



## Chapter 7

# Telecommunications, the Internet, and Wireless Technology

### Video cases:

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

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




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### Chapter 7: Telecommunications, the Internet, and Wireless Technology

#### 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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**Telecommunications and Networking in Today's Business World**

- **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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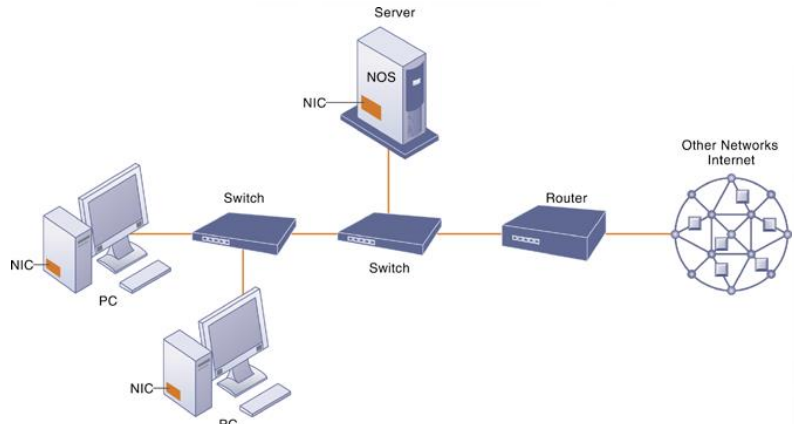
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**Telecommunications and Networking in Today's Business World**

- **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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**Telecommunications and Networking in Today's Business World**

- **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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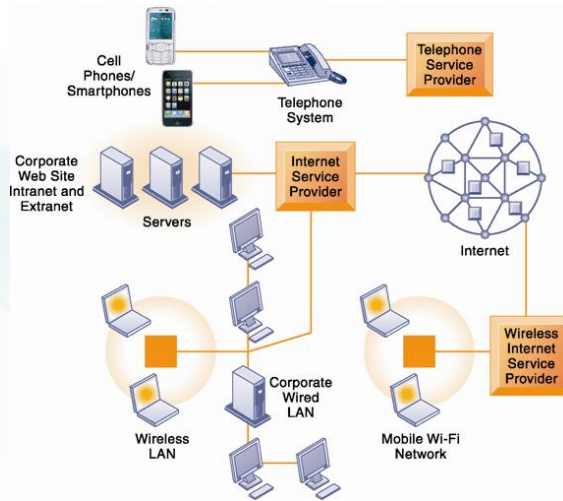
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**Corporate Network Infrastructure**

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**



The diagram illustrates a central 'Corporate Network Infrastructure' hub. It connects several key components:
 

- Cell Phones/Smartphones** and **Telephone System** are linked to a **Telephone Service Provider**.
- Servers** (representing Corporate Web Site, Intranet, and Extranet) are connected to an **Internet Service Provider**.
- The **Internet Service Provider** is connected to the **Internet** (represented by a globe icon).
- The **Internet** is connected to a **Wireless Internet Service Provider**.
- The **Wireless Internet Service Provider** is connected to a **Mobile Wi-Fi Network**.
- The **Mobile Wi-Fi Network** is connected to a **Corporate Wired LAN**.
- The **Corporate Wired LAN** is connected to a **Wireless LAN**.


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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*

The diagram illustrates the packet-switching process. On the left, a 'Message' is shown as a stack of four colored blocks. The top block is labeled 'Packet Number', the second 'Message Number', and the third 'Destination'. The bottom block is labeled 'Data'. This message is split into three separate packets: 'Packet 1', 'Packet 2', and 'Packet 3'. These packets travel through a network of nodes (represented by circles) via different paths. Packet 1 takes the top path, Packet 2 takes the middle path, and Packet 3 takes the bottom path. All three packets eventually reach a destination node on the right, where they are reassembled into a 'Reassembled Message'.

