Chapter 7

Telecommunications, the Internet, and Wireless Technology

Video cases:

Case 1: Telepresence Moves Out of the Boardrooom and Into the Field

Case 2: Unified Communications Systems: Virtual Collaboration with Lotus Sametime

LEARNING OBJECTIVES

- Identify the principal components of telecommunications networks and key networking technologies.
- Identify the different types of networks.
- Describe how the Internet and Internet technology work and how they support communication and e-business.
- Describe the principal technologies and standards for wireless networking, communication, and Internet access.
- Describe radio frequency identification and wireless sensor networks and identify why these are valuable business technologies.

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RFID and Wireless Technology Speed Up Production at Continental Tires

- **Problem:** Inefficient manual processes; large production environment
- **Solutions:** Track components in real time, optimize transportation, and expedite communication
  - Wi-Fi networks
  - RFID technologies
  - Mobile handhelds
  - Material inventory tracking software
- Demonstrates use of technology in production and supply chain to increase efficiency and lower costs

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- **Networking and Communication Trends**
  - **Convergence:**
    - Telephone networks and computer networks converging into single digital network using Internet standards
  - **Broadband:**
    - More than 68% U.S. Internet users have broadband access
  - **Broadband wireless:**
    - Voice, data communication are increasingly taking place over broadband wireless platforms

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- **Computer network**
  - **Two or more connected computers**
  - **Major components in simple network**
    - Client and server computers
    - Network interfaces (NICs)
    - Connection medium
    - Network operating system
    - Hubs, switches, routers
  - **Software-defined networking (SDN)**
    - Functions of switches and routers managed by central program

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Components of a Simple Computer Network

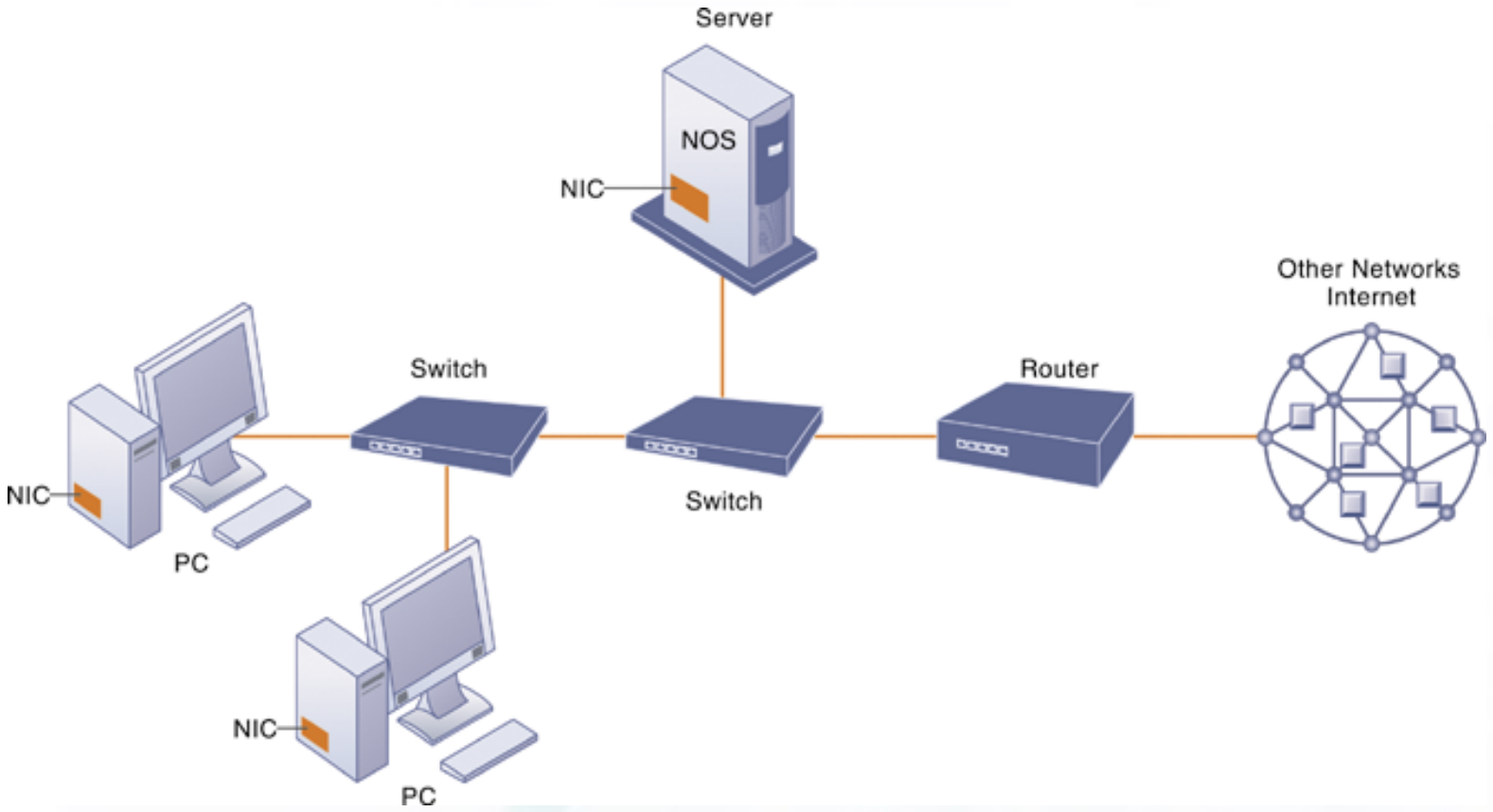

Figure 7-1 Illustrated here is a very simple computer network, consisting of computers, a network operating system residing on a dedicated server computer, cabling (wiring) connecting the devices, network interface cards (NIC), switches, and a router.

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- **Networks in large companies**
  - **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**

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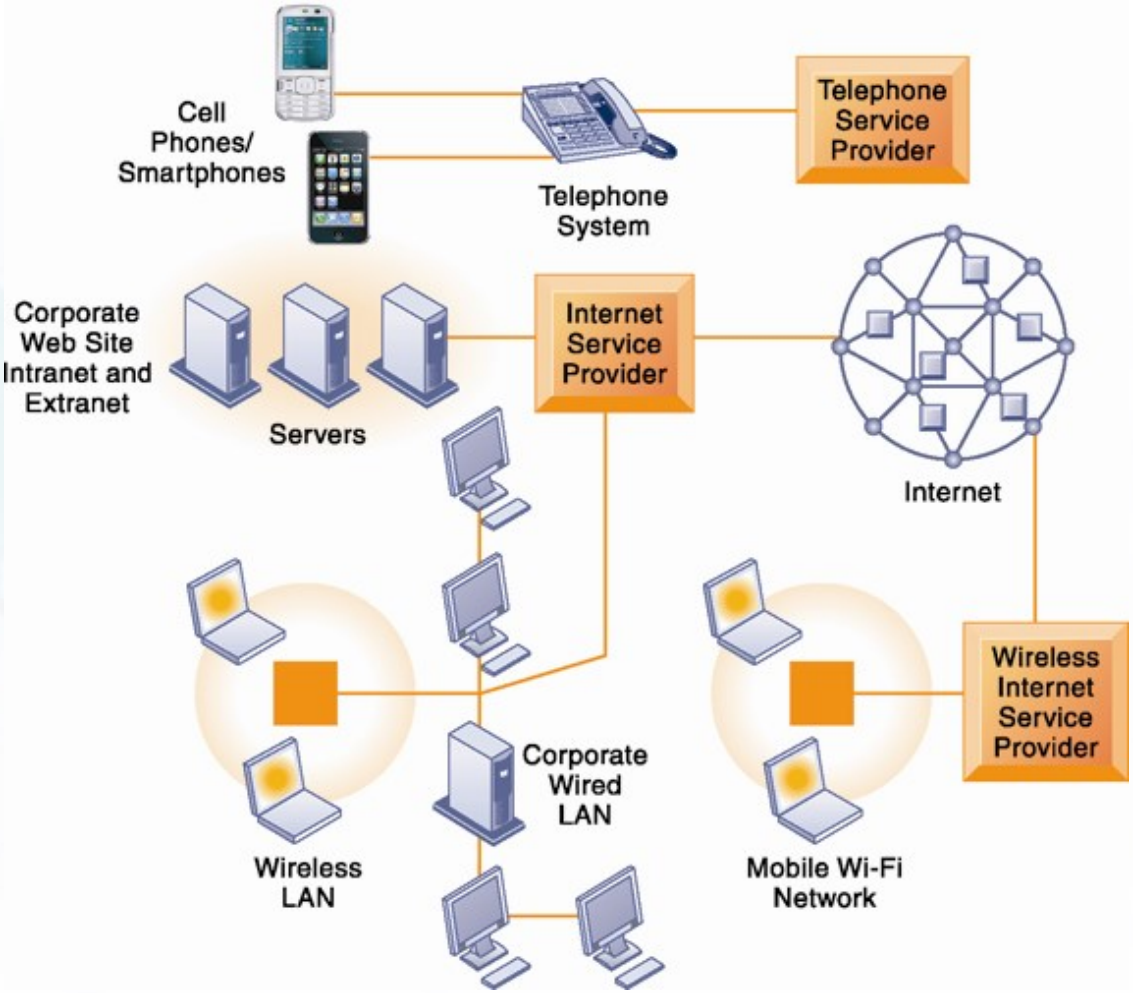
Corporate Network Infrastructure

