Chapter 8
Communications and Networks

Lecture Guide

- **Learning Objectives**
  - Explain connectivity, the wireless revolution, and communication systems.
  - Describe physical and wireless communication channels.
  - Differentiate between connection devices and services including dial-up, DSL, cable, satellite, and cellular.
  - Describe data transmission factors, including bandwidths and protocols.
  - Define networks and key network terminology including network interface cards and network operating systems.
  - Describe different types of networks, including local, home, wireless, personal, metropolitan, and wide area networks.
  - Describe network architectures, including topologies and strategies.
  - Explain the organization issues related to Internet technologies and network security.

Chapter Outline

- **Communications**
  - The process of sharing data, programs, and information between two or more computers including:
    - **E-mail**
      - Provides a fast, efficient alternative to traditional mail by sending and receiving electronic documents.
    - **Texting**
      - Provides very efficient direct text communication between individuals using short electronic messages.
    - **Video Conferencing**
      - Provides a very low-cost alternative to long-distance telephone calls using electronic voice and video delivery.
    - **Electronic commerce**
      - Buying and selling goods electronically.
  - **Connectivity** - using computer networks to link people and resources.
    - Connecting personal computers to other computers and information sources almost anywhere.
    - To efficiently and effectively use your computer you need to know about larger computer systems and their information resources.
  - **The Wireless Revolution** - the widespread use of mobile or wireless telephones.
    - The single most dramatic change in connectivity and communications in a decade has been the widespread use of mobile devices like smartphones and tablets with wireless Internet connectivity.
    - Allows individuals to stay connected with one another from almost anywhere at any time.

- While wireless technology was originally used primarily for voice communications, many of today's cell phones support e-mail, Web access, and a variety of Internet applications.
- Allows a wide variety of nearby devices to communicate with one another without having computers connected by cables or telephone.
- High speed Internet wireless technology allows individuals to connect to the Internet and share information from almost anywhere in the world.
  - **Communications systems -** electronic systems that transmit data from one location to another.
  - Four basic elements of a communication system include:
    - **Sending and receiving devices** –
      - these are often a computer or specialized communication device
      - originate (send) as well as accept (receive) messages in the form of data, information, and/or instructions.
    - **Connection devices** –
      - acts as an interface between the sending the receiving devices and communication channel
      - converts outgoing messages into packets that can travel across the communication channel and reverse the process for incoming messages.
    - **Data transmission specifications** - rules and procedures that coordinate the sending and receiving devices by physically defining how the message will be sent across the communication channel.
    - **Communication channel** –
      - transmission medium that carries the message.
      - medium can be a physical wire or cable, or it can be wireless.
- **Communications Channels**
  - Essential elemnt of every communication system
  - Actually carry the data from one computer to another.
  - Two categories of communication channels that connect sending and receiving devices include physical and wireless connection
  - **Physical Connections**- a solid medium to connect sending and receiving devices. These connections include:
    - **Twisted pair** – pairs of copper wires twisted together
      - Connections include twisted pair, coaxial cable and fiber-optic cable
      - Ethernet cables are often used in networks and to connect a variety of components to the system unit.
    - **Coaxial cable -** a high-frequency transmission cable consisting of a single, solid copper core. See Figure 8-4.
      - Used to deliver television signals as well as to connect computers in a network
    - **Fiber-optic cable** - transmits data as pulses of light through tiny tubes of glass.
      - Lighter, faster, and more reliable than coaxial cable
      - Rapidly replacing twisted-pair cable telephone lines.

- o **Wireless Connections**
- o Do not use a solid substance to connect sending and receiving devices.
- o Data is moved through the air.
- o Primary technologies used for wireless connections are Bluetooth, Wi-Fi, microwave, WiMax, LTE, and satellite connections.
  - **Bluetooth** is a short-range radio communication standard that transmits data over short distances of up to approximately 33 feet. Bluetooth is widely used for wireless headsets, printer connections, and handheld devices.
  - **Wi-Fi** (wireless fidelity) uses high frequency radio signals to transmit data. A number of standards for Wi-Fi exist, and each can send and receive data at a different speed. Most home and business wireless networks use Wi-Fi.
  - **Microwave** - communication through high-frequency radio waves. It is sometimes referred to as line-of-sight communication because microwaves can only travel in a straight line.
    - Because waves cannot bend with the curvature of the earth they can only be transmitted over relatively short distances.
    - For longer distances, the waves must be relayed by means of microwave stations with microwave dishes or antennas.
  - **WiMax** (Worldwide Interoperability for Microwave Access) is a new standard that extends the range of Wi-Fi networks using microwave connections. WiMax is commonly used by universities and others to extend the capability of existing Wi-Fi networks.
  - **LTE** (Long Term Evolution) is one of the newest wireless standards. Currently, LTE and WiMax connections provide similar performance. LTE, however, promises to provide greater speed and quality transmissions in the near future.
  - **Satellite** - amplified microwaves that use point-to-point communication to relay devices (satellites) orbiting 22,000 miles above the earth.
    - Rotate at a precise point and speed above the earth.
    - Amplify and relay microwave signals from one transmitter on the ground to another.
    - Used to send and receive large volumes of data.
    - Communication interferences can occur in bad weather.
    - Used by global positioning system (GPS) devices.
    - Used by many smartphones, including the Apple iPhone.

- **Connection Devices**
  - o At one time nearly all computer communication systems used standard telephone lines and analog signals. Computers use digital signals. A modem is required to convert the digital signals to analog signals and vice versa.
  - o **Modems** (modulator-demodulator) **-** connect computers over analog phone lines.
    - Modems convert the computer's digital signal to an analog transmission to send over the phone line (modulation) and then re-convert it to digital when receiving information from the phone lines (demodulation).

