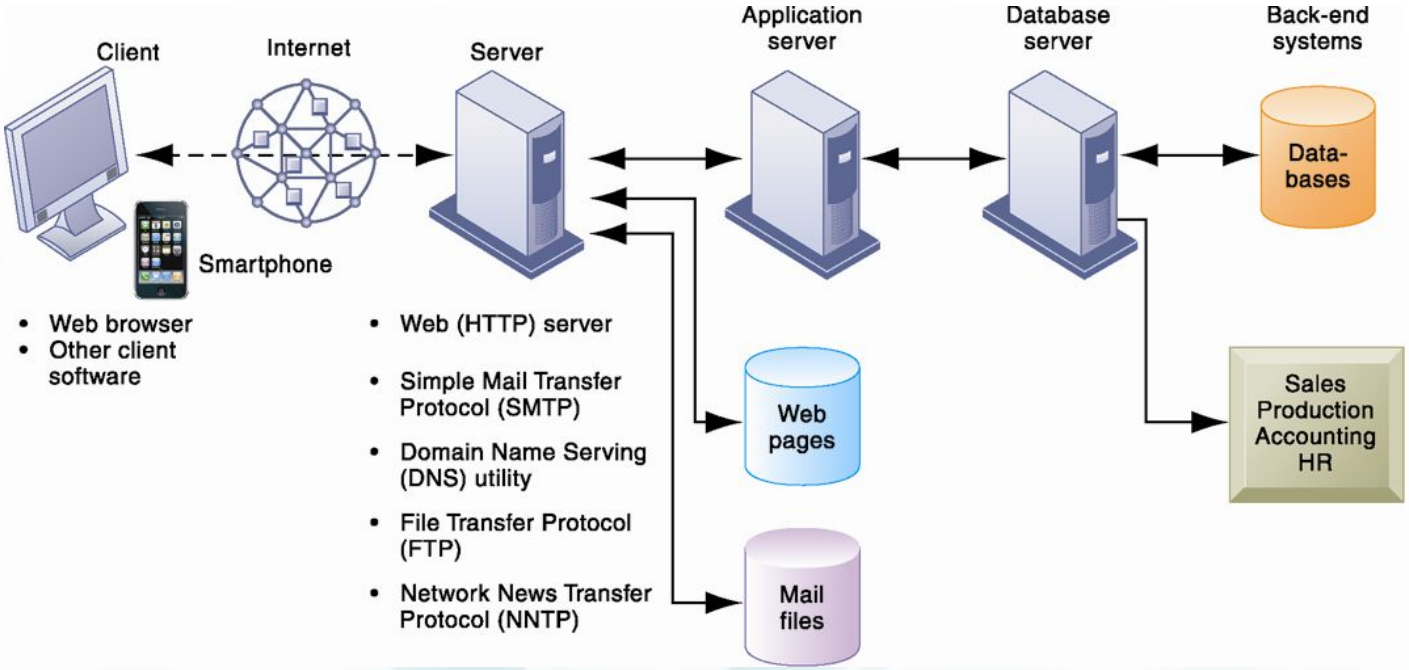
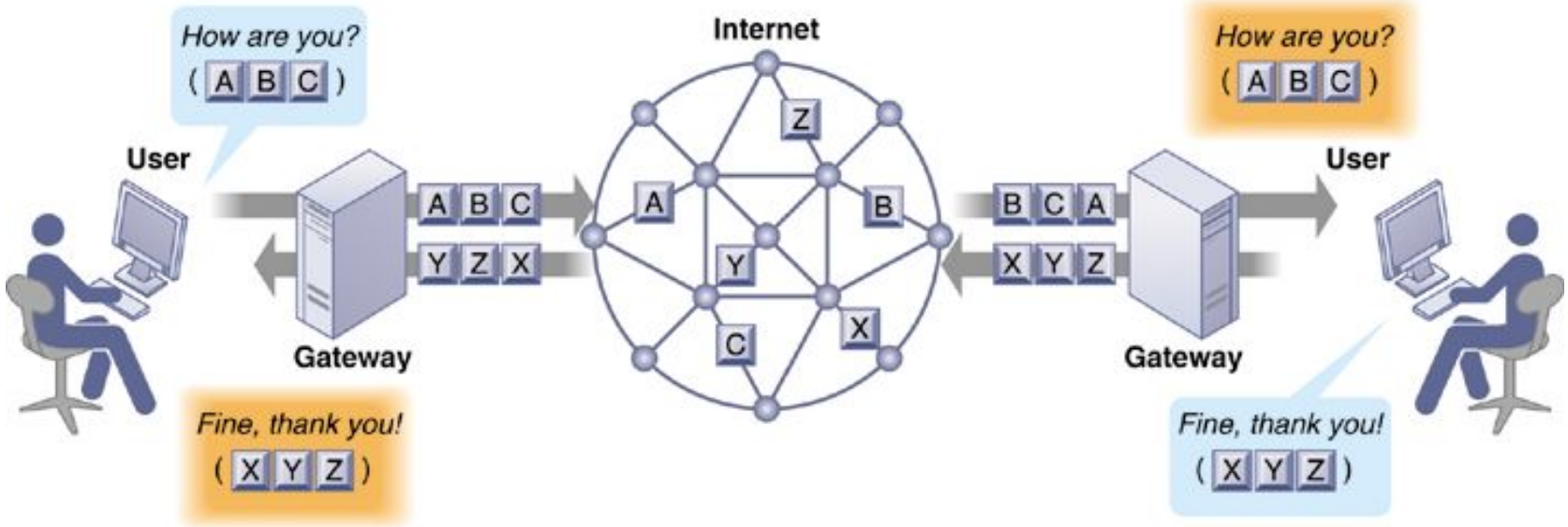