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

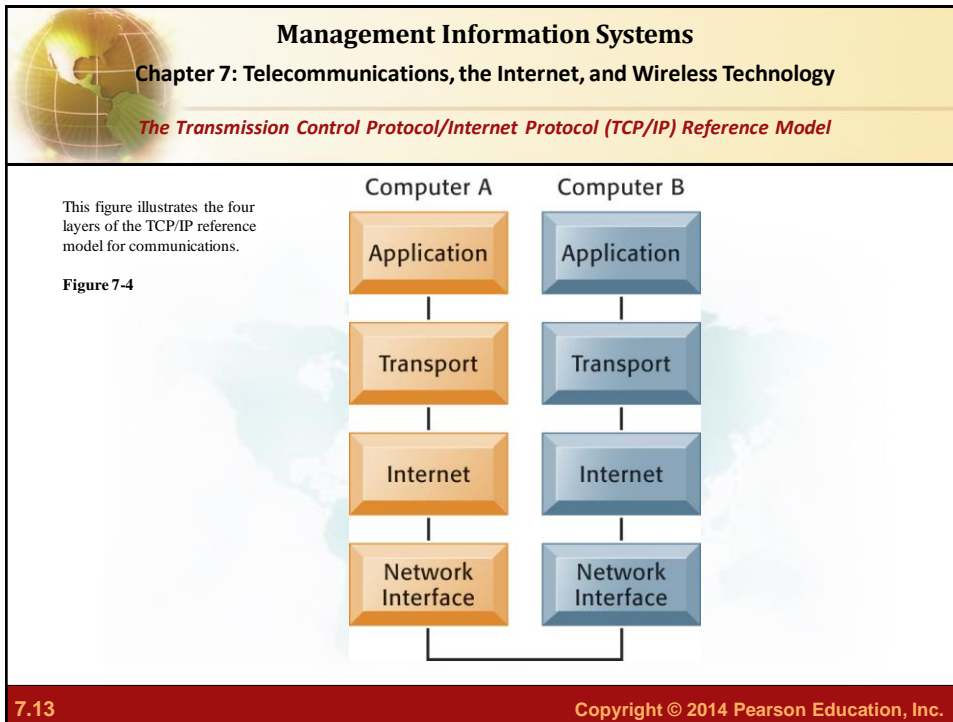
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**Telecommunications and Networking in Today's Business World**

- **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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**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)**

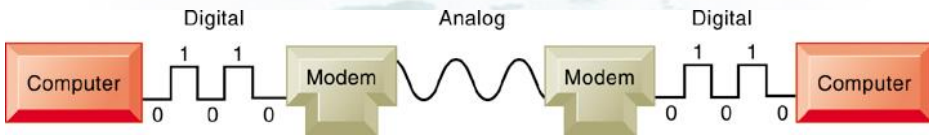
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#### Functions of the Modem



The diagram illustrates the process of data transmission over an analog network. On the left, a red box labeled 'Computer' sends a digital signal represented by a square wave with pulses for '1' and no pulse for '0'. The signal sequence is '1', '1', '0'. This signal enters a green box labeled 'Modem'. The signal then travels through a wavy line representing an analog transmission medium. It then enters a second green box labeled 'Modem', which converts the analog signal back into a digital signal. This second digital signal, with pulses for '1' and no pulse for '0', is sent to a final red box labeled 'Computer'. The signal sequence is '1', '1', '0'.

**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 Global Internet**

- **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**

Internet Root Domain  
 Top-level domains  
 Second-level domains  
 Third-level domains  
 Hosts

Computer1

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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**

Backbone  
 Regional Hubs (MAEs and NAPs)  
 Domain Local ISP  
 Regular Phone Line  
 Home  
 Client IP Address

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*Interactive Session: Organizations*