- Transfer rate is in bits-per-second; typically measured in millions of megabits per second (Mbps)
- Four commonly used types of modems include:
  - **Telephone** – used to connect a computer directly to a telephone line; either internal or external
  - **DSL (digital subscriber line)** – uses standard phone lines to create a high-speed connection directly to the phone company's offices; external and usually use USB or Ethernet port to connect to system.
  - **Cable** – uses the same coaxial cable as a television to create a high-speed connection. Connect using USB or Ethernet port.
  - **Wireless** (also known as a WWAN- wireless wide area network modem). Commonly a USB or ExpressCard device that provides very portable high-speed connectivity from virtually anywhere.
- **Connection Service**
  - **T1**– special high speed lines from telephone companies that support all digital communications.
    - T3 or DS3 provide higher capacity options
    - Used by large companies.
    - Too costly for most individuals.
    - Have largely been replaced with optical carrier (OC) lines which are much faster.
  - **Dial-up** - uses existing telephones and telephone modems to connect to the Internet. Very slow and has been replaced by other higher-speed connection services.
  - **Digital subscriber line (DSL)** - uses existing telephone lines to provide high-speed connections. Much faster than dial-up.
  - **ADSL (asymmetric digital subscriber line)** is one of the most widely used types of DSL
  - **Cable** - use existing television cables to provide high-speed connections. Usually faster than DSL.
  - **Fiber Optic Service (FiOS)** is a new technology in some areas but not widely available**.** Current providers of FiOS include Google and Verizon with speeds faster than cable or DSL.
  - **Satellite connection services** - use satellites to provide wireless connections. Slower than DSL and cable modem but higher availability
  - **Cellular** services - **Cellular service providers** including Verizon, AT&T, Sprint, and T-Mobile support voice and data transmission to wireless devices. Cellular services have gone through different generations.
    - **1G (first generation mobile telecommunications)** started in the 1980s using analog radio signals to provide analog voice transmission service.
    - **2G (second generation mobile telecommunications)** stared in the 1990s using digital radio signals. This generation focused on voice transmission and was too slow for effective Internet connectivity.

- **3G (third generation mobile telecommunications)** started in the 2000s providing services capable of effective connectivity to the Internet and marked the beginning of smartphones.
- While **4G (fourth generation mobile telecommunications)** have begun to replace 3g with providers using WiMax and LTE connections to provide faster transmission speeds. A user's experience with 4G will depend on several factors including carrier, geography, and proximity to cell towers. 4G technologies can provide speeds up to 10 times faster than 3G.

- **Data transmission**
  - **Bandwidth** – is a measurement of the width or capacity of the communication channel. How much information can move across the communication channel in a given amount of time.
  - Four categories of bandwidth include:
    - **Voiceband (low bandwidth)** - used for standard telephone communication by personal computers with telephone modems and dial-up service. Can transmit text documents but is too slow for many types of transmitting high-quality audio and video.
    - **Medium band** - used in special leased lines to connect midrange computers and mainframes as well as to transmit data over long distances. Capable of very high-speed data transfer.
    - **Broadband** – widely used by DSL, cable, and satellite connections for high-capacity transmissions. Several users can simultaneously use a single broadband connection for high-speed data transfer.
    - **Baseband** - widely used to connect individual computers that are located close to one another. Like broadband, it is able to support high-speed transmission. Unlike broadband, however, baseband can only carry a single signal at one time.
  - **Protocols** for data transmission to be successful, sending and receiving devices must follow a set of communications rules for exchange of information. Protocols are the rules for exchanging data between computers.
    - http or hypertext transfer protocol is a widely used protocol used for Web traffic. Another protocol, https or hypertext Transfer Protocol Secure is becoming widely used to protect the transfer of sensitive information. **TCP/IP – Transmission Control Protocol/Internet Protocol** is the standard protocol for the Internet. Essential features involve – sending and receiving devices and breaking information into small parts for transmission across the Internet
      - **Identification**: Every computer on the Internet has a unique numeric address called an IP address (Internet Protocol address). Uses a domain name server (DNS) that automatically converts text-based addresses to numeric IP addresses.
      - **Packetization**: Information sent or transmitted across the Internet usually travels through numerous interconnected networks. Before a message is sent, it is reformatted or broken down into small parts called packets. Each packet is then sent separately over the Internet,

> possible travelling different routes to one common destination. At the receiving end, the packets are reassembled into the correct order.

- **Networks**
  - A computer network is a communication system that connects two or more computers so they can exchange information and share resources.
  - Number of specialized terms that describe computer networks include:
    - **Node**—any device that is connected to a network.
    - **Client** —a node that requests and uses resources available from other nodes. Typically, a client is a user's personal computer.
    - **Server**—a node that shares resources with other nodes. Dedicated servers specialize in performing specific tasks.
    - **Directory server**—specialized server that manages resources such as user accounts for an entire network.
    - **Host**—any computer system that can be accessed over a network.
    - **Router** —a node that forwards or routes data packets from one network to their destination in another network
    - **Switch**—central node that coordinates the flow of data by sending messages directly between sender and receiver nodes. A hub previously filled this purpose by sending a received message to all connected nodes, rather than just the intended node.
    - **Network interface cards (NIC)**—expansion cards located within the system unit that connect the computer to a network. Sometimes referred to as a LAN adapter.
    - **Network operating systems (NOS)**—control and coordinate the activities of all computers and other devices on a network.
    - **Network administrator**—a computer specialist responsible for efficient network operations and implementation of new networks.
- **Network Types**
  - **Local Area Networks (LANs)-** Networks with nodes that are in close physical proximity, typically spanning less than a mile and are owned and operated by individual organizations.
    - **Network gateway** - device that allows one LAN to be linked to other LANs or to larger networks.
    - The most common standard in which nodes in a LAN can be connected to one another is known as **Ethernet.**
  - **Home Networks -** networks being used by individuals in their homes and apartments. Allow different computers to share resources, including a common Internet connection
  - **Wireless LAN (WLAN) -** uses radio frequencies to connect computers and other devices. All communications pass through the network's centrally located **wireless access point** or base station. This access point interprets incoming radio frequencies and routes communications to the appropriate devices. In public places wireless access points are known as **hotspots** and typically use Wi-Fi technology. Most mobile computing devices have an internal wireless network card to connect to hotspots.

