Telecommunications, the Internet, and Wireless Technology

STUDENT LEARNING OBJECTIVES

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

- **What are the different types of networks?**

- **How do the Internet and Internet technology work and how do they support communication and e-business?**

Essentials of Management Information Systems
Chapter 7 Telecommunications, the Internet, and Wireless Technology

STUDENT LEARNING OBJECTIVES

- **What are the principal technologies and standards for wireless networking, communication, and Internet access?**

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Student Support Materials

Learning Tracks

1. Broadband Network Services and Technologies

2. Cellular System Generations

3. Wireless Applications for Customer Relationship Management, Supply Chain Management, and Healthcare

4. Introduction to Web 2.0

Video Cases

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

Case 2: Virtual Collaboration with IBM Sametime

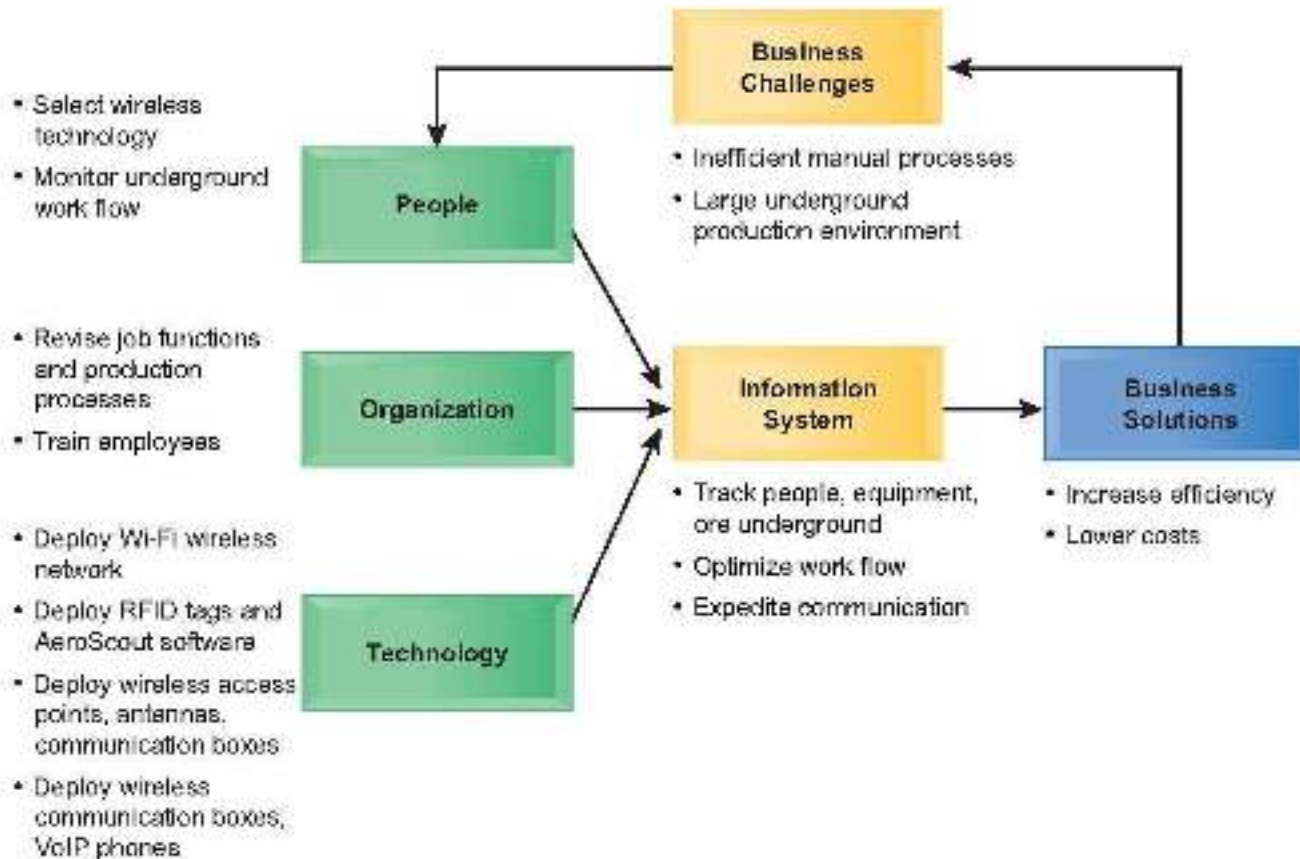**RFID and Wireless Technology Speed Up Production at Continental Tires**

- **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**

RFID and Wireless Technology Speed Up Production at Continental Tires

- Select wireless technology
- Monitor underground work flow

People

Business Challenges

- Inefficient manual processes
- Large underground production environment

- Revise job functions and production processes
- Train employees

Organization

Information System

Business Solutions

- Track people, equipment, ore underground
- Optimize work flow
- Expedite communication

- Increase efficiency
- Lower costs

- Deploy Wi-Fi wireless network
- Deploy RFID tags and AeroScout software
- Deploy wireless access points, antennas, communication boxes
- Deploy wireless communication boxes, VoIP phones

Technology

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

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 75 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?

- **Major components in simple network**
  - Client computer
  - Server computer
  - Network interfaces
  - Connection medium
  - Network operating system (NOS)
  - Hub or switch
- **Routers**
- **Software defined networking (SDN)**

Principal components of telecommunications networks and key networking technologies?

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.
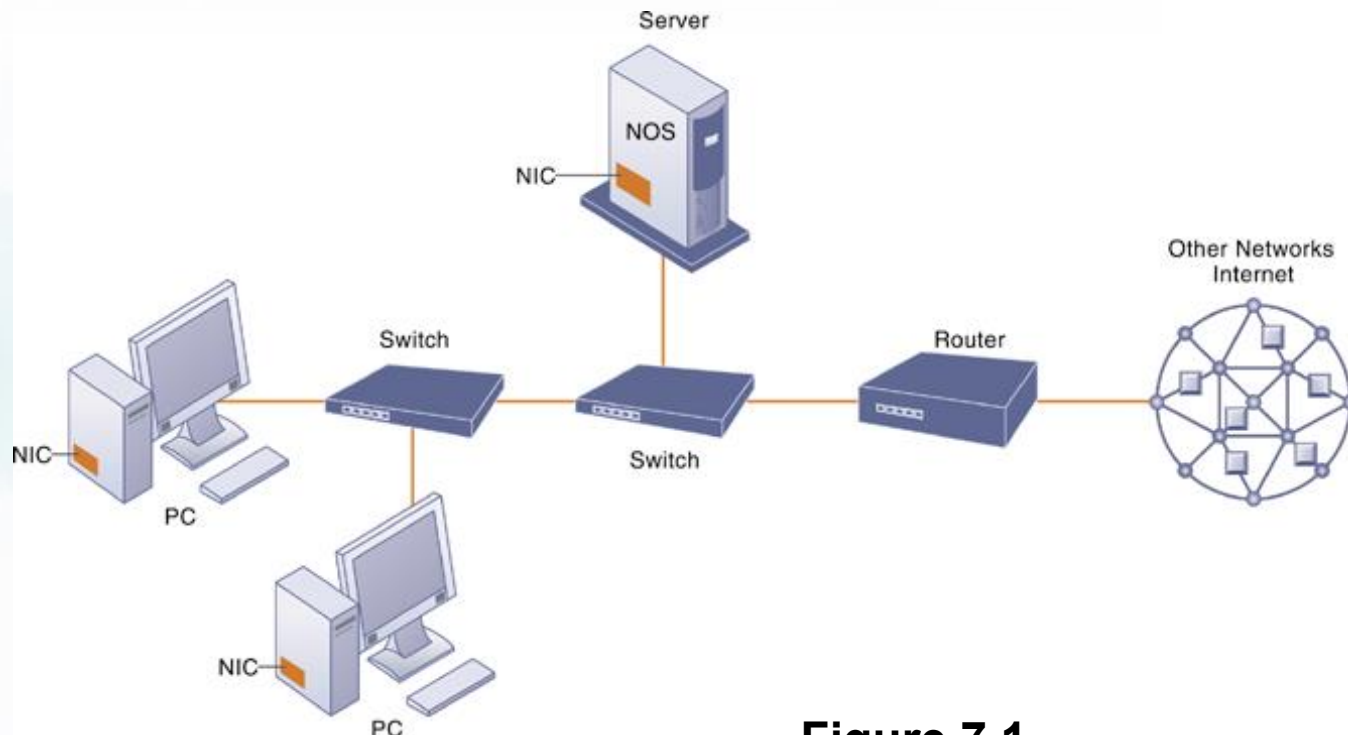