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 7-2



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- **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

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- **Key digital networking technologies (cont.)**
  - **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

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Packet-Switched Networks and Packet Communications

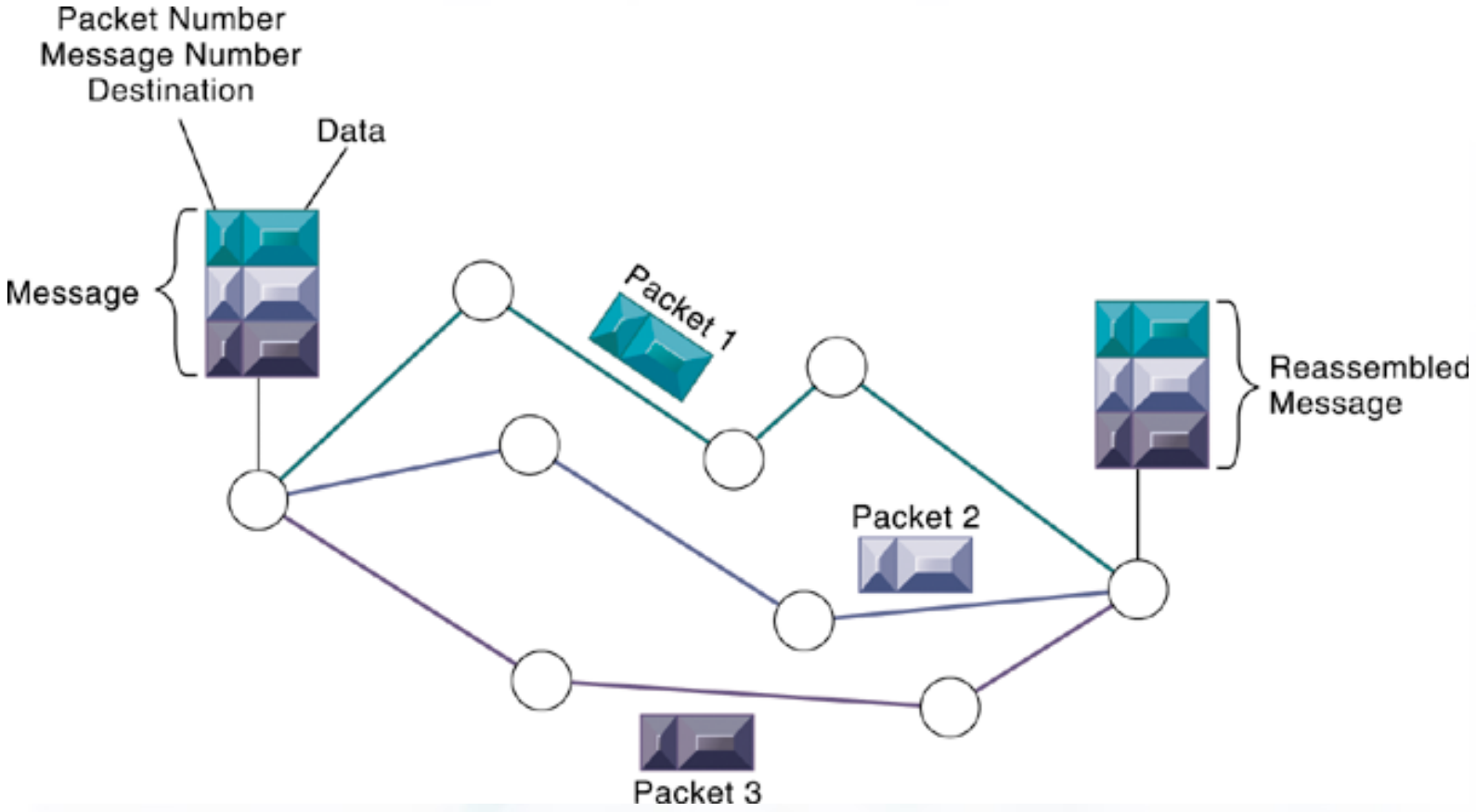

Figure 7-3 Data are grouped into small packets, which are transmitted independently over various communications channels and reassembled at their final destination.

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Telecommunications and Networking in Today's Business World

- **Key digital networking technologies (cont.)**
  - **TCP/IP and connectivity**
    - **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

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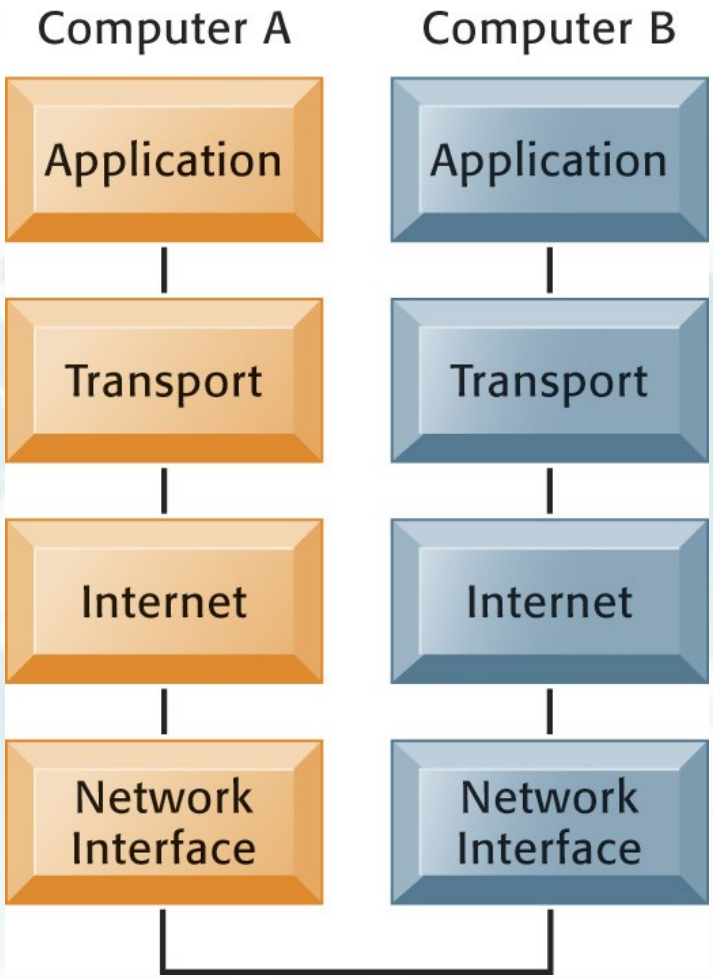
The Transmission Control Protocol/Internet Protocol (TCP/IP) Reference Model