Figure 6-10

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.

The Global Internet



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

A Virtual Private Network Using the Internet

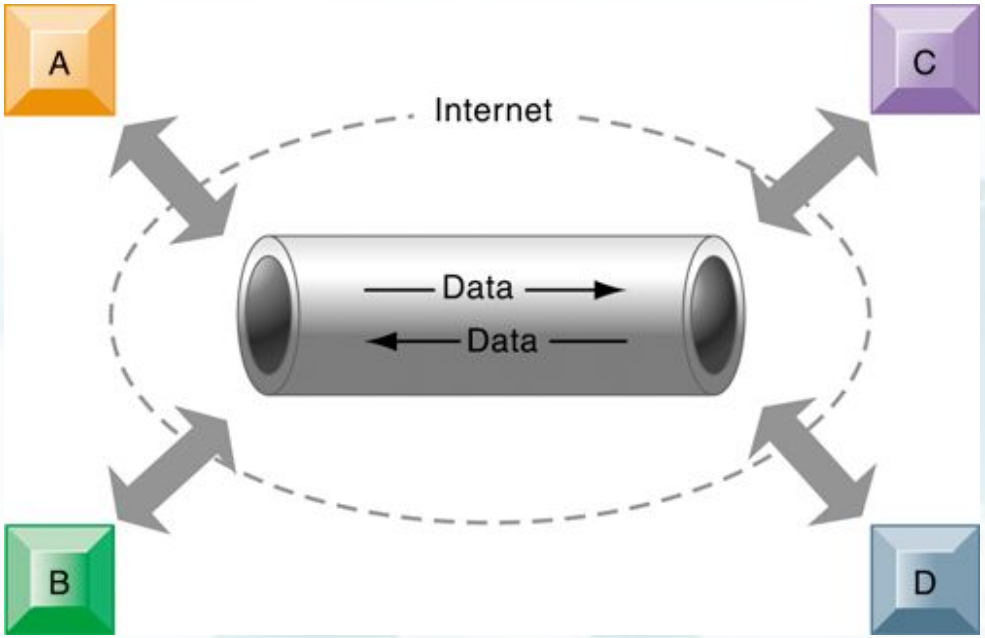


Figure 6-12

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.

Interactive Session: People
Monitoring Employees on Networks—Unethical or Good Business?