Figure 7.1

Networks in Large Companies

- **Components 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

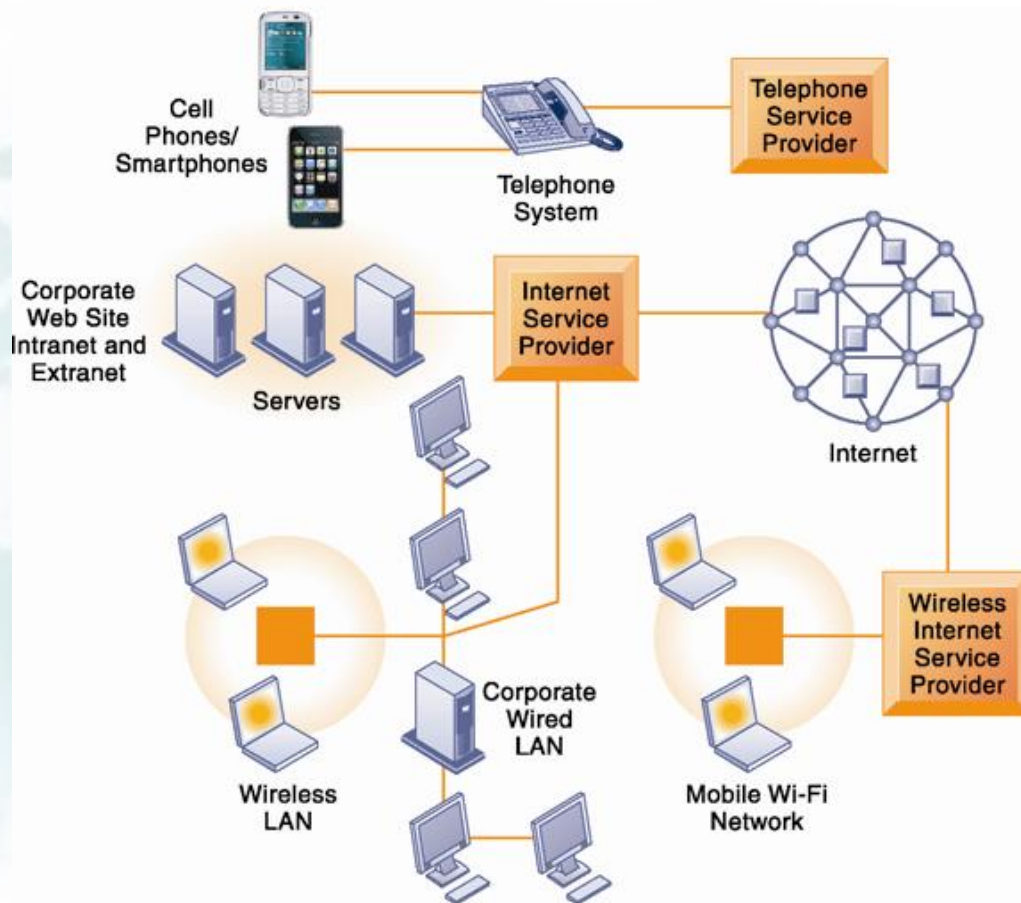**Principal components of telecommunications networks and key networking technologies?**

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

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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Principal components of telecommunications networks and key networking technologies?

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

Principal components of telecommunications networks and key networking technologies?

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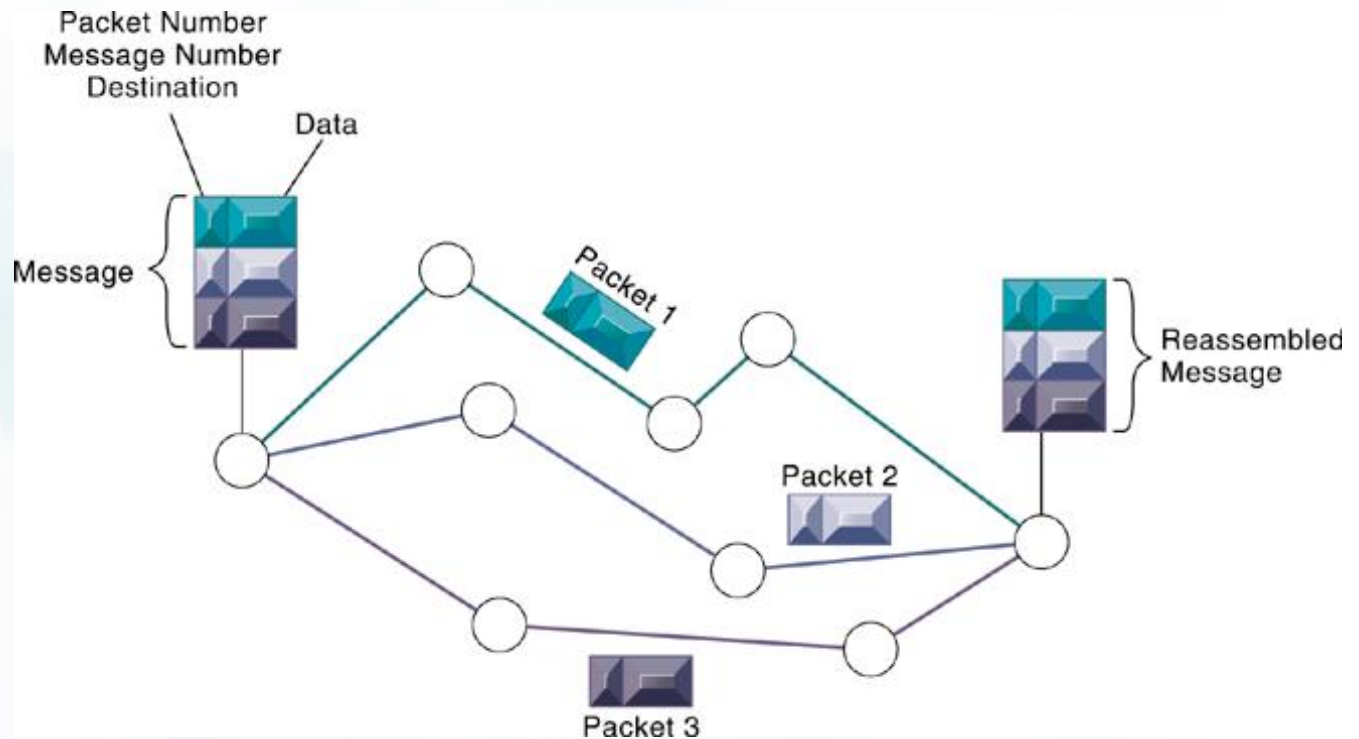
Data are grouped into small packets, which are transmitted independently over various communications channels and reassembled at their final destination.