- o **Personal area network (PAN)** - type of wireless network that works within a very small area—your immediate surroundings. PANs connect cell phones to headsets, PDAs to other PDAs, keyboards to cell phones, and so on. Most popular PAN technology is Bluetooth, with a maximum range of around 30 feet.
  - o **Metropolitan Area Networks (MANs)-** span distances up to 100 miles. Frequently used links between office buildings that are located throughout a city. MANs are typically owned by a group of organizations who jointly own and operate the network or by a single network service provider who provides network services for a fee. Microwave relays and satellites are used to reach users over long distances.
  - o **Wide Area Networks (WANs) -** countrywide and worldwide networks. Provide access to regional service (MAN) providers and typically span distances greater than 100 miles. They use microwave relays and satellites to reach users over long distances. The widest of all WANs in the Internet, which spans the entire globe.
    - ▪ The primary difference between a PAN, LAN, MAN, and WAN is the geographic range.
- **Network Architecture**
  - o Describes how a network is arranged and how resources are coordinated and shared.
  - o **Topology –** Describes the physical arrangement of a network and how resources are coordinated and shared.
    - ▪ **Bus network**
      - Each device is connected to a common cable called a bus or backbone and all communications travel along this bus.
    - ▪ **Ring network**
      - Each device is connected to two other devices, forming a ring. When a message is sent, it is passed around the right until it reaches the intended destination. See Figure 8-17
    - ▪ **Star**
      - Each device is connected directly to a central network switch.
      - Whenever a node sends a message, it is routed to the switch, which then passes the message along to the intended recipient.
      - Most widely used network topology today.
      - Range of applications includes small networks in the home to very large networks in major corporations. See Figure 8-18
    - ▪ **Tree**
      - Each device is connected to a central node, either directly or through one or more other devices.
      - Central node is connected to two or more subordinate nodes that in turn are connected to other subordinate nodes, and so forth, forming a treelike structure.
      - Also known as a hierarchical network. See Figure 8-19
    - ▪ **Mesh**
      - Newest type of topology and does not use a specific physical layout.

- Requires that each node have more than one connection to the other nodes. The resulting pattern forms the appearance of a mesh.
- If a path between two nodes is somehow disrupted, data can be automatically rerouted.
- Wireless technologies are frequently used to build mesh networks. See Figure 8-20

- **Strategies**
  - Every network has a strategy, or way of coordinating the sharing of information and resources. Two of the most common network strategies are client/server and peer-to-peer.
    - **Client/server** network - use central servers to coordinate and supply services to other nodes on the network. The server provides access to resources such as Web pages, databases, application software, and hardware
      - Strategy is based on specialization. Server nodes coordinate and supply specialized services, and client nodes request the services.
      - Commonly used server operating systems are Windows Server, Mac OS X Server, Linux, and Solaris.
      - Client/server networks are widely used on the Internet.
      - Advantage of the client/server network strategy include:
        - Ability to handle very large networks efficiently.
        - Availability of powerful network management software to monitor and control network activities.
      - The major disadvantages of the client/server network strategy are the cost of installation and maintenance
    - **Peer-to-peer (P2P)** network - nodes have equal authority and can act as both clients and servers. Many current popular game, movie, and music sharing services use this network strategy.
      - Special file-sharing, software such as BitTorrent can be used to obtain files located on another personal computer.
      - Advantage of P2P:
        - Easy and inexpensive (often free) to set up and use.
      - Disadvantage of P2P:
        - Lack of security controls or other common management functions.

- **Organizational Networks**
  - **Intranet Technologies**
    - A private network within an organization that resembles the Internet.
    - Uses browsers, web sites, and web pages.
    - Organizations use intranets to provide information to their employees such as electronic telephone directories, e-mail addresses, internal job openings, and more.
    - Accessible only to those within the organization.
    - Easy and intuitive for employees to use.
  - **Extranet**

- A private network that connects more than one organization.
- Many organizations use Internet technologies to allow suppliers and others limited access to their networks.
- Main purpose is to increase efficiency and reduce costs.
  - **Network Security**
  - Securing large corporate networks requires specialized technology. Three technologies commonly used to ensure network security include:
    - **Firewalls**
      - A security system designed to protect an organization's network against external threats.
      - Consists of hardware and software that control access to a company's intranet or other internal networks.
      - Sometimes organizational firewalls include a special computer or software called a **proxy server.** This system is a gatekeeper. All communications between the company's internal networks and the outside world must pass through it.
    - **Intrusion detection systems (IDS)**
      - Works with firewalls to protect an organization's network.
      - Uses sophisticated statistical techniques to analyze all incoming and outgoing network traffic.
      - Uses advanced pattern matching and heuristics to recognize signs of a network attack and disable access before an intruder can do damage.
    - **Virtual private networks (VPN)**
      - Create a secure private connection between a remote users and an organization's internal network.
      - Connection is heavily encrypted
      - Special VPN protocols create the equivalent of a dedicated line between a user's home or laptop computer and a company server.
- **Careers In IT**
  - Network administrators manage a company's LAN and WAN networks.
  - **Duties**
    - Design, implementation, and maintenance of networks.
    - Maintenance of both hardware and software related to a company's intranet and Internet networks.
    - Diagnosing and repairing problems with these networks.
    - Planning and implementations of network security
  - Bachelor's degree or an advanced associate's degree in computer science, computer technology, or information systems as well as practical networking experience or technical certification.
  - Annual salary of $46,000 to $84,000.
  - Expected to be among the fastest-growing jobs in the near future.
- **A Look to the Future**
  - **Telepresence Lets You Be There without Actually Being There**
  - Telepresence seeks to create the illusion that you are actually at a remote location, seeing, hearing, and someday maybe even feeling as though you were really there.