**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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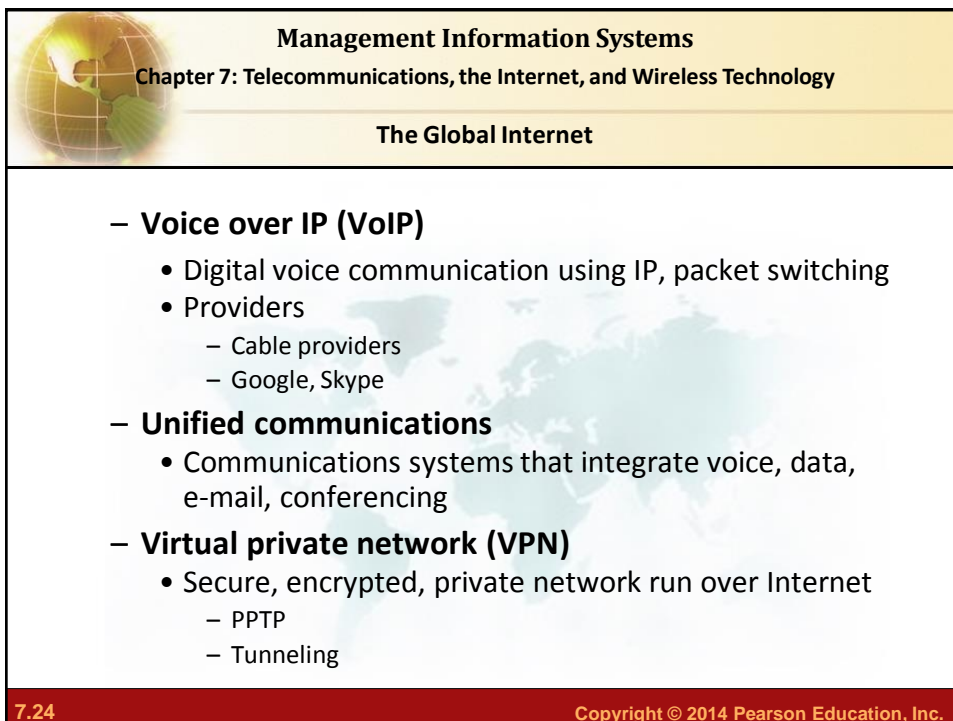
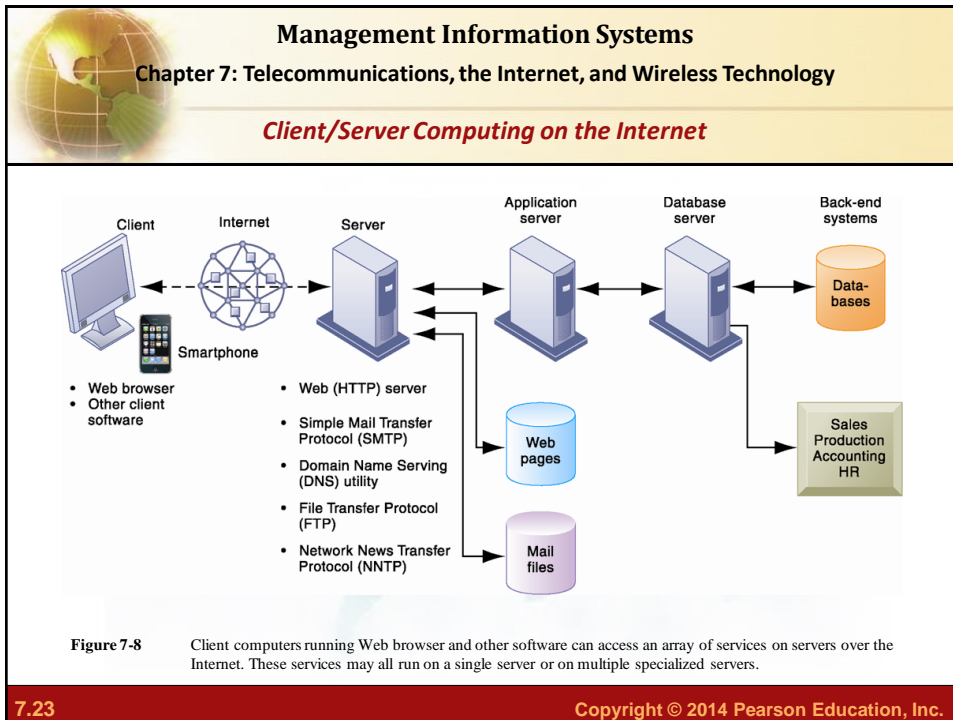


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**The Global Internet**

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

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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 Global Internet**

- **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

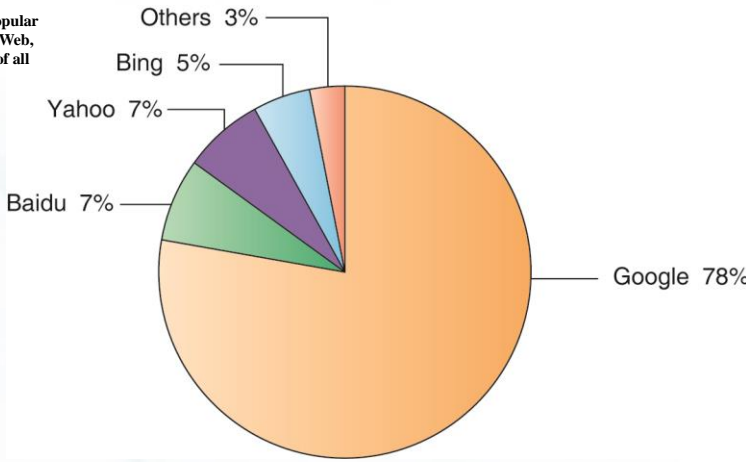
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**Top U.S. Web Search Engines**