- **Read the Interactive Session and then discuss the following questions:**
  - **Should managers monitor employee e-mail and Internet usage? Why or why not?**
  - **Describe an effective e-mail and Web use policy for a company.**
  - **Should managers inform employees that their Web behavior is being monitored? Or should managers monitor secretly? Why or why not?**

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
  - **Mobile search—**now 15% of all searches in 2011
- **Search engine marketing**—major source of Internet advertising revenue
- **SEO**—process of improving rankings in search engine results
- **Social search**—Google +1, Facebook Like
- **Shopping bots**—Use intelligent agent software for searching Internet for shopping information

Top U.S. Web Search Engines

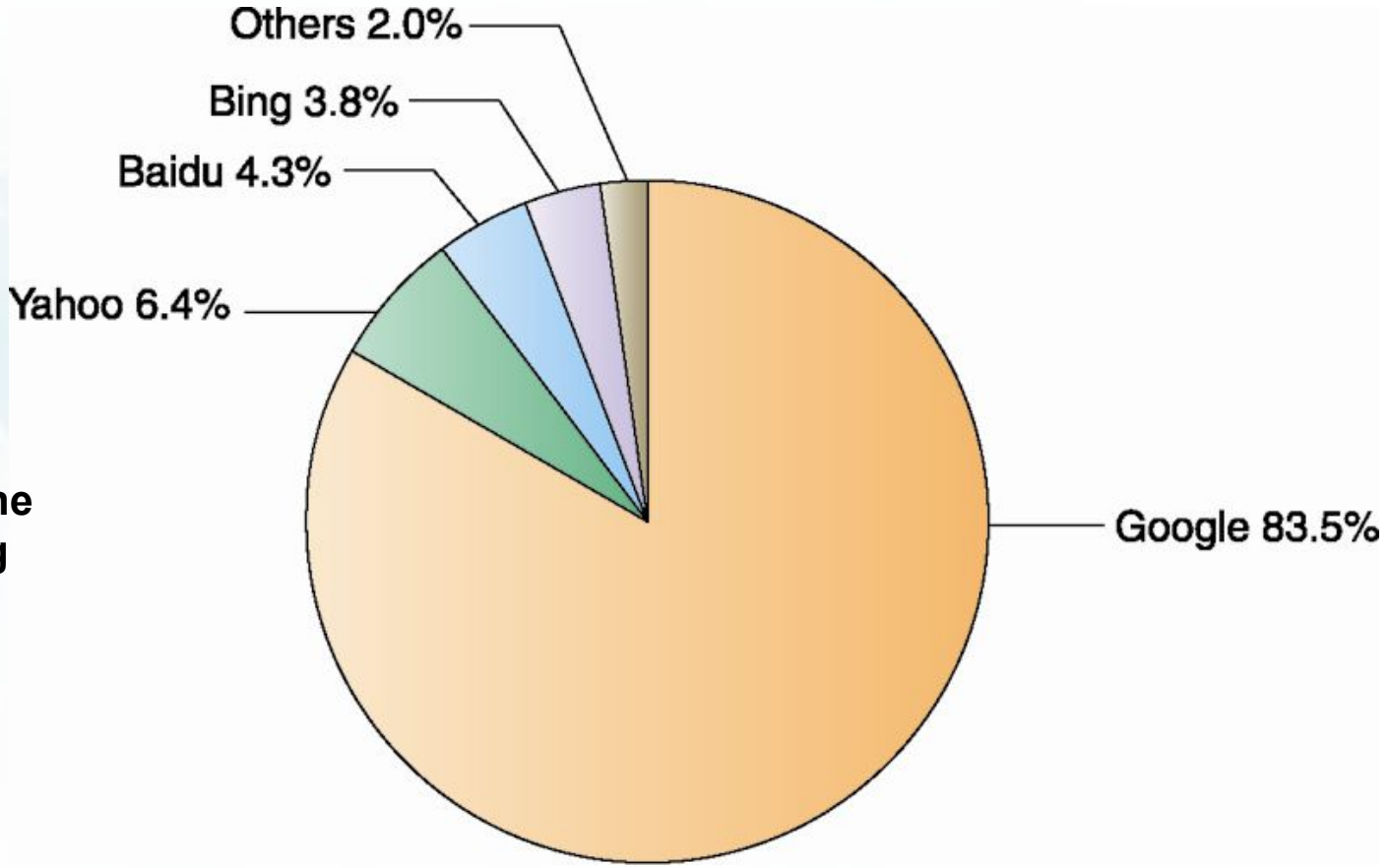


Figure 6-13

Google is the most popular search engine on the Web, handling 84% of all Web searches.

How Google Works

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.