- o Today's early telepresence implementations mainly focus on an extension of videoconferencing.
- o Might be used to allow people to work in hazardous areas from a safe remote location. Doctors and medical specialists might be able to perform surgeries on people unable to travel.

Teaching Tips

- **Communications**
  - o Emphasize that connectivity is the fastest growing sector of the computer industry and that **The Wireless Revolution** is the single most dramatic change in connectivity and communications in the past five years.
  - o Discuss why it is called a revolution.
  - o Give an overview of the different parts of a communication system that will be covered.
  - o You can refer to the basic communications model that is discussed in public speaking classes and how computers work in the same fashion. See Figure 8-2
    - **Sending and receiving devices**
    - **Communication channel = medium**
    - **Connection devices**
    - **Data transmission specifications = message**
- **Communications Channels**
  - o Emphasize that there are two types of channels:
  - o **Physical (wired)** - a solid medium to connect sending and receiving devices.
    - Mention that twisted pair – uses copper wires to conduct electricity, covers the least distance and is the slowest of the wired channels
    - **Coaxial cable -** a high-frequency transmission cable, uses copper wire to conduct electricity, has a medium-range distance capability and speed.
    - **Fiber-optic cable** - transmits data as pulses of light through tiny tubes of glass or plastic, covers the farthest distance and has the fastest transmission speed
  - o Bring samples of the physical (wired) channels to class. It gives the students a clear visual and makes it easier to open a discussion on the various types. [Word of caution – do not let students handle the piece of fiber-optic cable – it has tiny strands of glass that may stick into their skin. Passing it around is easier if it is sealed in a plastic freezer bag.]
  - o **Wireless-Give specific examples for each category**
    - **Bluetooth** is a short-range radio communication standard that transmits data over short distances of up to approximately 33 feet. Bluetooth is widely used for wireless headsets, printer connections, and handheld devices.
    - **WiFi -** (wireless fidelity) uses high frequency radio signals to transmit data. A number of standards for Wi-Fi exist, and each can send and receive data at a different speed. Most home and business wireless networks use Wi-Fi.

- **Microwave -** communication through high-frequency radio waves and provides line-of-sight communication but over short distances. Bluetooth is a form of microwave transmission
- **WiMax** (Worldwide Interoperability for Microwave Access) is a new standard that extends the range of Wi-Fi networks using microwave connections. WiMax is commonly used by universities and others to extend the capability of existing Wi-Fi networks.
- **LTE** (Long Term Evolution) is one of the newest wireless standards. Currently, LTE and WiMax connections provide similar performance. LTE, however, promises to provide greater speed and quality transmissions in the near future.
- **Satellite -** amplified microwaves that use point-to-point communication to relay devices (satellites) orbiting the earth. Communication interferences can occur in bad weather.
  - **GPS (global positioning system)**
- **Infrared** uses infrared light waves to communicate over short distances. Line of sight, remotes
- o As a lab exercise task students with interviewing and identifying which (if any) of the wireless communication channels are used at their school.
- **Connection Devices See** Figure 8-9
  - o **Signals**
    - Analog – continuous electronic waves
    - Digital – represents the presence or absence of an electronic pulse
  - o You can emphasize the difference between modems and higher speed devices.
  - o Most students are familiar with both and are interested in how you can connect using the higher speed devices.
  - o Discuss how DSL uses standard phone lines
  - o See Figure 8-11 and have students identify how each of the basic types of modems are used
- **Connections Services**
  - o Describe the following services and give examples of each:
  - o DSL, Cable, Satellite, Cellular
  - o Discuss the cellular service generations of mobile communications 1g, 2g, 3g and 4g.
  - o Have students research and prepare graphs for 1g-4g rates
- **Data transmission**
  - o Bandwidth can be difficult for students to understand. You can use an analogy of a highway and the wider the road the more cars can travel on it in a given amount of time.
  - o Protocols can be compared to foreign services and how different countries have different ways to communicate. Mention Internet protocol TCP/IP
  - o You can discuss with students how it is possible to determine which computer on the Internet was used to send an e-mail or to access a certain Web site. Discussing the concept of the "digital footprint" with students is often enlightening.
- **Making IT Work** – the Mobile Internet should be really interesting to your students; you can have student develop questions for a jeopardy game for this chapter