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



Search Engine	Market Share
Google	78%
Baidu	7%
Yahoo	7%
Bing	5%
Others	3%

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

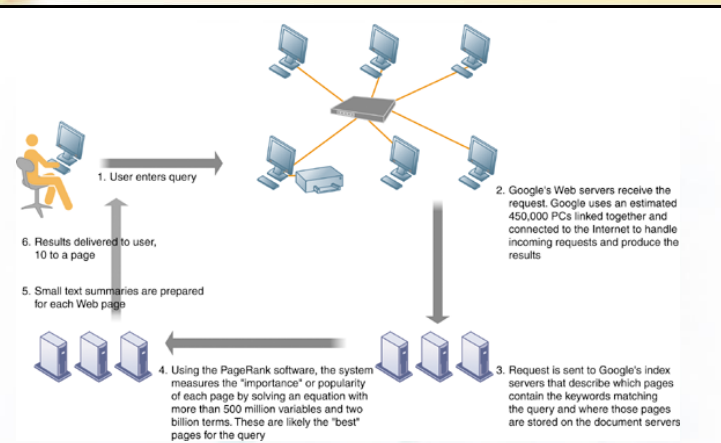
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#### How Google Works




The diagram illustrates the Google search process in six steps:

1. User enters query
2. Google's Web servers receive the request. Google uses an estimated 450,000 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

**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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**The Global Internet**

- **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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**The Global Internet**

- **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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**The Global Internet**

- **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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**The Wireless Revolution**

- **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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**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: 802.11
    - 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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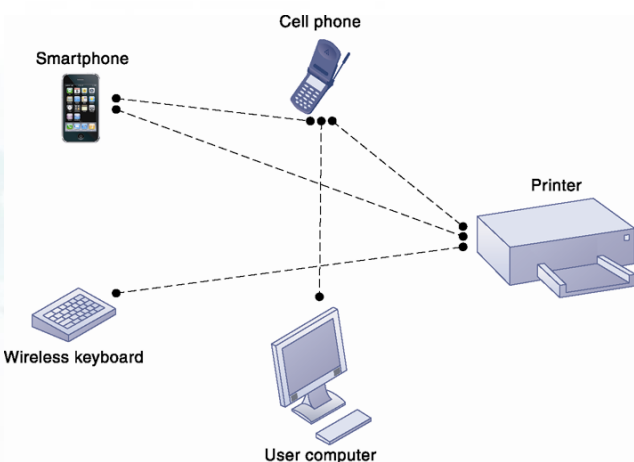


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**A Bluetooth Network (PAN)**

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**



The diagram illustrates a Bluetooth Personal Area Network (PAN). It features five devices: a Smartphone, a Cell phone, a Wireless keyboard, a User computer, and a Printer. Dashed lines represent the wireless connections between these devices. The Smartphone and Cell phone are connected to each other and to the Printer. The Wireless keyboard is connected to the User computer, which is also connected to the Printer. The Printer is the central hub for the network, receiving data from all other devices.

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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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**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)**
  - **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**

The diagram illustrates the RFID process. On the left is a 'Tag', a small rectangular device. In the center is an 'RFID Reader', a larger rectangular device. Dashed lines representing 'Radio waves' emanate from the tag towards the reader. An arrow points from the reader to a 'Host computer' on the right, which consists of a monitor, a tower unit, and a keyboard.

A microchip holds data including an identification number. The rest of the tag is an antenna that transmits data to a reader.

Has an antenna that constantly transmits. When it senses a tag, it wakes it up, interrogates it, and decodes the data. Then it transmits the data to a host system over wired or wireless connections.

Processes the data from the tag that have been transmitted by the reader.

**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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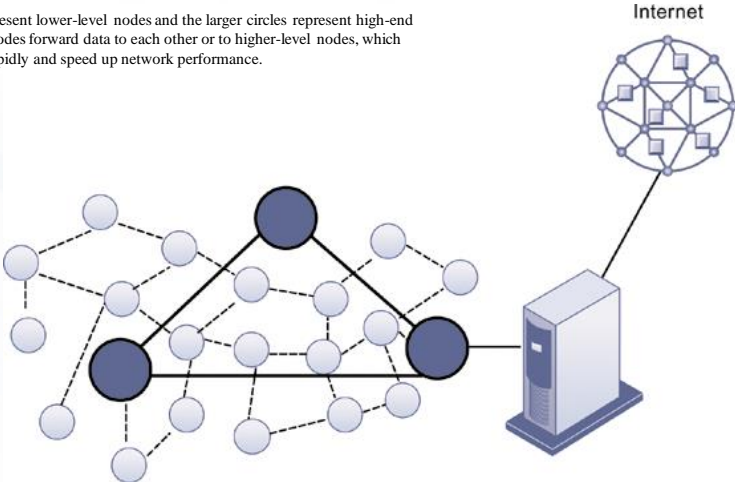
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### A Wireless Sensor Network

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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