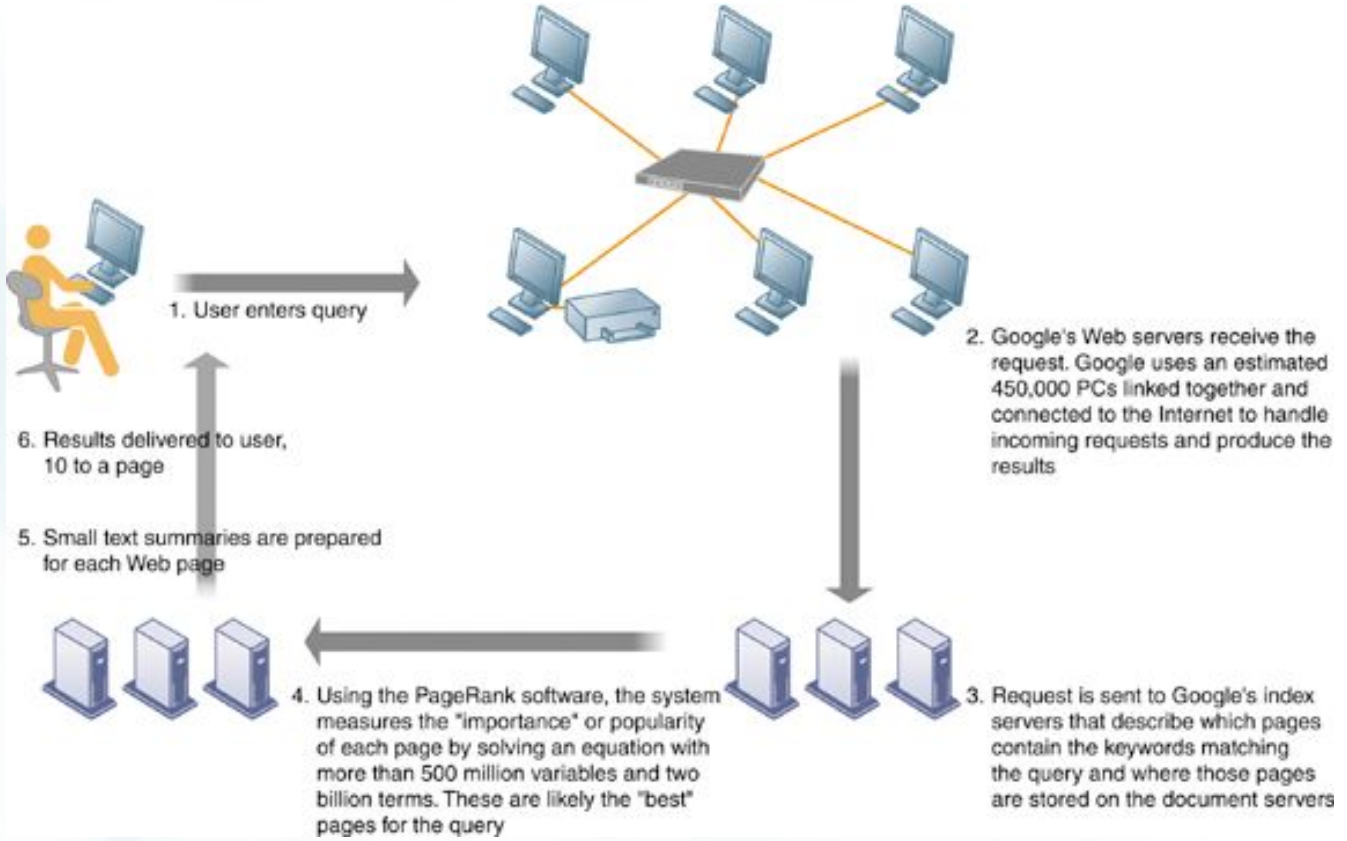


Figure 6-14

The World Wide Web

- **Web 2.0**
  - Second-generation services enabling people to collaborate, share information, and create new services online
  - **Blogs:** chronological, informal Web sites created by individuals
  - **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
  - **Social networking sites**—enable users to build communities of friends and share information

Web 3.0

- **"Semantic Web"**
  - A collaborative effort led by W3C to add layer of meaning to the existing Web
  - Goal is to reduce human effort in searching for and processing information
- **Ways to make Web more "intelligent" and intuitive**
  - Increased communication and synchronization with computing devices, communities
- **More widespread use of cloud computing, mobile computing**

- **Cellular systems**
  - **Competing standards for cellular service**
    - **CDMA:** United States only
    - **GSM:** rest of world, AT&T, T-Mobile
  - **Third-generation (3G) networks**
    - Higher transmission speeds suitable for broadband Internet access
  - **Fourth-generation (4G) networks**
    - Entirely packet-switched
    - Up to 100 Mbps

The Wireless Revolution

- **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 standards: 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

A Bluetooth Network (PAN)

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.