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

Figure 7-4



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Communications Networks

- **Signals: Digital versus analog**
  - **Modem: translates digital signals into analog form (and vica versa)**
- **Types of networks**
  - **Local-area networks (LANs)**
    - Ethernet
    - Client/server vs. peer-to-peer
  - **Wide-area networks (WANs)**
  - **Metropolitan-area networks (MANs)**
  - **Campus area networks (CANs)**

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Functions of the Modem

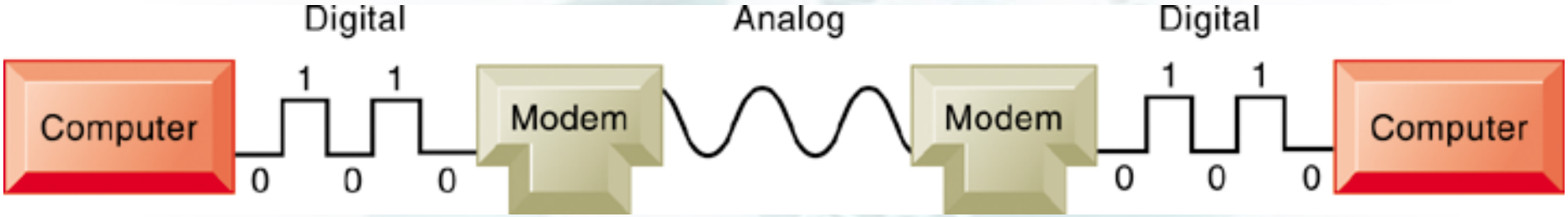

Figure 7-5 A modem is a device that translates digital signals into analog form (and vice versa) so that computers can transmit data over analog networks such as telephone and cable networks.

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Communications Networks

- **Physical transmission media**
  - **Twisted pair wire (CAT5)**
  - **Coaxial cable**
  - **Fiber optics cable**
  - **Wireless transmission media and devices**
    - Satellites
    - Cellular systems
- **Transmission speed**
  - **Bits per second (bps)**
  - **Hertz**
  - **Bandwidth**

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- **The Internet**
  - **World's most extensive network**
  - **Internet service providers (ISPs)**
    - Provide connections
    - Types of Internet connections
      - Dial-up: 56.6 Kbps
      - Digital subscriber line (DSL/FIOS): 385 Kbps–40 Mbps
      - Cable Internet connections: 1–50 Mbps
      - Satellite
      - T1/T3 lines: 1.54–45 Mbps

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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

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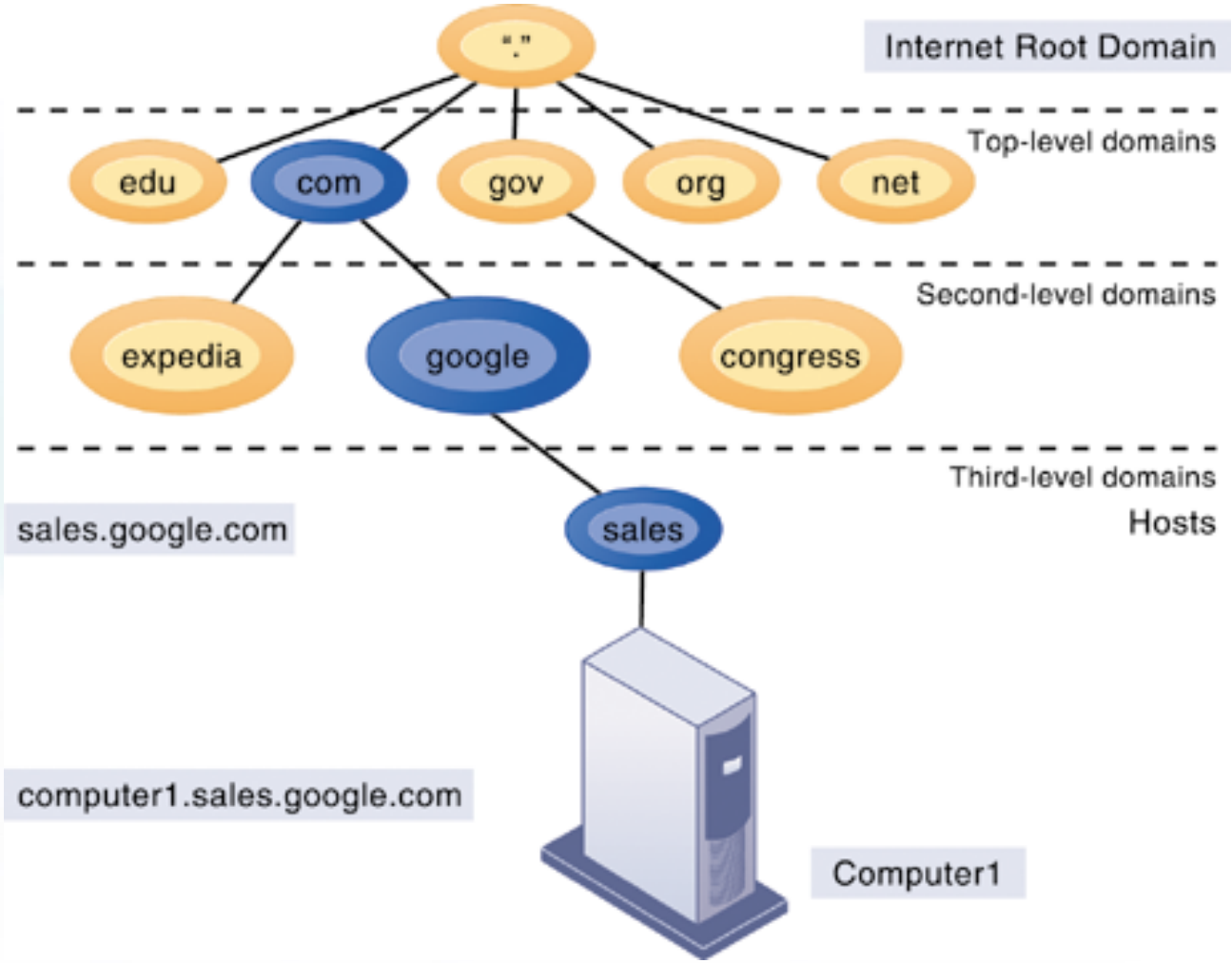
The Domain Name System

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 7-6



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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.