- **Networks**
  - You can emphasize the basic parts that comprise a network.
  - Figure 8-13 is a good illustration of all the parts of a network as it makes it easier for the students to grasp the terminology that is used to describe computer networks (node, client, server, directory server, host, router, switch, network interface card, network operating system, and network administrator)
- **Network Types**
  - The divisions between the types of networks are not as clear cut from a technical perspective because some types of devices that used to be solely used for a WAN can be used in LAN environments. Some students can point this fact out. It is best to state that you are taking this from a geographical perspective.
  - Many students have installed or want to install a home network
- **Network Architecture**
  - How a network is arranged and how resources are coordinated and shared.
  - Figure 8-17 in the text provides a diagram of the ring network topology.
  - Figure 8-18 in the text provides a diagram of the star network topology. Stress to students that the star network is the most widely used network topology today. It is used in small networks in the home and very large networks in major corporations.
- **Strategies**
  - Most of the students have had experiences with BitTorrent, and other types of downloading programs. You can use these as an example of how client/server and peer-to-peer work.
  - Open a discussion with students and explore their experiences with the use of this type of downloading programs. Why pay for it – when you can get it for free? Problem with downloading viruses from these unsecured sites. Copyright infringements. All of this is further explored in Chapter 9.
- **Organizational internets**
  - **Intranet**
    - Emphasize that it is a private network within an organization that resembles the Internet and it provides services accessible only to those within the organization.
  - **Extranet**
    - Emphasize that it is a private network that connects more than one organization to allow suppliers and others limited access to their networks.
    - Good examples are organizations that use Just In Time inventory.
    - Good discussion on this would be how Wal-Mart uses this type of network and why they are so successful by doing so.
  - **Network Security**
    - **Firewalls**
      - Both hardware and software
      - Good for home use as well
      - Have students identify what type of firewall they are using on their personal computers.
    - **Intrusion detection systems (NIDS)**

- Ask students to search the Internet for more information on how this system can recognize network attacks and disable access
  - **Virtual Private Network (VPN)** – This technology is widely used by many people who work from home.
    - Ask students to do research to find out what is needed to use VPN

Key Terms

Key Term	Definition
1G (first generation mobile telecommunications)	Started in the 1980s using analog radio signals to provide analog voice transmission service.
2G (second generation mobile telecommunications)	Started in the 1990s using digital radio signals. This generation focused on voice transmission and was too slow for effective Internet connectivity.
3G (third generation mobile telecommunications)	A network that allows portable devices such as cell phones and properly equipped laptop computers to download data from the Internet
4G (third generation mobile telecommunications)	Provides faster transmission speeds than 3G. 3G started in the 2000s providing services capable of effective connectivity to the Internet and marked the beginning of smartphones.
analog signal	Continuous electronic waves.
asymmetric digital subscriber line (**ADSL**)	The most widely used type of DSL.
backbone	See bus.
bandwidth	A measurement of the width or capacity of the communication channel.
base station	A network's centrally located receiver that interprets incoming radio frequencies and routes communications to the appropriate devices. (see also wireless receiver)
baseband	Widely used to connect individual computers that are located close to one another. Baseband can only carry a single signal at one time.
Bluetooth	A short-range wireless communication standard that uses microwaves to transmit data over short distances
broadband	The bandwidth used for high-capacity transmissions.
bus	All communication travels along a common connecting cable called a bus or a backbone. As information passes along the bus, it is examined by each device on the system board to see if the information is intended for that device.
cable modem	Use existing television cables to provide high-speed connections to the Internet.
cable service	A service provided by cable television companies using their existing television cables. These connections are faster than DSL.
cellular service provider	Includes Verizon, AT&T, Spring, and T-Mobile supporting voice and data transmissions to wireless devices.

client	A node that requests and uses resources available from other nodes.
client/server network	A computer network where one computer coordinates and supplies services to other nodes on the network.
coaxial cable	A high-frequency transmission cable with a single solid-copper core.
communication channel	The actual connecting or transmission medium that carries the message.
communication system	An electronic system that transmit data from one location to another
computer network	A communication system that connects two or more computers so that they can exchange information and share resources.
connectivity	Using computer networks to link people and resources.
demodulation	The process of converting from analog to digital.
dial-up service	Using standard telephone lines and conventional modems to link to the Internet or other computers
digital signal	A representation of the presence or absence of an electronic pulse – on/off
digital subscriber line (**DSL**)	Uses existing telephone lines to provide high-speed connections
digital subscriber line (**DSL**) service	A service provided by telephone companies using existing telephone lines to provide high-speed connections.
directory server	A specialized server that manages resources, such as user accounts, for an entire network.
domain name server (**DNS**)	Converts text-based addresses to IP addresses
downlink	Receives data from a satellite.
DS3	Same as T1 leased line
Ethernet	The most common way in which nodes can be connected to one another and communications can be controlled.
Ethernet cable	A twisted-pair cable that is commonly used in networks and to connect a variety of components to the system unit.
extranet	A private network that connects more than one organization.
fiber-optic cable	Transmits data as pulses of light through tiny tubes of glass.
firewall	A security system designed to protect an organization's network against external threats.
global positioning system (**GPS**)	Global positioning system (GPS) devices use location information sent by satellites to uniquely determine the geographic location of the device.
hierarchical network	Consists of several computers linked to a central host computer, but also are hosts to other, smaller computers or peripheral devices.
home network	Local Area Networks used by individuals in their homes and apartments.
host	A large centralized computer, usually a minicomputer or a mainframe.

hotspot	Wireless access points that provide Internet access and are often available in public places such as coffee shops, libraries, bookstores, colleges, and universities.
http (hypertext transfer protocol)	Widely used protocol for web traffic.
https (hypertext transfer protocol secure)	Is a widely used protocol used for Web traffic and is used to protect the transfer of sensitive information.
hub	The center or central node for other nodes.
infrared	Uses infrared light waves to communicate over short distances.
intranet	A private network within an organization that resembles the Internet.
intrusion detection system (**IDS**)	A system that works with firewalls to protect an organization's network.
IP address (Internet protocol address)	A unique numeric address for every computer on a network.
local area network (**LAN**)	Networks with nodes that are in close physical proximity
low bandwidth	Used for standard telephone communication. (see also voiceband)
LTE (Long Term Evolution)	A wireless standard, comparable to WiMax.
medium band	The bandwidth used in special leased lines to connect minicomputers and mainframes
megabits per second (Mbps)	The transfer rate of millions of bits per second.
mesh network	A new type of topology that does not use a specific of physical layout.
metropolitan area network (**MAN**)	A network that span distances up to 100 miles.
microwave	A type of communication that uses high-frequency radio waves.
modem	Modulator-demodulator enables digital personal computers to communicate across analog telephone lines.
modulation	The process of converting from digital to analog.
network administrator	A computer specialist responsible for efficient network operations and implementation of new networks.
network architecture	Describes the structure of how a network is arranged and how resources are coordinated and shared.
network gateway	A device that allows one LAN to be linked to other LANs or to larger networks.
network interface card (**NIC**)	Expansion cards located within the system unit that connect the computer to a network
network operating system (**NOS**)	An operating system that control and coordinate the activities of all computers and other devices on a network.
node	Any device that is connected to a network.
optical carrier (OC)	High-speed lines used by large corporations for all-digital transmission.
packet	Data reformatted or broken down into small parts
peer-to-peer (**P2P**) network	A type of network where each node has equal authority and