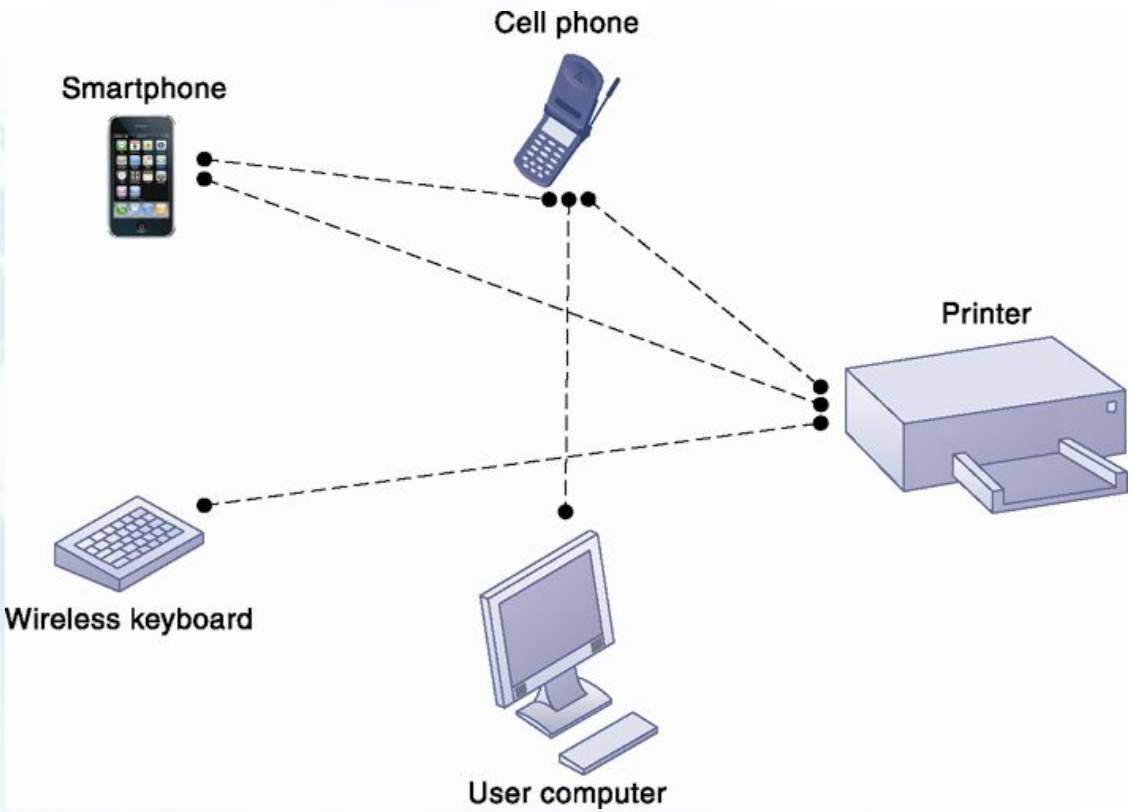


Figure 6-15

An 802.11 Wireless LAN

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.