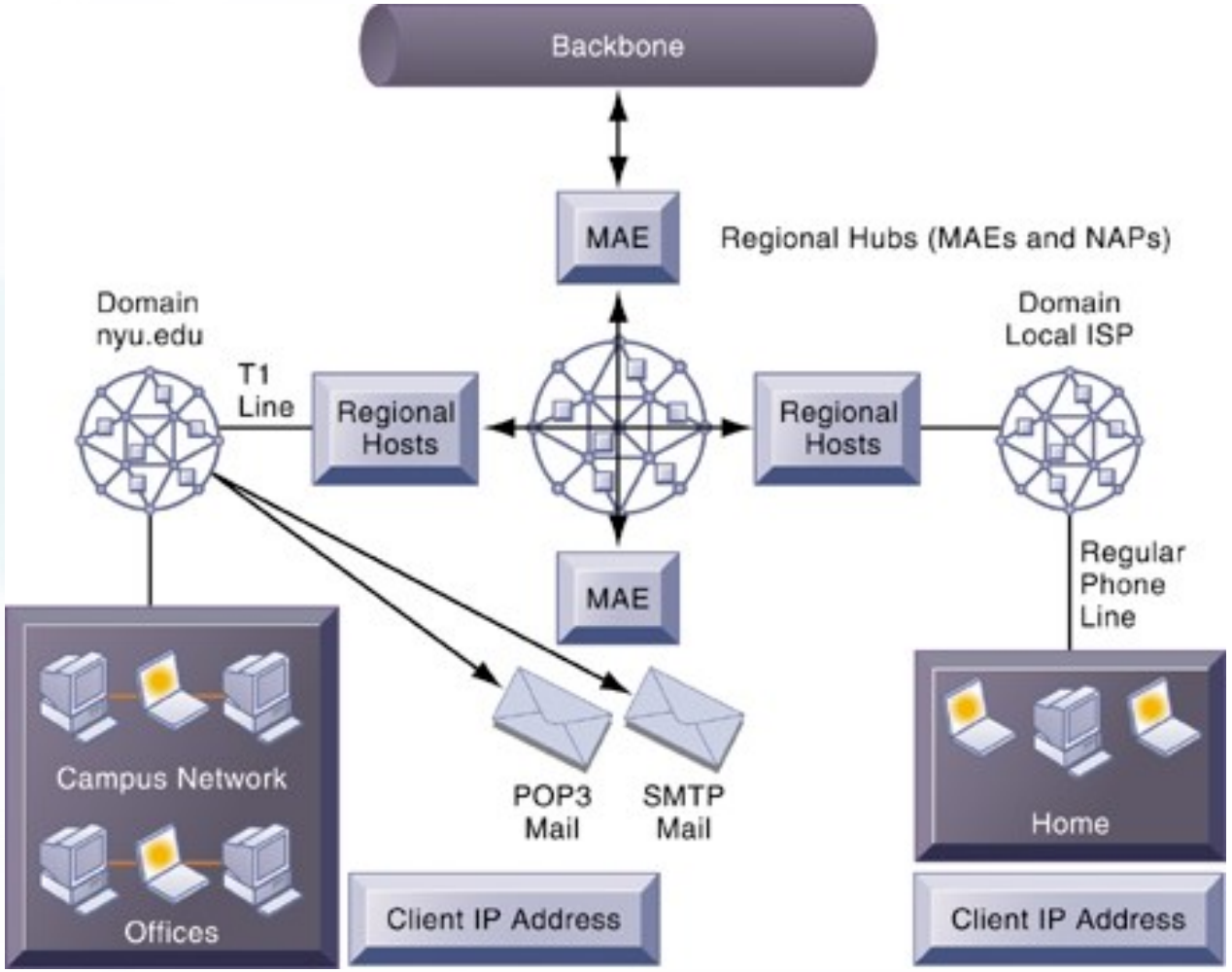

Figure 7-7

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The Battle over Net Neutrality

Read the Interactive Session and 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?

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- Internet services
  - E-mail
  - Chatting and instant messaging
  - Electronic discussion groups / newsgroups
  - Telnet
  - File Transfer Protocol (FTP)
  - World Wide Web

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Client/Server Computing on the Internet

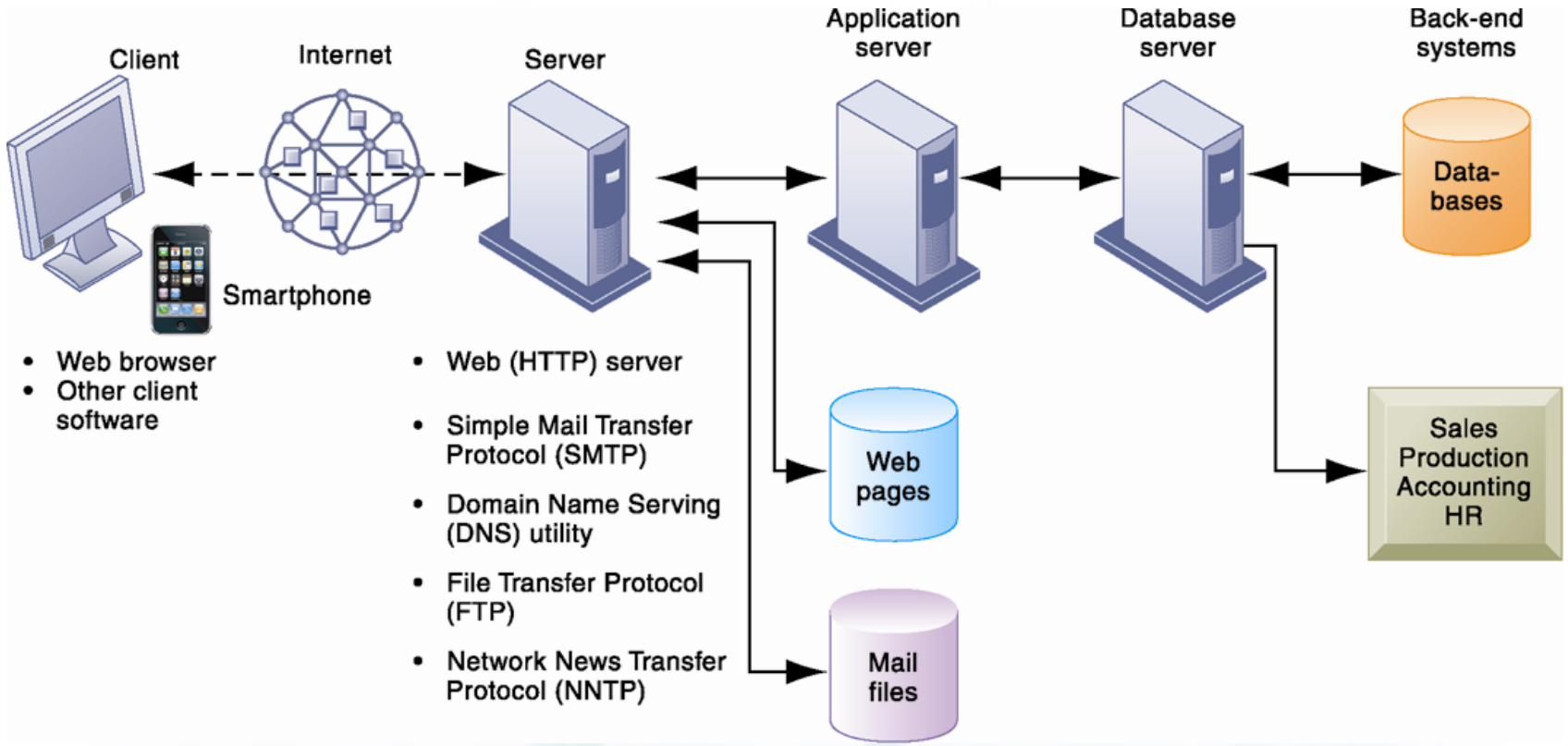

Figure 7-8 Client computers running Web browser and other software can access an array of services on servers over the Internet. These services may all run on a single server or on multiple specialized servers.