Figure 7.3

Principal components of telecommunications networks and key networking technologies?

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

Principal components of telecommunications networks and key networking technologies?

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

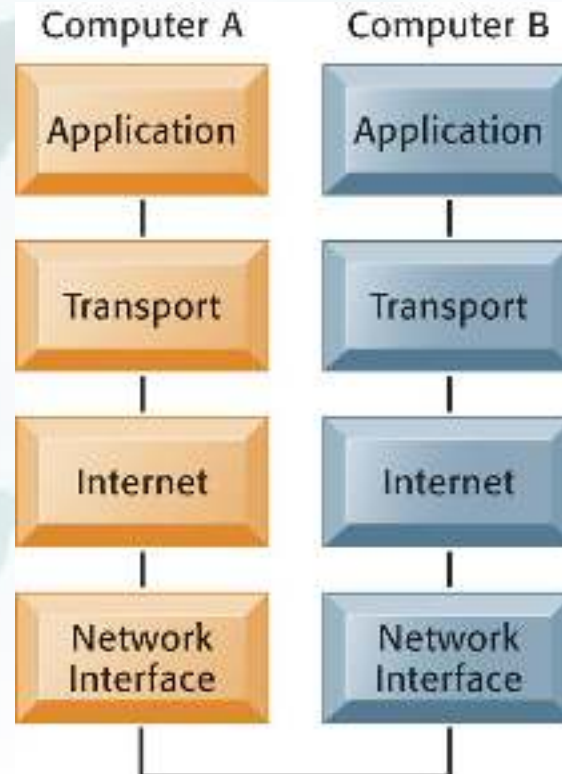**This figure illustrates the four layers of the TCP/IP reference model for communications.**

Figure 7.4

What are the different types of networks?

Types of Networks

- **Digital versus analog signals**

    - Modem: translates digital signals into analog form

- **Local-area networks (LANs)**
    - Ethernet is standard for physical medium
    - Workgroup network model (peer-to-peer architecture)
    - Windows domain network model

- **Campus-area networks (CANs)**

- **Wide-area networks (WANs)**

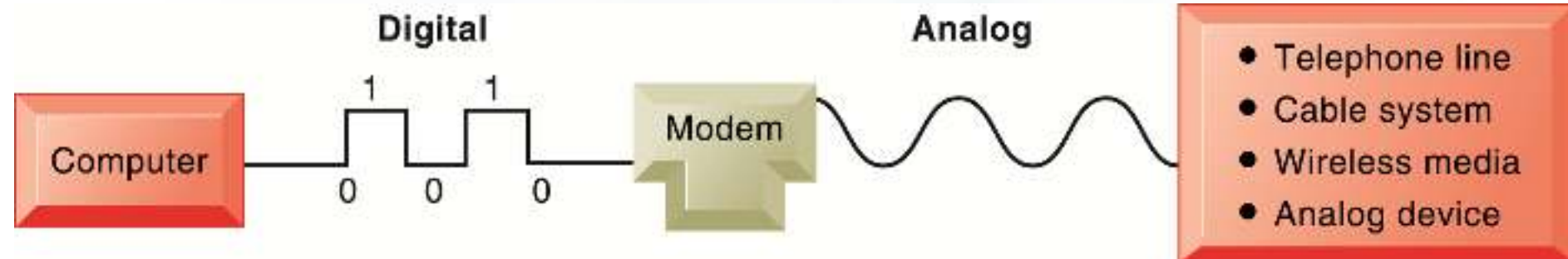- **Metropolitan-area networks (MANs)**

What are the different types of 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 7.5

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What are the different types of networks?

Transmission Media and Transmission Speeds

- **Transmission media:**

  - **Types:** twisted pair wire, coaxial cable, wireless

  - **Speeds:** Wide range depending on software/hardware combination

- **Transmission speed**

  - **Bps, Mbps:** rate of information transmitted

  - **Hertz:** Number of cycles per second

  - **Bandwidth:** Difference between highest and lowest frequencies on single channel

How the Internet works and supports e-business

What Is the Internet?

- **World's most extensive network**

- **Internet service providers (ISPs) provide connections**

  - **Digital subscriber line**

  - **Cable Internet connections**

  - **T1 lines**

How the Internet works and supports e-business

- **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

How the Internet works and supports e-business

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

- **Internet architecture and governance**

  - **Network service providers**

    - Own trunk lines (high-speed backbone networks)

  - **Regional telephone and cable TV companies**

    - Provide regional and local access

  - **Professional organizations and government bodies establish Internet standards**