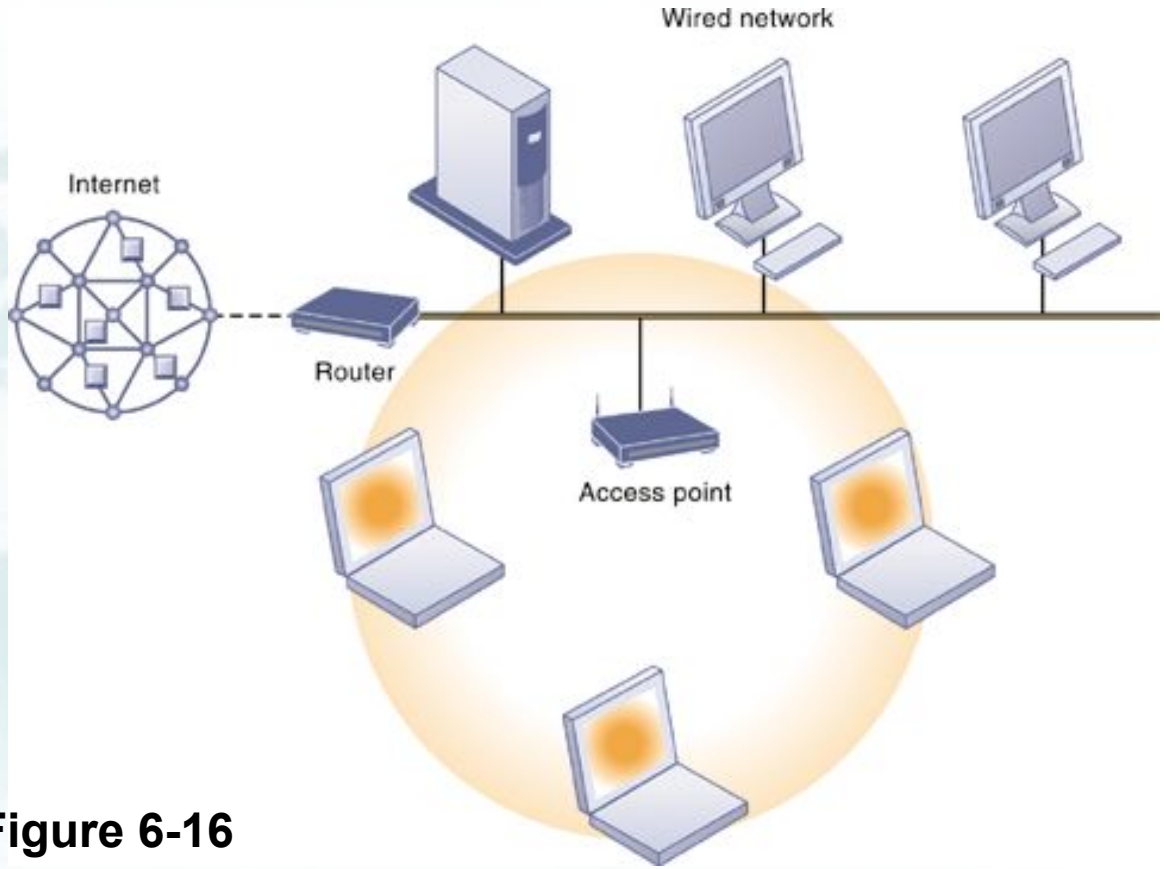


Figure 6-16

- **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

- **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

The Wireless Revolution

- 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

How RFID Works

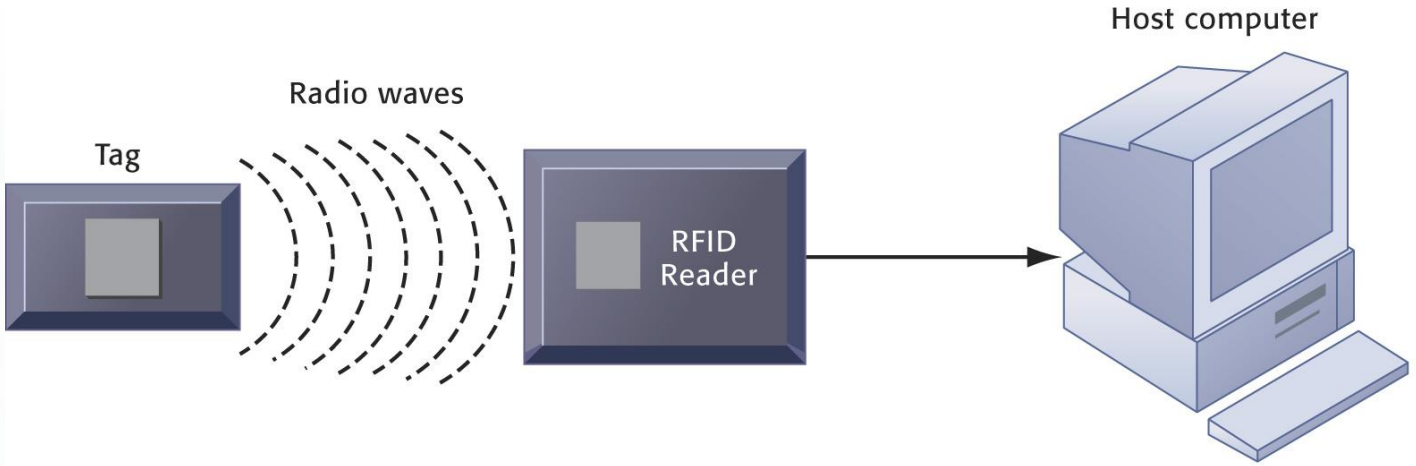


Figure 6-17

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.