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The Global Internet

- **Voice over IP (VoIP)**
  - Digital voice communication using IP, packet switching
  - Providers
    - Cable providers
    - Google, Skype
- **Unified communications**
  - Communications systems that integrate voice, data, e-mail, conferencing
- **Virtual private network (VPN)**
  - Secure, encrypted, private network run over Internet
    - PPTP
    - Tunneling

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How Voice over IP Works

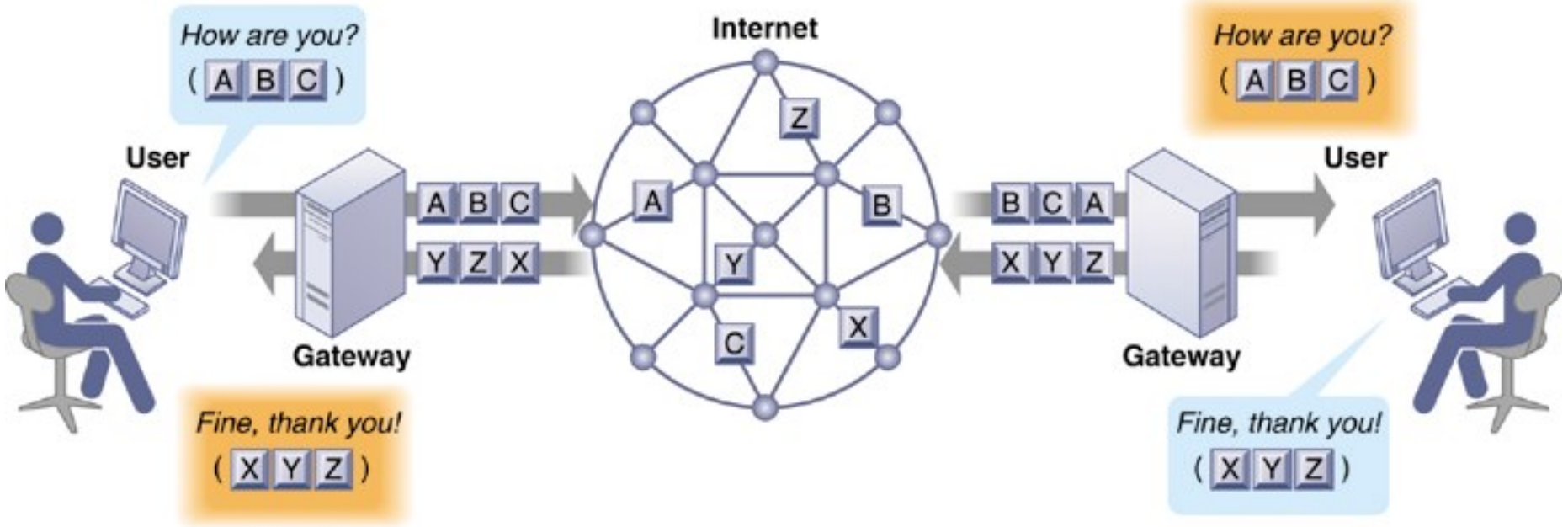

Figure 7-9 A VoIP phone call digitizes and breaks up a voice message into data packets that may travel along different routes before being reassembled at the final destination. A processor nearest the call's destination, called a gateway, arranges the packets in the proper order and directs them to the telephone number of the receiver or the IP address of the receiving computer.

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A Virtual Private Network Using the Internet

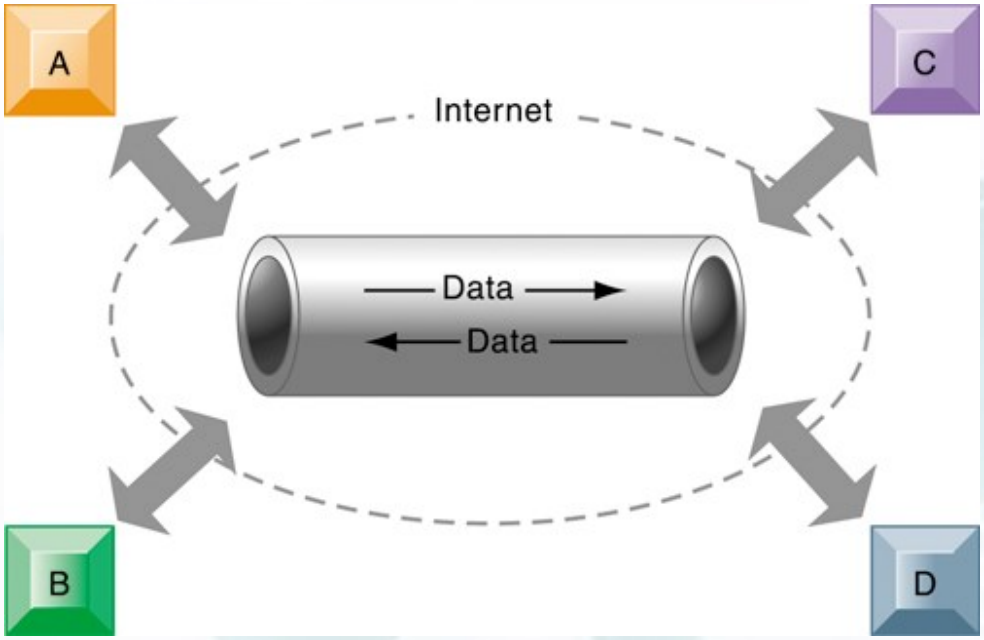

Figure 7-10 This VPN is a private network of computers linked using a secure "tunnel" connection over the Internet. It protects data transmitted over the public Internet by encoding the data and "wrapping" them within the Internet Protocol (IP). By adding a wrapper around a network message to hide its content, organizations can create a private connection that travels through the public Internet.

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Interactive Session: Management

Monitoring Employees on Networks—Unethical or Good Business?

Read the Interactive Session and 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?

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- **The Web**
  - **Hypertext Markup Language (HTML)**
  - **Hypertext Transfer Protocol (HTTP):**
    - Communications standard used for transferring Web pages
  - **Uniform resource locators (URLs):**
    - Addresses of Web pages
      - http://www.megacorp.com/content/features/082602.html
  - **Web servers**
      - Software for locating and managing Web pages

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The Global Internet

- Search engines
  - Started as simpler programs using keyword indexes
  - Google improved indexing and created page ranking system
- Mobile search: 20% of all searches in 2012
- Search engine marketing
  - Major source of Internet advertising revenue
- Search engine optimization (SEO)
  - Adjusting Web site and traffic to improve rankings in search engine results