    - IAB

    - ICANN

    - W3C

How the Internet works and supports e-business

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.
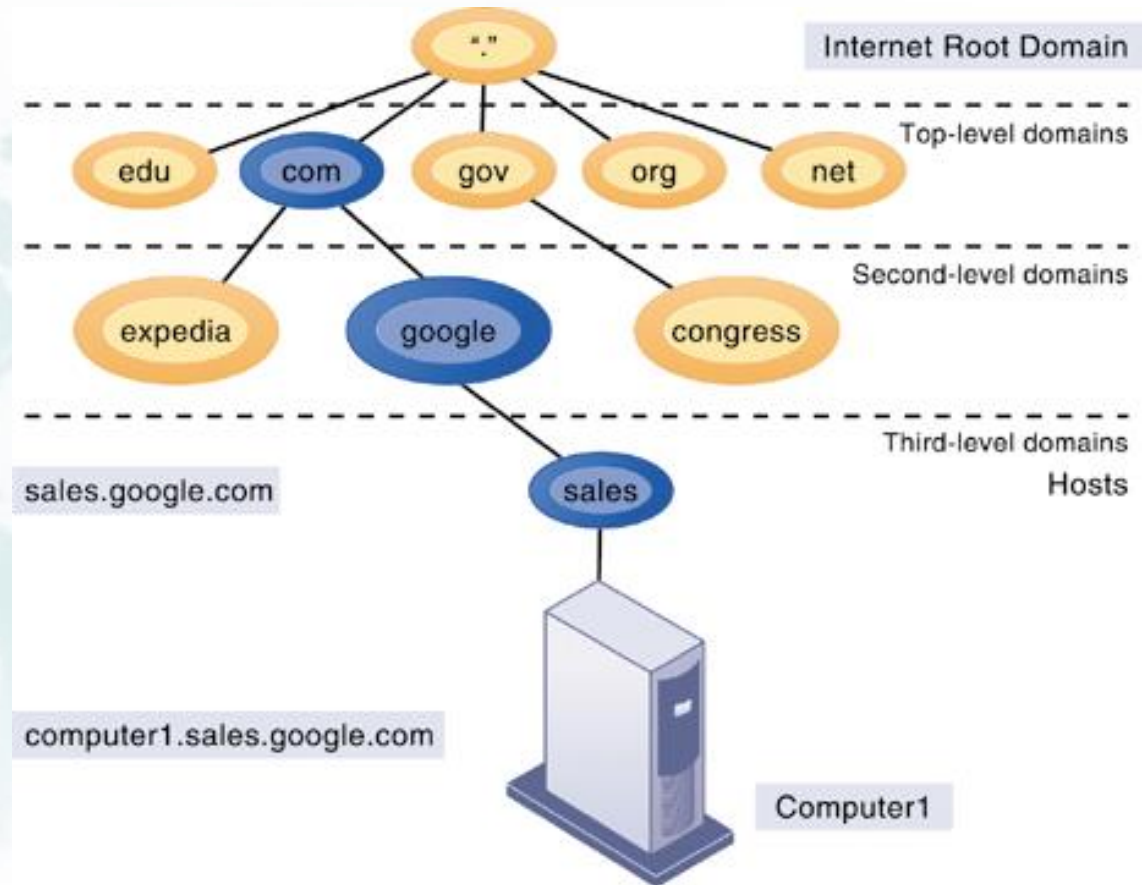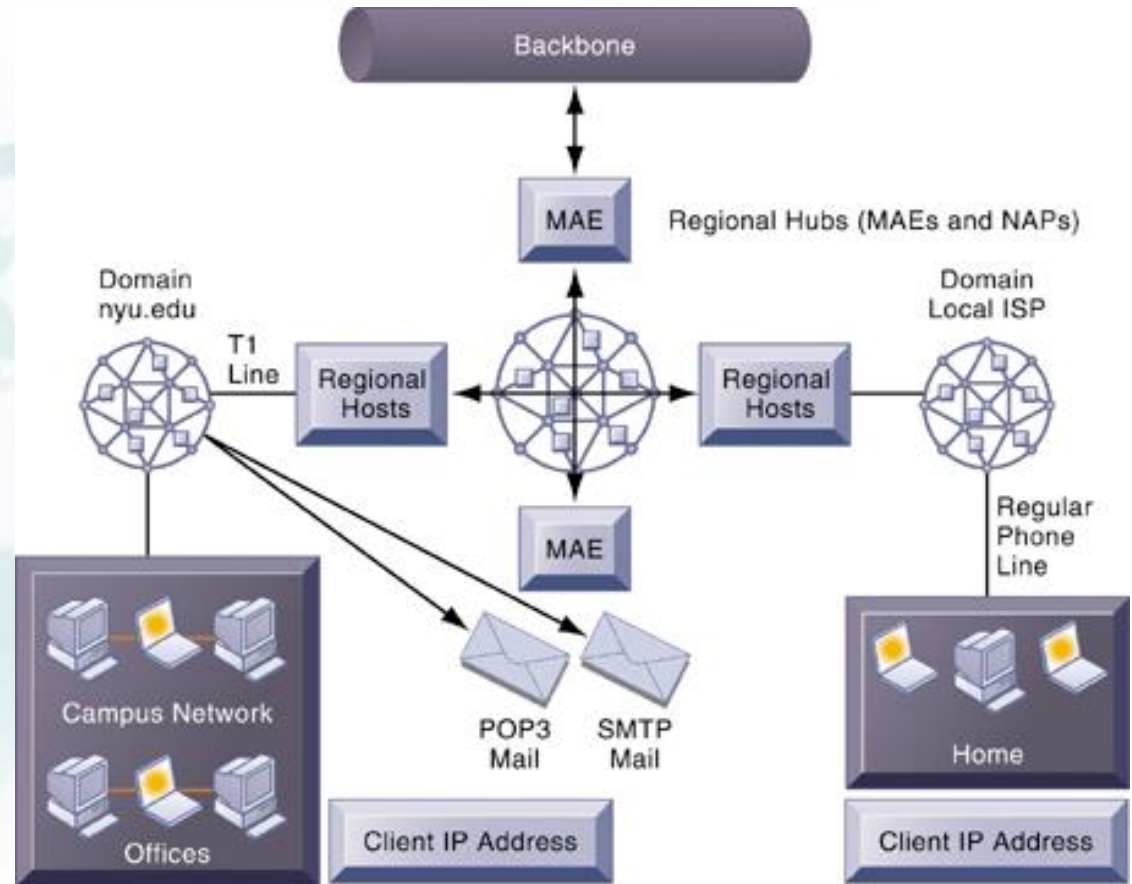

Figure 7.7

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The Battle over Net Neutrality

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 net 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?**

7.25

How the Internet works and supports e-business

- **The Future Internet: IPv6 and Internet 2**
  - **IPv6**
    - New addressing scheme for IP numbers
    - Will provide more than a quadrillion new addresses
    - Not compatible with current IPv5 addressing
  - **Internet2**
    - Advanced networking consortium
      - Universities, businesses, government agencies, other institutions
    - Developed high-capacity 100 Gbps testing network
    - Testing leading-edge new technologies for Internet

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How the Internet works and supports e-business

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)**

How the Internet works and supports e-business

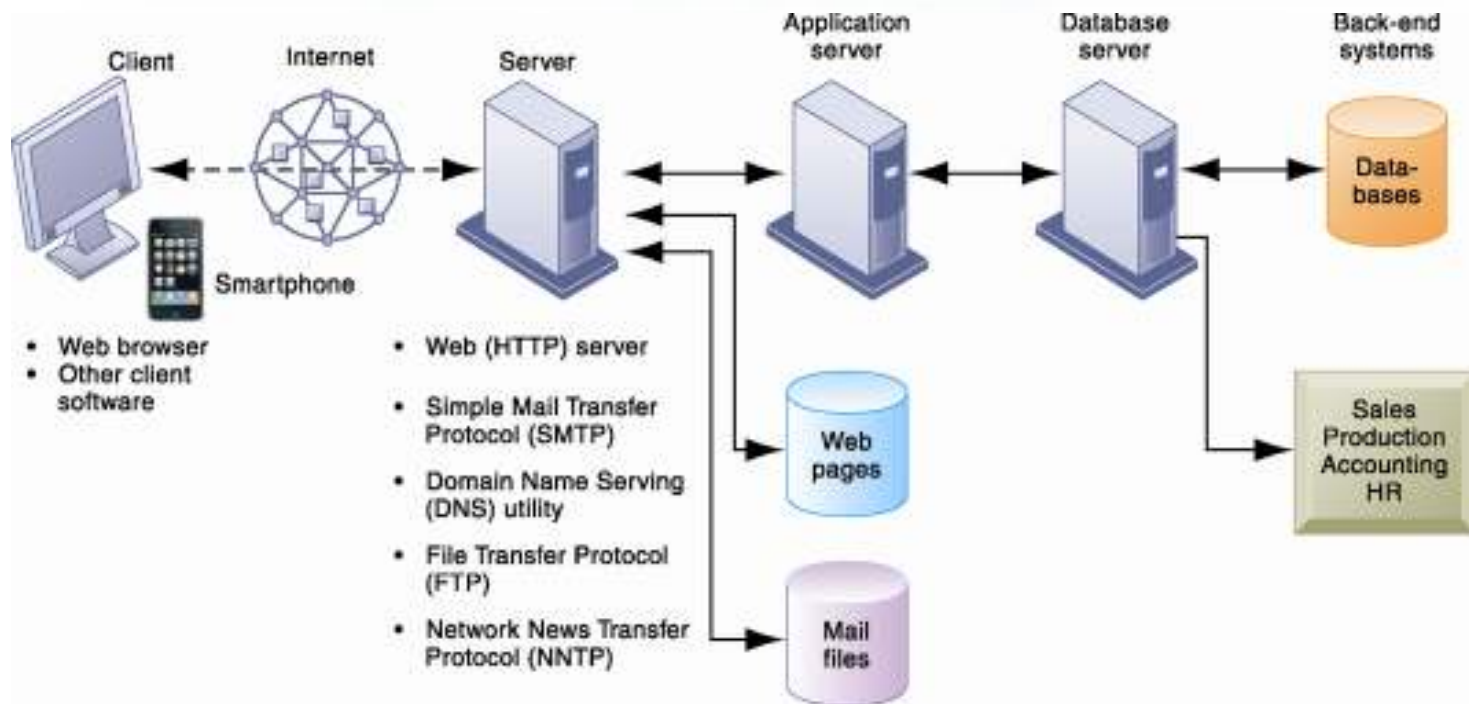# Client/Server Computing on the Internet

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.