The Wireless Revolution

- **Wireless sensor networks (WSNs)**
  - 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.

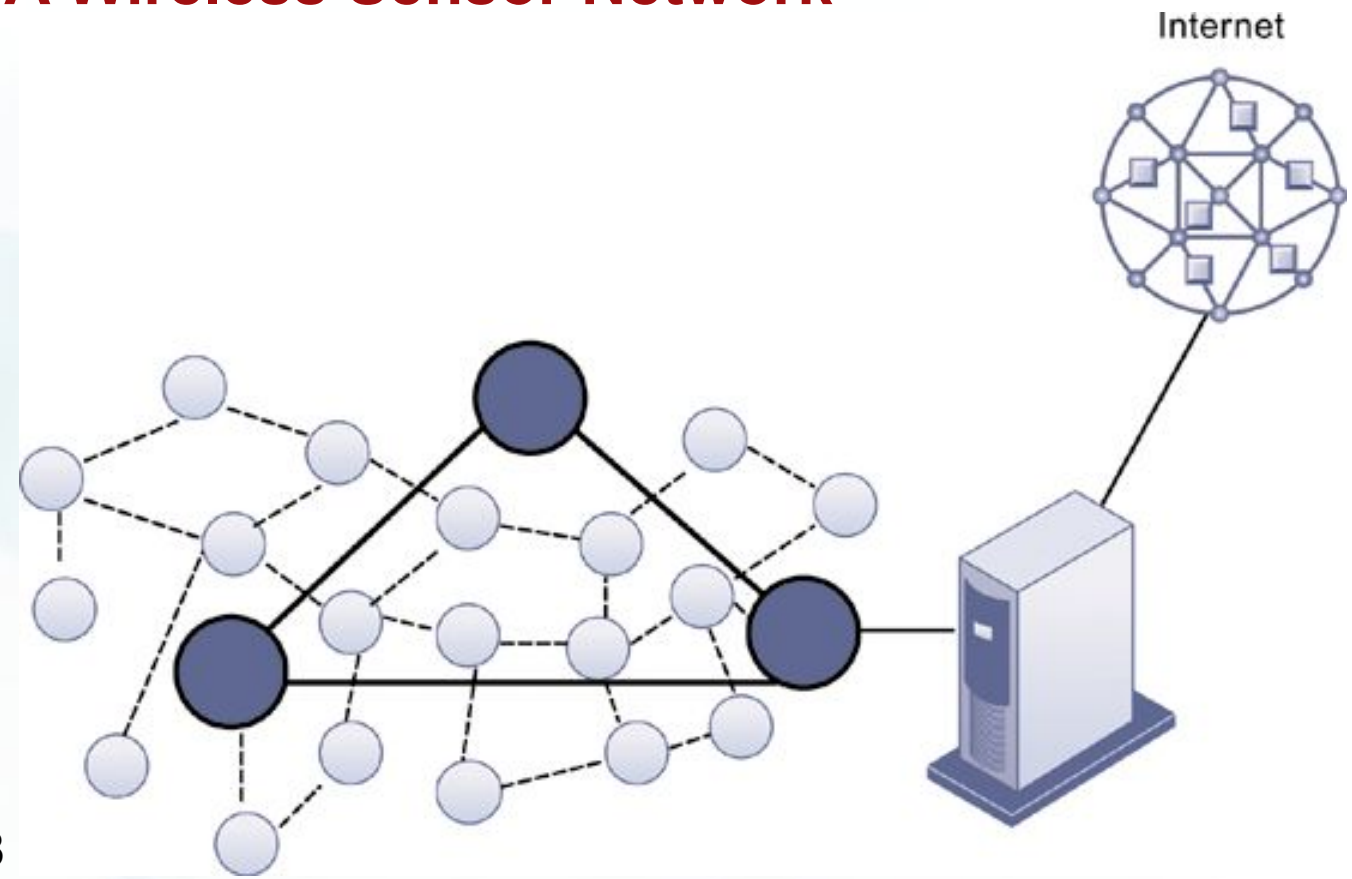


Figure 6-18