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Top U.S. Web Search Engines

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

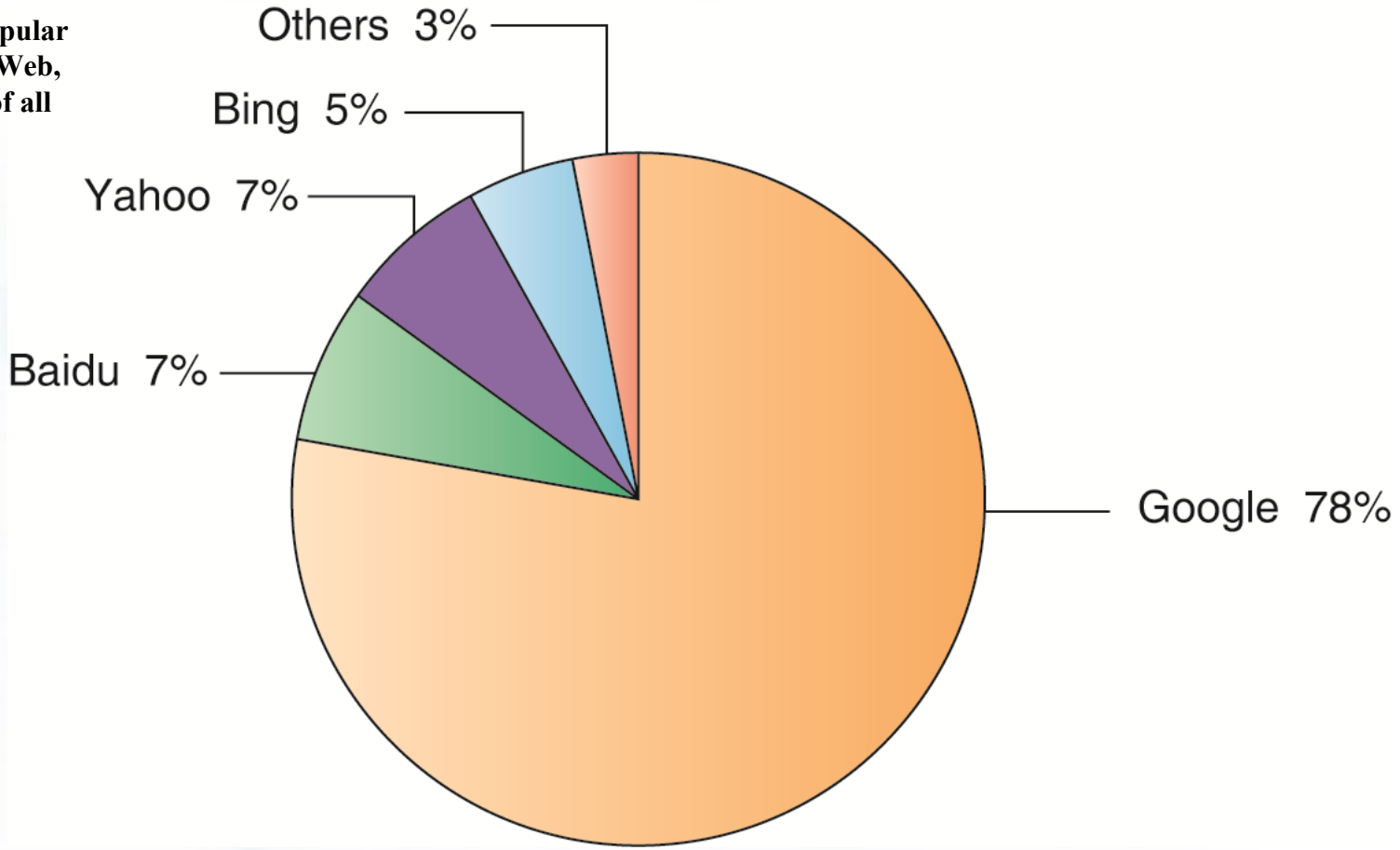

Figure 7-11

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The Global Internet

- Social search
  - Google +1, Facebook Like
- Semantic search
  - Anticipating what users are looking for rather than simply returning millions of links
- Intelligent agent shopping bots
  - Use intelligent agent software for searching Internet for shopping information

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How Google Works

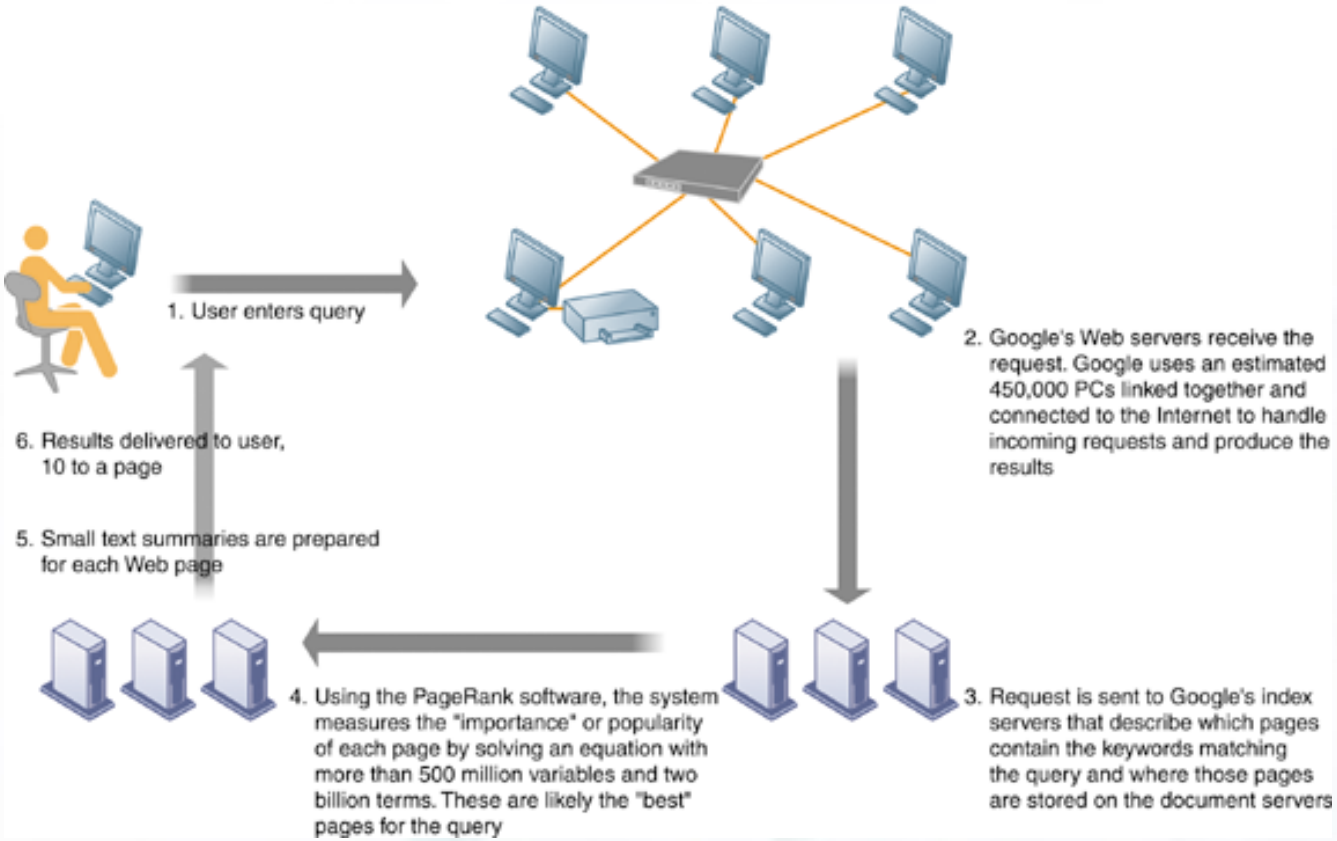

Figure 7-12 The Google search engine is continuously crawling the Web, indexing the content of each page, calculating its popularity, and storing the pages so that it can respond quickly to user requests to see a page. The entire process takes about one-half second.