	can act as both client and server.
personal area network (**PAN**)	Wireless networks for PDAs, cell phones, and other small gadgets
protocol	Rules for exchanging data between computers
proxy server	A computer through which all communications between the company's internal networks and the outside world must pass.
ring network	Network in which each device is connected to two other devices, forming a ring. There is no host computer, and messages are passed around the ring until they reach the correct destination.
router	A node that forwards or routes data packets from one network to their destination in another network.
satellite	A type of communication that uses satellites orbiting about 22,000 miles above the earth as microwave relay stations.
satellite connection service	Use satellites to provide wireless connections. Slower than DSL and cable, but available almost anywhere.
server	A node that shares resources with other nodes.
star network	A number of small computers or peripheral devices are linked to a central unit.
strategy	A way of coordinating the sharing of information and resources
switch	A node that that coordinates direct flow of data between other nodes.
T1	Special high-speed copper lines leased from telephone companies.
T3	Special line combined with T1 lines to form a higher capacity line.
telephone line	A type of cable that uses 2, 4, or 8 pairs of copper wire.
telephone modem	A type of modem used to connect a computer directly to a telephone line.
topology	How a network is arranged or configured
transfer rate	The speed at which data can be transmitted
transmission control protocol/Internet protocol (**TCP/IP**)	The standard protocol for the Internet
tree network	A network topology where each device is connected to a central node, either directly or through one or more devices.
twisted pair cable	Cable consisting of pairs of copper wire that are twisted together.
uplink	Relates to sending data to a satellite.
virtual private network (VPN)	A security technology that creates a secure private connection between a remote user and an organization's internal network.
voiceband	Used for standard telephone communication. (see also low bandwidth)

wide area network (**WAN**)	A countrywide or worldwide network that spans distances greater than 100 miles.
Wi-Fi (wireless fidelity)	A wireless standard used to connect computers to each other and to the Internet.
Wi-Max (Worldwide Interoperability for Microwave Access)	The technology used to extend Wi-Fi ranges over greater distances.
wireless access point	All communications in a wireless network passes through a centrally located base station or wireless access point.
wireless LAN (WLAN)	Local area network that uses wireless devices to connect nodes together.
wireless modem	A modem that may be internal, external or a PC Card sends and receives through the air.
wireless wide area network (WWAN) modem	A wireless modem that provides very high-speed connectivity from virtually anywhere

Answers to End-of-Chapter Materials
Chapter 8

Num	Multiple Choice Answers (Book)	Matching Answers (Book)	Multiple Choice Answers (www.mhhe.com/ce2015 Only)	Matching Answers (www.mhhe.com/ce2015 Only)
1	A	B	A	I
2	A	I	D	E
3	A	A	B	H
4	D	D	C	D
5	B	H	A	G
6	A	F	A	A
7	B	E	C	F
8	B	J	C	C
9	A	G	C	J
10	A	C	B	B

Open Ended Questions:

1. **Define communications including connectivity, the wireless revolution, and communication systems.**

- **Communications** is the process of sharing data, programs, and information between two or more computers.

- **Connectivity** is a concept related to using computer networks to link people and resources. For example, connectivity means that you can connect your personal computer to other computers and information sources almost anywhere. With this connection, you are linked to the world of larger computers and the Internet.

- **Wireless revolution** - The single most dramatic change in connectivity and communications in the past few years has been the widespread use of mobile devices like smartphones and tablet PCs with wireless Internet connectivity.

- **Communication systems** are electronic systems that transmit data from one location to another. Four basic elements of a communication system include:
  o Sending and receiving devices - originate (send) as well as accept (receive) messages in the form of data, information, and/or instructions.
  o Connection devices - convert outgoing messages into packets that can travel across the communication channel and reverse the process for incoming messages.
  o Communication channel – transmission medium that carries the message. Medium can be a physical wire or cable, or it can be wireless.

o Data transmission specifications - rules and procedures that coordinate the sending and receiving devices by physically defining how the message will be sent across the communication channel.

2. **Discuss communication channels including physical connections (twisted-pair, coaxial, and fiber-optic cable) and wireless connections (Bluetooth, WiFi, microwave, WiMax, LTE, satellite, and infrared).**

- **Communications Channels**
  o Actually carry the data from one computer to another.
  o Two categories of communication channels that connect sending and receiving devices include physical and wireless connection

- **Physical Connections- a solid medium to connect sending and receiving devices. These connections include:**
  o Twisted pair – pairs of copper wires twisted together
    ▪ Standard telephone lines, Ethernet cables
    ▪ Ethernet cables are often used in networks and to connect a variety of components to the system unit.
  o Coaxial cable - a high-frequency transmission cable consisting of a single, solid copper core.
    ▪ Used to deliver television signals as well as to connect computers in a network
  o Fiber-optic cable - transmits data as pulses of light through tiny tubes of glass.
    ▪ Compared to coaxial cable, it is lighter, faster, and more reliable at transmitting data.
    ▪ Rapidly replacing twisted-pair cable telephone lines.