How the Internet works and supports e-business

How Voice over IP Works

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.
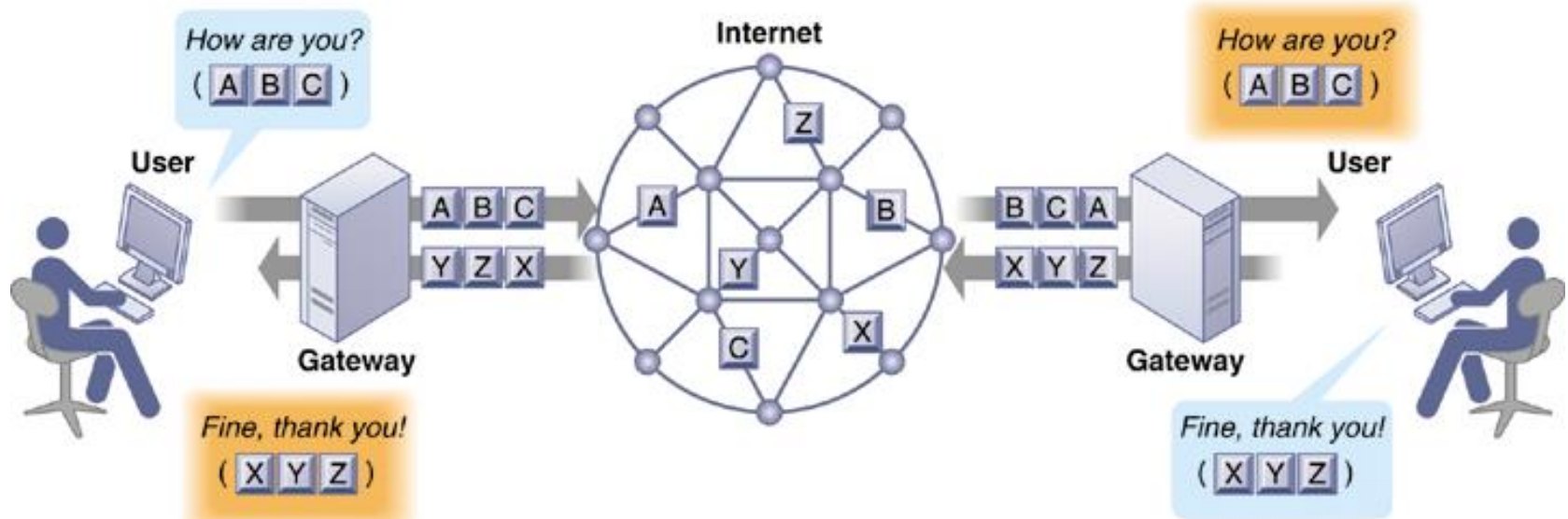
Figure 7.9

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Monitoring Employees on Networks: Unethical?

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

• **Read the Interactive Session and then discuss the following questions:**

1. Should managers monitor employee email and Internet usage? Why or why not?
2. Describe an effective email and web use policy for a company.
3. Should managers inform employees that their web behavior is being monitored? Or should managers monitor secretly? Why or why not?

How the Internet works and supports e-business

A Virtual Private Network Using the Internet

Figure 7.10

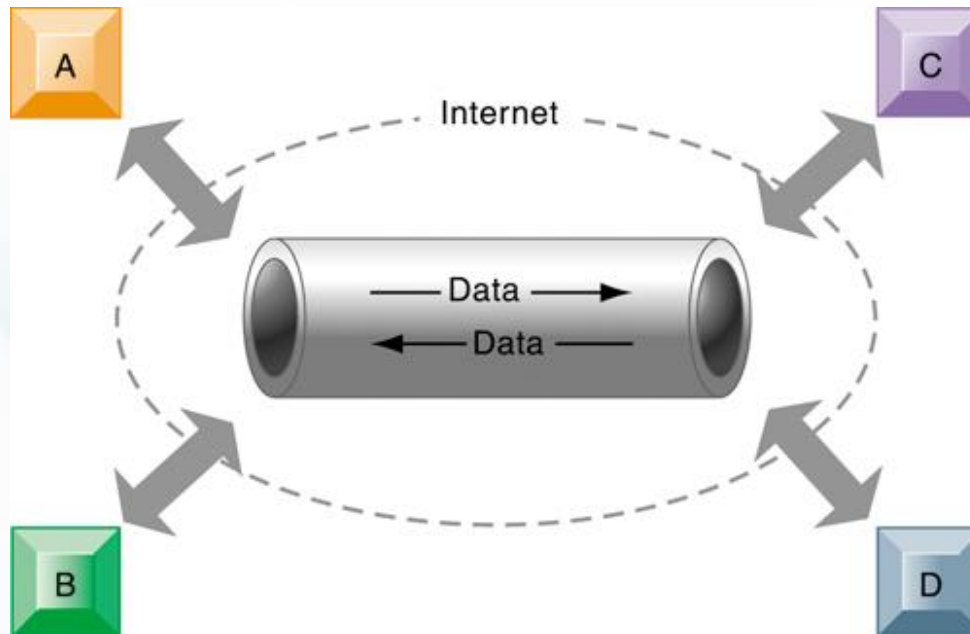**This VPN is a private network of computers linked using a secure "tunnel" connection over the Internet. It protects data transmitted over the public Internet by encoding the data and "wrapping" them within the Internet Protocol (IP). By adding a wrapper around a network message to hide its content,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

The 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

How the Internet works and supports e-business

- **Searching for information on the Web**

    - **Search engines**

        - Early1990s engines used keyword indexes

        - Google implemented page ranking

    - **Mobile search** – now 50% of all searches in 2015

    - **Semantic search**

        - Goal is to include understanding of human language and behavior to deliver more relevant results

    - **Predictive search**- Guesses what you're looking for

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How the Internet works and supports e-business

- **Search engine marketing** – Major source of Internet advertising revenue

- **Social search**

  Effort to provide more relevant results by including pages visited by user's social network

  Google +1, Facebook Like

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How the Internet works and supports e-business

- **Visual search-** facial recognition software

- **Intelligent agent shopping bots** – intelligent agent software for searching Internet for shopping information, e.g. PriceGrabber

- **SEO** – process of improving rankings in search engine results with search engine optimization

  - Google updates algorithm to mitigate link farming

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How the Internet works and supports e-business