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- **Web 2.0**
  - **Second-generation services**
  - **Enabling collaboration, sharing information, and creating new services online**
  - **Features**
    - Interactivity
    - Real-time user control
    - Social participation (sharing)
    - User-generated content

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- **Web 2.0 services and tools**
  - **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
    - Blogosphere
    - Microblogging
  - **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

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- Web 3.0: The "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
  - Making Web more "intelligent" and intuitive
  - Increased communication and synchronization with computing devices, communities
  - "Web of things"
  - Increased cloud computing, mobile computing

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- **Cellular systems**
  - **Competing standards**
    - CDMA: United States only
    - GSM: Rest of world, AT&T, T-Mobile
  - **Third-generation (3G) networks**
    - 144 Kbps
    - Suitable for e-mail access, Web browsing
  - **Fourth-generation (4G) networks**
    - Up to 100 Mbps
    - Suitable for Internet video

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- **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: 802.11
    - Used for wireless LAN and wireless Internet access
    - Use access points: device with radio receiver/transmitter for connecting wireless devices to a wired LAN

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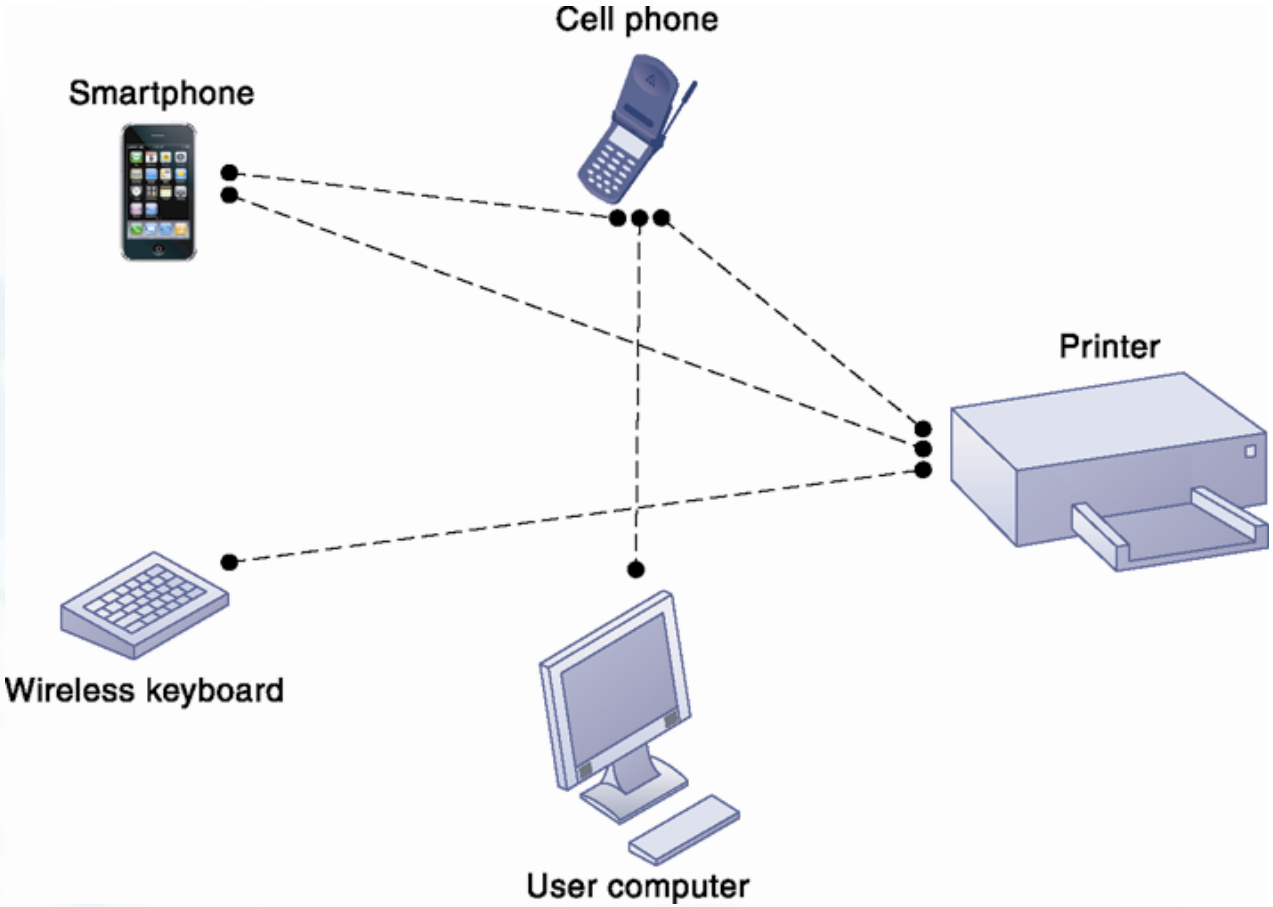
A Bluetooth Network (PAN)

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



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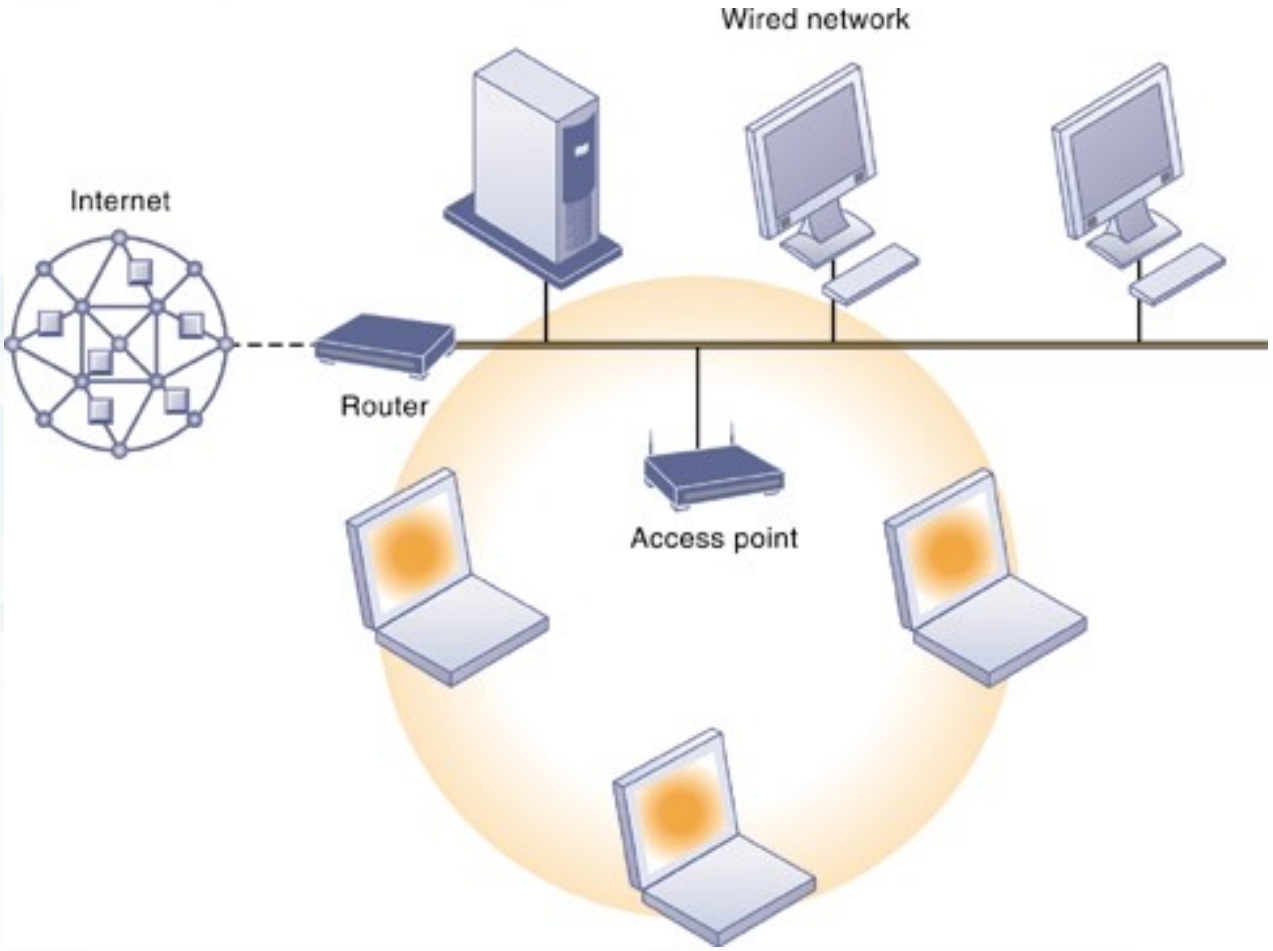
An 802.11 Wireless LAN