- **Wireless Connections**
  o Do not use a solid substance to connect sending and receiving devices. Data is moved through the air. Primary technologies used for wireless connections are Bluetooth, Wi-Fi, microwave, WiMax, LTE, and satellite connections.

  o **Bluetooth** is a short-range radio communication standard that transmits data over short distances of up to approximately 33 feet. Bluetooth is widely used for wireless headsets, printer connections, and handheld devices.
  o **Wi-Fi (wireless fidelity)** uses high frequency radio signals to transmit data. A number of standards for Wi-Fi exist, and each can send and receive data at a different speed. Most home and business wireless networks use Wi-Fi.
  o **Microwave** - communication through high-frequency radio waves. It is sometimes referred to as line-of-sight communication because microwaves can only travel in a straight line.
    ▪ Because waves cannot bend with the curvature of the earth they can only be transmitted over relatively short distances.
    ▪ For longer distances, the waves must be relayed by means of microwave stations with microwave dishes or antennas.
  o **WiMax (Worldwide Interoperability for Microwave Access)** is a new standard that extends the range of Wi-Fi networks using microwave connections. WiMax is

commonly used by universities and others to extend the capability of existing Wi-Fi networks.

- o **LTE (Long Term Evolution**) is one of the newest wireless standards. Currently, LTE and WiMax connections provide similar performance. LTE, however, promises to provide greater speed and quality transmissions in the near future.

- o **Satellite -** amplified microwaves that use point-to-point communication to relay devices (satellites) orbiting 22,000 miles above the earth.
    - Rotate at a precise point and speed above the earth.
    - Amplify and relay microwave signals from one transmitter on the ground to another.
    - Used to send and receive large volumes of data.
    - Communication interferences can occur in bad weather.
    - Used by global positioning system (GPS) devices.
    - Used by many smartphones, including the Apple iPhone.

3. **Discuss connection devices including modems (telephone, DSL, cable, and wireless modems) and connection services (DSL, ADSL, cable, satellite, and cellular connection services).**

- **Connection Devices**
    - o At one time nearly all computer communication used telephone lines.
    - o Telephones typically send and receive analog signals, which are continuous electronic waves.
    - o Computers send and receive digital signals.
    - o To convert the digital signals to analog signals and vice versa, you need a modem.

- **Modems (modulator-demodulator)**
    - o Modems convert the computer's digital signal to an analog transmission to send over the phone line (modulation) and then re-convert it to digital when receiving information from the phone lines (demodulation).
    - o Transfer rate is in bits-per-second; typically measured in millions of bits (megabits) per second (Mbps)
    - o Four commonly used types of modems include:
        - **Telephone** – used to connect a computer directly to a telephone line
        - **DSL** (digital subscriber line) – uses standard phone lines to create a high-speed connection directly to the phone company's offices
        - **Cable** – uses the same coaxial cable as a television to create a high-speed connection.
        - **Wireless** (also known as a WWAN- wireless wide area network modem). Commonly a USB or ExpressCard device that provides very portable high-speed connectivity from virtually anywhere.

- **Connection service**
    - o **Digital subscriber line (DSL)** – is provided by telephone companies using existing telephone lines to provide high-speed connections. **ADSL (asymmetric digital subscriber line)** is one of the most widely used types of DSL.

- o **Cable** – is provided by cable television companies using existing television cables to provide high-speed connections, faster than DSL.
- o **Satellite** connection services - use satellites to provide wireless connections. Slower than DSL and cable modem but higher availability.
- o **Cellular** services - **Cellular service providers** including Verizon, at&t, Sprint, and t-Mobile support voice and data transmission to wireless devices. Cellular services have gone through different generations.
  - ▪ **1g (first generation mobile telecommunications)** started in the 1980s using analog radio signals to provide analog voice transmission service.
  - ▪ **2g (second generation mobile telecommunications)** stared in the 1990s using digital radio signals. This generation focused on voice transmission and was too slow for effective Internet connectivity.
  - ▪ **3g (third generation mobile telecommunications**) started in the 2000s providing services capable of effective connectivity to the Internet and marked the beginning of smartphones.
  - ▪ While **4g** (**fourth generation mobile telecommunications**) has been widely marketed by several cellular services, not everyone acknowledges that this generation has begun. Most experts, however, do acknowledge that 4g has entered into its infancy with providers using WiMax and LTE connections to provide faster transmission speeds. While current speeds are only marginally faster than 3g, 4g technologies promise to provide speeds up to 10 times faster than 3g in the near future.

4. **Discuss data transmission including bandwidths (voiceband, medium band, broadband, and baseband) as well as protocols (IP addresses, domain name servers, and packetization)**

- **Data transmission**
  - o Several factors affect how data is transmitted. These factors include bandwidth and protocols.

- **Bandwidth** - a measurement of the width or capacity of the communication channel. It means how much information can move across the communication channel in a given amount of time. Four categories of bandwidth include:
  - o **Voiceband** (low bandwidth) - used for standard telephone communication by computers with telephone modems and dial-up service.
  - o **Medium band** - used in special leased lines to connect minicomputers and mainframes as well as to transmit data over long distances. Capable of very high-speed data transfer.
  - o **Broadband** – widely used by DSL, cable, and satellite connections for high-capacity transmissions. Several users can simultaneously use a single broadband connection for high-speed data transfer.
  - o **Baseband** - widely used to connect individual computers that are located close to one another. Like broadband, it is able to support high-speed transmission. Unlike broadband, however, baseband can only carry a single signal at one time.