Top U.S. Web Search Engines

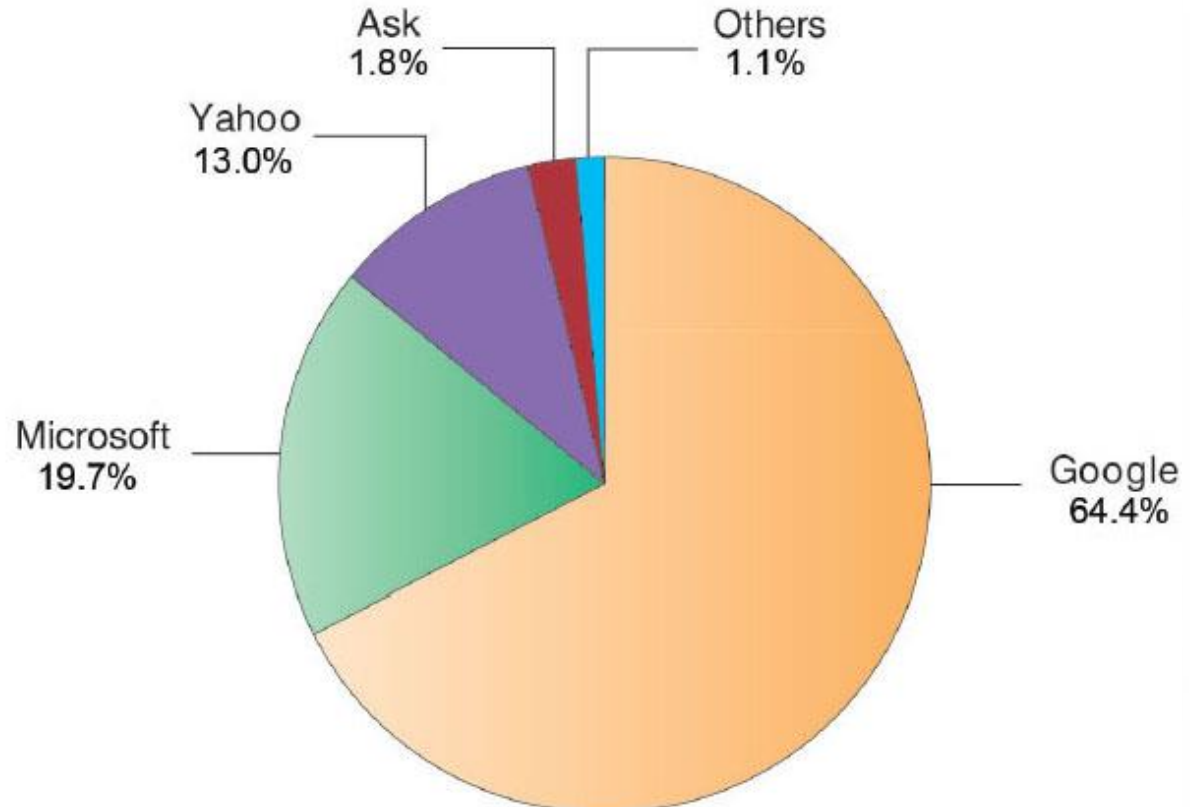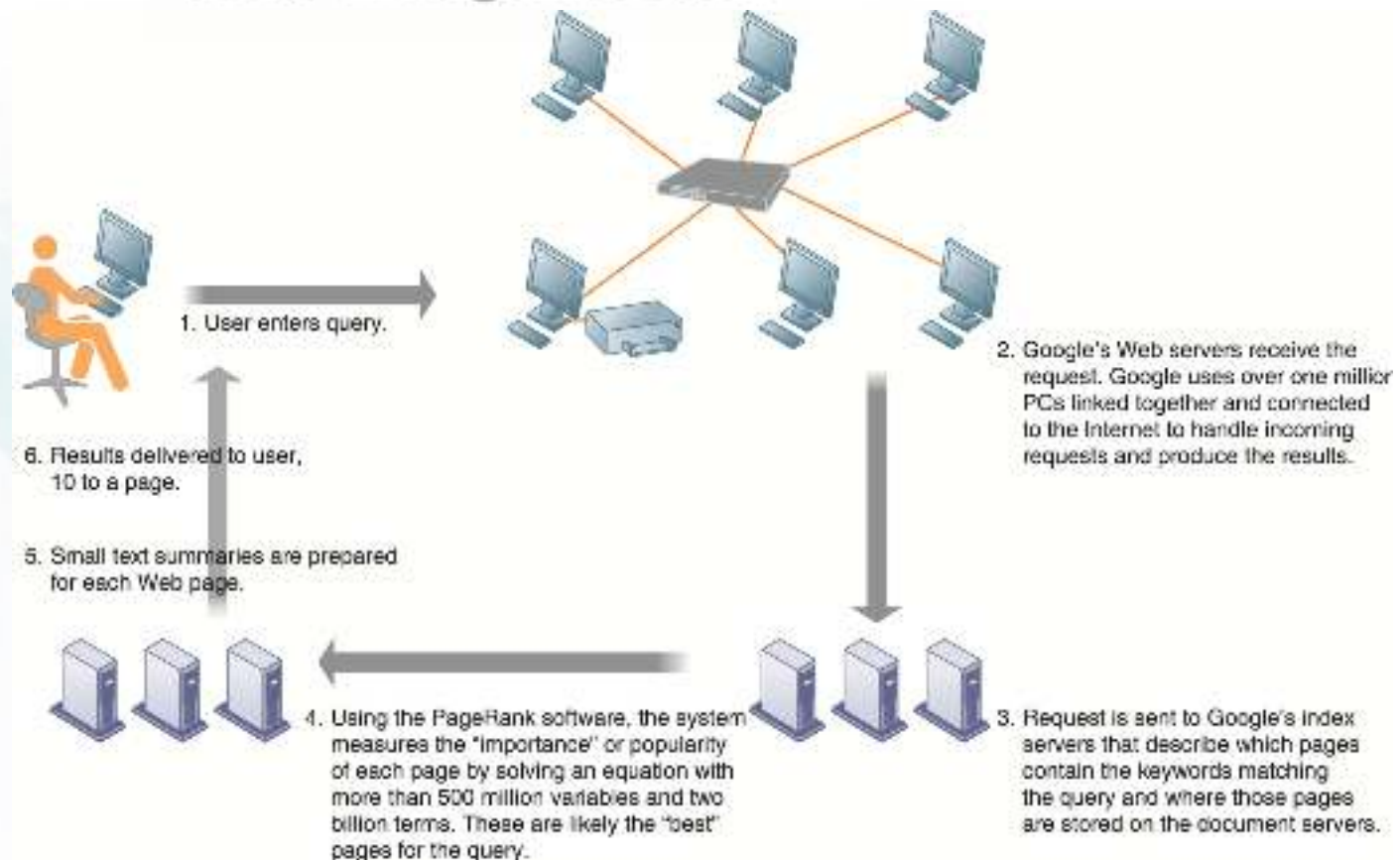**Figure 7.11**

Google is the most popular search engine on the Web, handling 67 percent of all Web searches.

Ask 1.8%

Others 1.1%

Yahoo 13.0%

Microsoft 19.7%

Google 64.4%

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How the Internet works and supports e-business

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 7.12

1. User enters query.

2. Google's Web servers receive the request. Google uses over one million PCs linked together and connected to the Internet to handle incoming requests and produce the results.

3. Request is sent to Google's index servers that describe which pages contain the keywords matching the query and where those pages are stored on the document servers.

4. Using the PageRank software, the system measures the "importance" or popularity of each page by solving an equation with more than 500 million variables and two billion terms. These are likely the "best" pages for the query.