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 7-14



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- **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

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- **Radio frequency identification (RFID)**
  - **RFID tags:**
    - Tiny tags with embedded microchips contain data about an item and location
    - Transmit radio signals over short distances to RFID readers
  - **RFID readers:**
    - Send data over network to computer for processing
  - **Active RFID:**
    - Tags have batteries
    - Data can be rewritten
    - Range is hundreds of feet

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The Wireless Revolution

- **RFID (cont.)**
  - **Passive RFID:**
    - Range is shorter
    - Smaller, less expensive
    - Powered by radio frequency energy
  - **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**

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How RFID Works

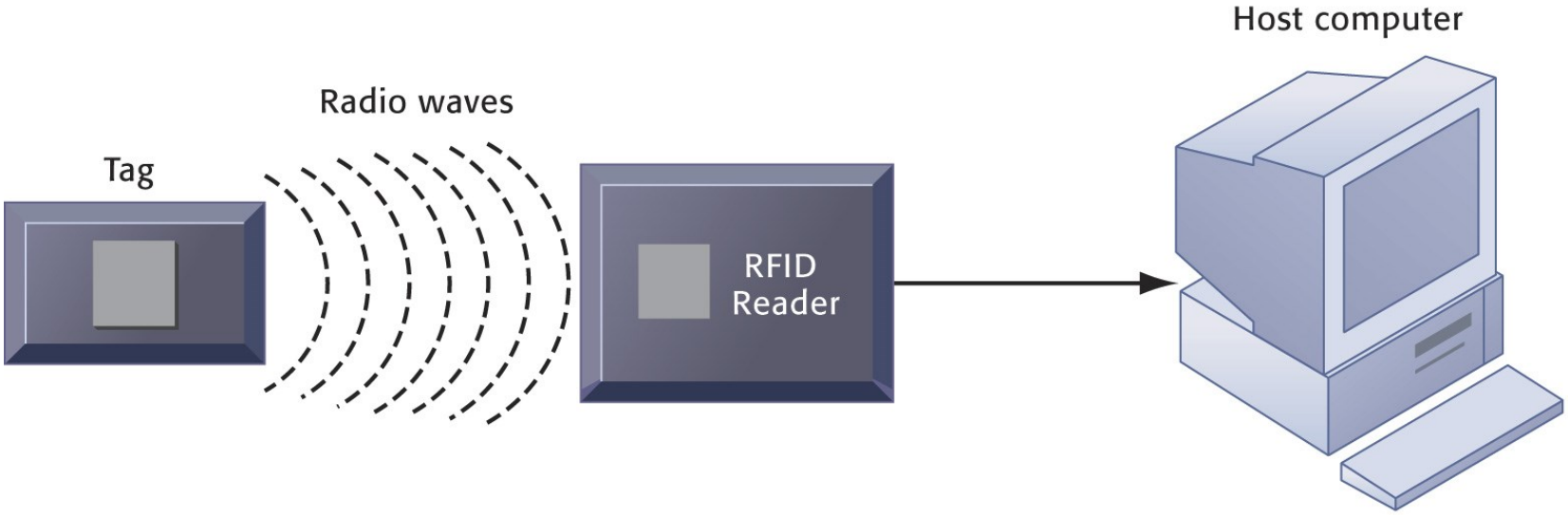

Figure 7-15 RFID uses low-powered radio transmitters to read data stored in a tag at distances ranging from 1 inch to 100 feet. The reader captures the data from the tag and sends them over a network to a host computer for processing.

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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

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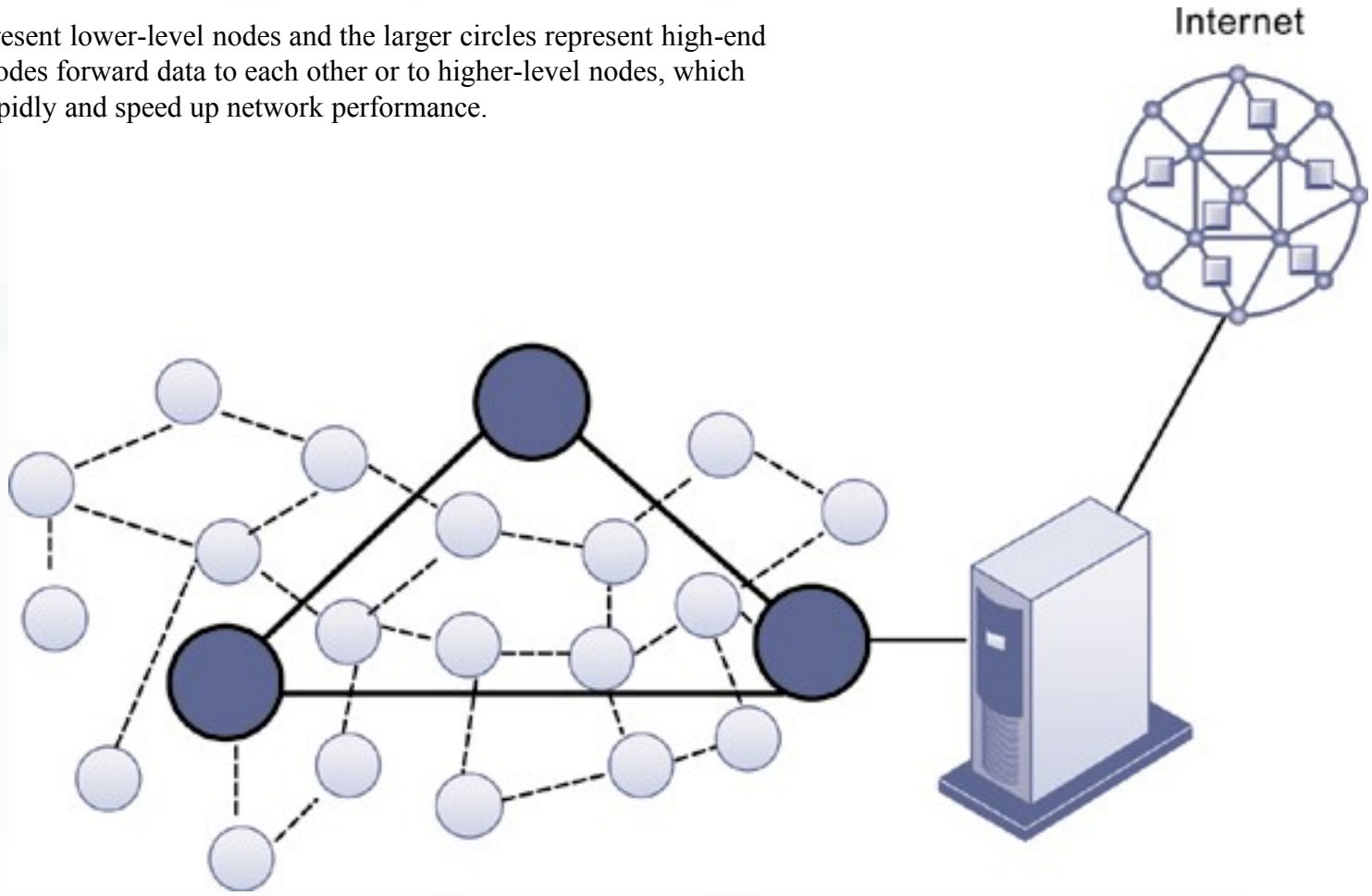
A Wireless Sensor Network

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 7-16



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Discussion

- Should all major retailing and manufacturing companies switch to RFID? Why or why not?
- Compare Wi-Fi and high-speed cellular systems for accessing the Internet. What are the advantages and disadvantages of each?

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