5. Small text summaries are prepared for each Web page.

6. Results delivered to user, 10 to a page.

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

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How the Internet works and supports e-business

Web 3.0 and the Future Web

- **Developing techniques to make searching Web more productive and meaningful**

- **"Semantic Web"**
  - A collaborative effort led by W3C to add layer of meaning to the existing Web

- **Ways to make Web more "intelligent" and intuitive**

- **"Internet of Things"**

- **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 web browsing but not Web browsing

  - **Fourth-generation (4G) networks**

    - Entirely packet-switched

    - Up to 100 Mbps

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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

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The Wireless Revolution

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.
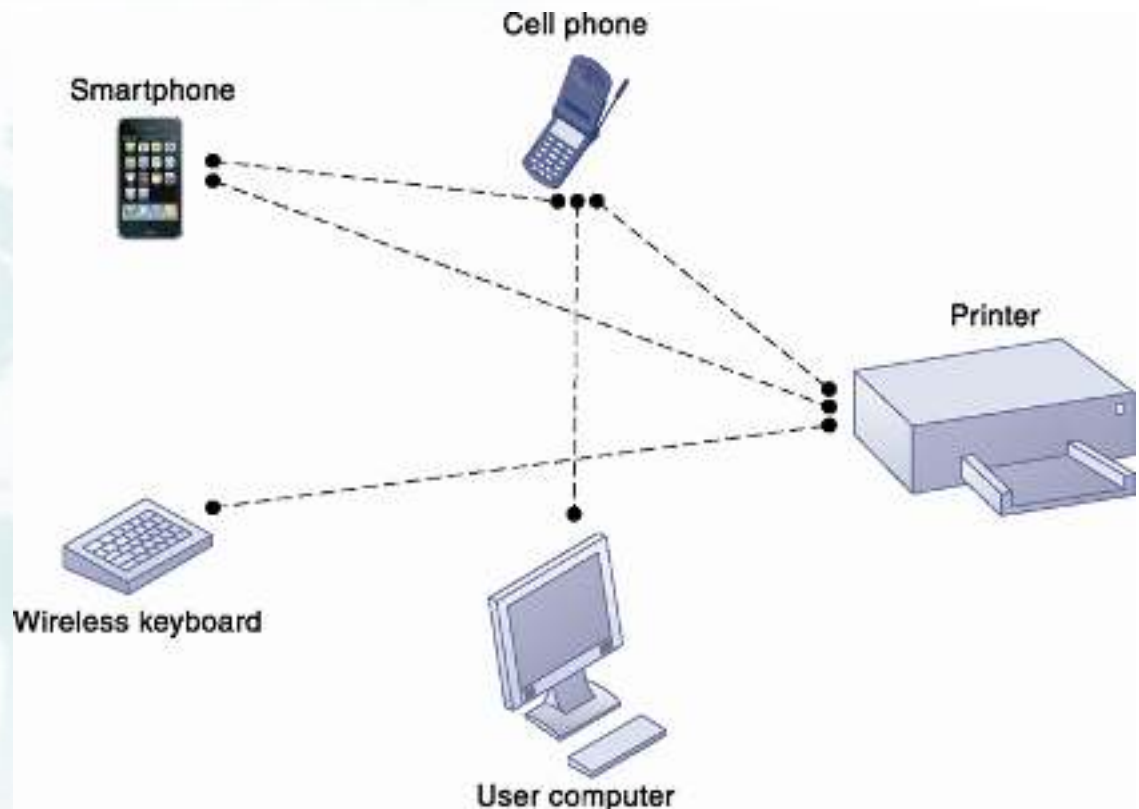
Figure 7.13

The Wireless Revolution

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.
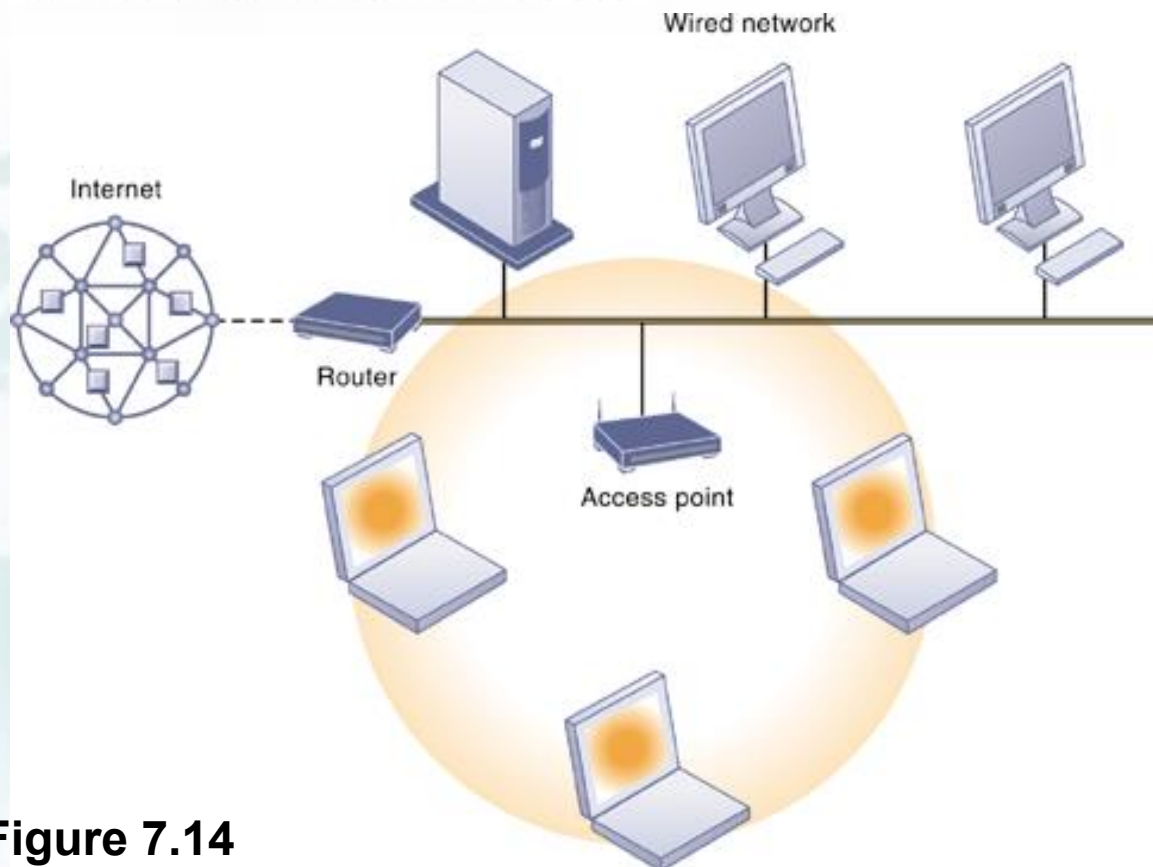

Figure 7.14

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The Wireless Revolution

- **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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The Wireless Revolution

- **Radio frequency identification (RFID)**

  - Use tiny tags with embedded microchips containing data about an item and location

  - Tag antennas to transmit radio signals over short distances to special RFID readers, which send data over network to computer for processing

  - Common uses:

    - Automated toll-collection

    - Tracking goods in a supply chain

  - Requires companies to have special hardware and software

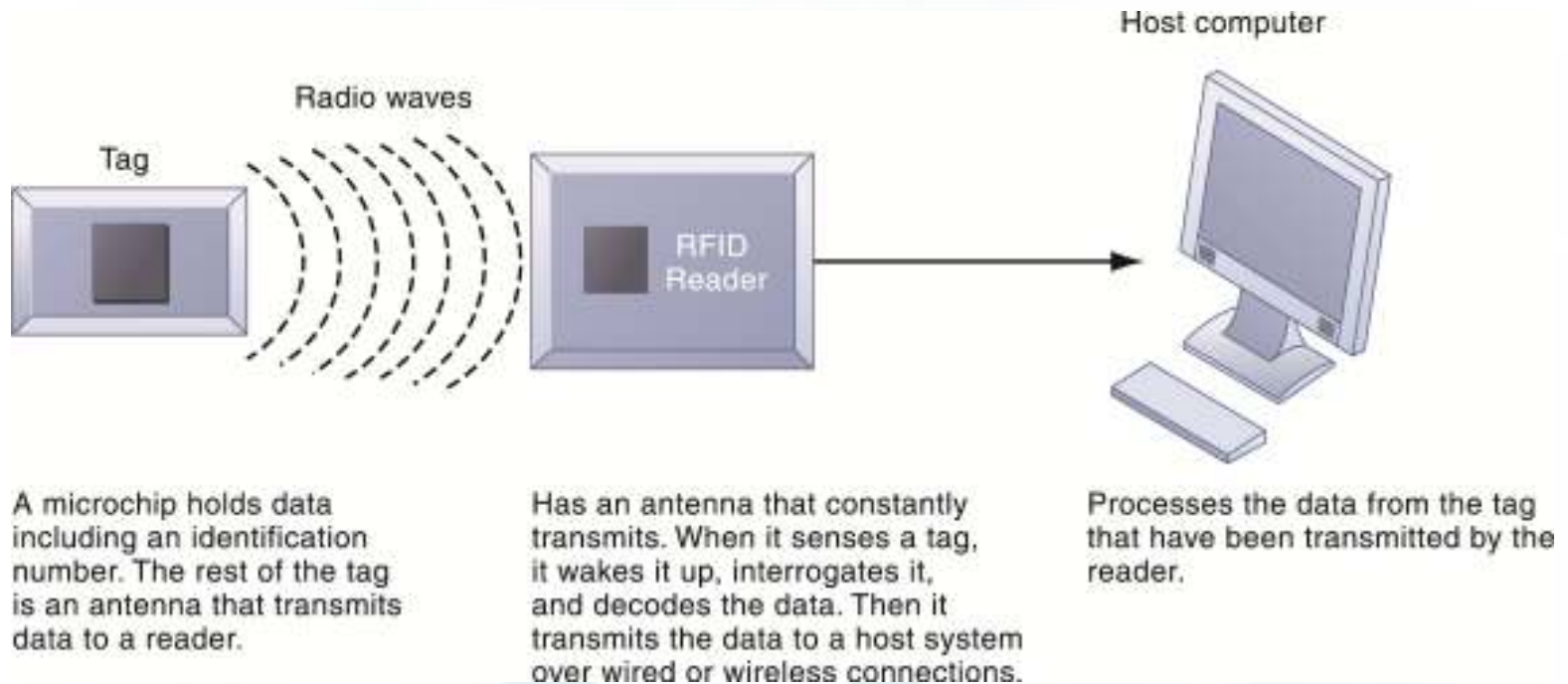 - Reduction in cost of tags making RFID viable for many firms

The Wireless Revolution

How RFID Works

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 7.15

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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

  - Major sources of "Big Data" and fueling "Internet of Things"

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The Wireless Revolution

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.
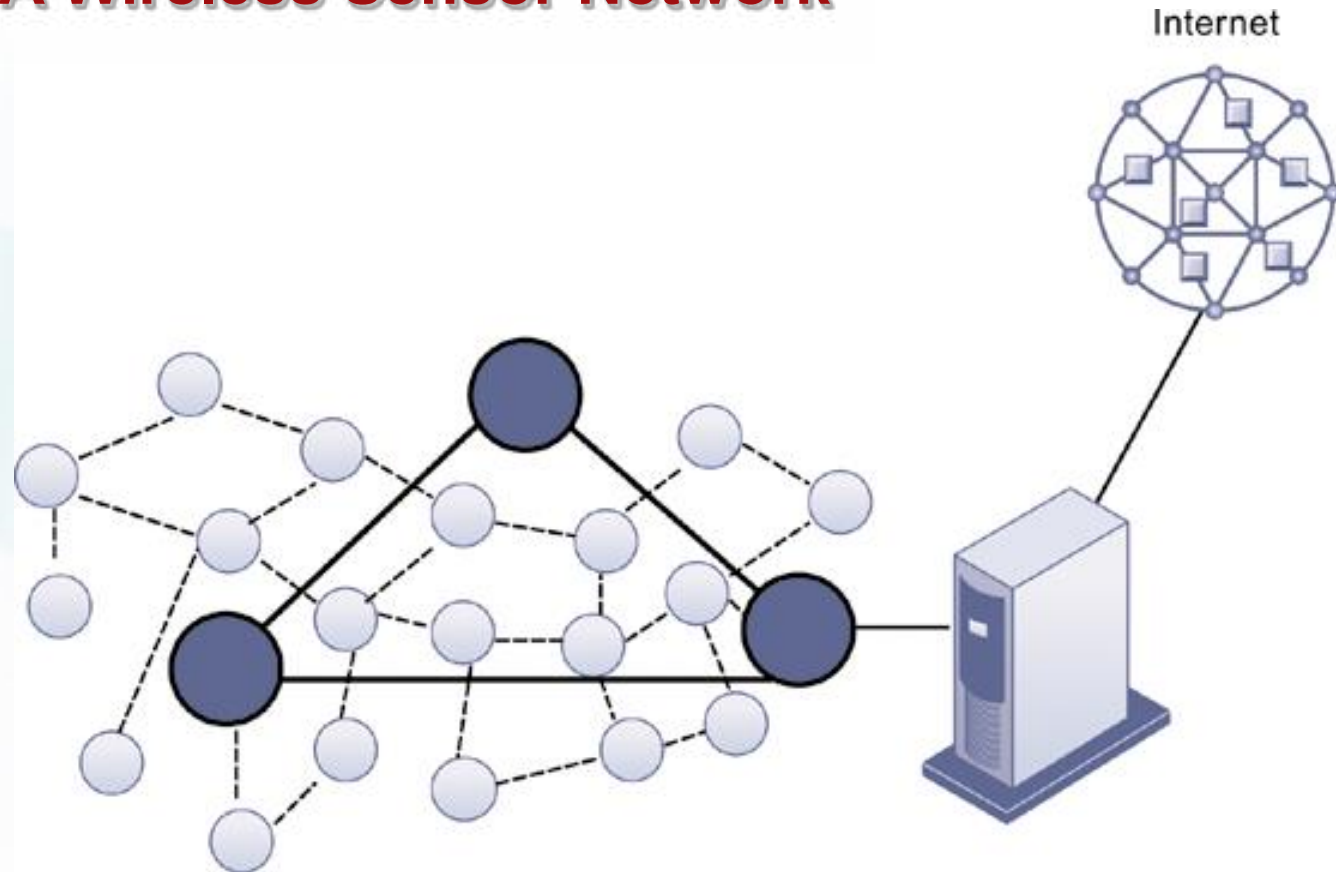
Figure 7.16