- **Protocols** - For data transmission to be successful, sending and receiving devices must follow a set of communications rules for exchange of information. Protocols are the rules for exchanging data between computers.
  - http or hypertext transfer protocol is a widely used protocol used for Web traffic. Another protocol, https or hypertext Transfer Protocol Secure is becoming widely used to protect the transfer of sensitive information. **TCP/IP – Transmission Control Protocol/Internet Protocol** is the standard protocol for the Internet.
    - Essential features involve – sending and receiving devices and breaking information into small parts for transmission across the Internet
    - Identification: Every computer on the Internet has a unique numeric address called an IP address (Internet Protocol address). Uses a domain name server (DNS) that automatically converts text-based addresses to numeric IP addresses.
    - Packetization: Information sent or transmitted across the Internet usually travels through numerous interconnected networks. Before a message is sent, it is reformatted or broken down into small parts called packets. Each packet is then sent separately over the Internet, possible travelling different routes to one common destination. At the receiving end, the packets are reassembled into the correct order.

5. **Discuss networks by identifying and defining specialized terms that describe computer networks.**
   - **Networks**
     - A computer network is a communication system that connects two or more computers so they can exchange information and share resources.

     - **Node**—any device that is connected to a network.
     - **Client** —a node that requests and uses resources available from other nodes.
     - **Server**—a node that shares resources with other nodes.
     - **Directory server**—specialized server that manages resources such as user accounts for an entire network.
     - **Host**—any computer system that can be accessed over a network.
     - **Router**—a node that forwards or routes data packets from one network to their destination in another network.
     - **Switch**—central node that coordinates the flow of data by sending messages directly between sender and receiver nodes. A hub previously filled this purpose; older, less efficient type of switch.
     - **Network interface cards (NIC)**— expansion cards located within the system unit that connect the computer to a network.
     - **Network operating systems (NOS)**—control and coordinate the activities of all computers and other devices on a network.
     - **Network administrator**—a computer specialist responsible for efficient network operations and implementation of new networks.

6. Discuss network types including local area, home, wireless, personal, metropolitan, and wide area networks.

- **Network Types**
  - **Local Area Networks (LAN)** - Networks with nodes that are in close physical proximity, typically spanning less than a mile and are owned and operated by individual organizations.
    - **Network gateway** - device that allows one LAN to be linked to other LANs or to larger networks.
    - The most common standard in which nodes in a LAN can be connected to one another is known as **Ethernet**.

  - **Home Networks** - networks being used by individuals in their homes and apartments. Allow different computers to share resources, including a common Internet connection

  - **Wireless LAN (WLAN)** - uses radio frequencies to connect computers and other devices. All communications pass through the network's centrally located **wireless access point** or **base station**. This access point interprets incoming radio frequencies and routes communications to the appropriate devices. In public places wireless access points are known as **hotspots** and typically use Wi-Fi technology.

  - **Personal area network (PAN)** - type of wireless network that works within a very small area—your immediate surroundings. PANs connect cell phones to headsets, PDAs to other PDAs, keyboards to cell phones, and so on. Most popular PAN technology is Bluetooth, with a maximum range of around 30 feet. Virtually all wireless peripheral devices available today use Bluetooth, including the controllers on popular game systems like the PlayStation and Wii.

  - **Metropolitan Area Networks (MAN)** - span distances up to 100 miles. Frequently used links between office buildings that are located throughout a city. MANs are typically owned by a group of organizations who jointly own and operate the network or by a single network service provider who provides network services for a fee.

  - **Wide Area Networks** - countrywide and worldwide networks. Provide access to regional service (MAN) providers and typically span distances greater than 100 miles. They use microwave relays and satellites to reach users over long distances

7. Define network architecture including topologies (bus, ring, star, tree, and mesh) and strategies (client/server and peer-to-peer).

- **Network Architecture**
  - o Describes how a network is arranged and how resources are coordinated and shared.
  - o **Topology** – Describes the physical arrangement of a network and how resources are coordinated and shared.

    - **Bus network**
      - Each device is connected to a common cable called a bus or backbone and all communications travel along this bus.

    - **Ring network**
      - Each device is connected to two other devices, forming a ring. When a message is sent, it is passed around the right until it reaches the intended destination.

    - **Star**
      - Each device is connected directly to a central network switch.
      - Whenever a node sends a message, it is routed to the switch, which then passes the message along to the intended recipient.
      - Most widely used network topology today.
      - Range of applications includes small networks in the home to very large networks in major corporations.

    - **Tree**
      - Each device is connected to a central node, either directly or through one or more other devices.
      - Central node is connected to two or more subordinate nodes that in turn are connected to other subordinate nodes, and so forth, forming a treelike structure.
      - Also known as a hierarchical network

    - **Mesh**
      - Newest type of topology and does not use a specific physical layout.
      - Requires that each node have more than one connection to the other nodes. The resulting pattern forms the appearance of a mesh.
      - If a path between two nodes is somehow disrupted, data can be automatically rerouted.
      - Wireless technologies are frequently used to build mesh networks.

  - o **Strategies** - Every network has a strategy, or way of coordinating the sharing of information and resources. Two of the most common network strategies are client/server and peer-to-peer.

- **Client/server network** - use central computers to coordinate and supply services to other nodes on the network. The server provides access to resources such as Web pages, databases, application software, and hardware
  - Strategy is based on specialization. Server nodes coordinate and supply specialized services, and client nodes request the services.
  - Commonly used server operating systems are Windows Server, Mac OS X Server, Linux, and Solaris.
  - Client/server networks are widely used on the Internet.
  - Advantage of the client/server network strategy include:
    - Ability to handle very large networks efficiently.
    - Availability of powerful network management software to monitor and control network activities.
  - Disadvantage of the client/server network strategy include:
    - Cost of installation and maintenance

- **Peer-to-peer (P2P) network** - nodes have equal authority and can act as both clients and servers. Many current popular game, movie, and music sharing services use this network strategy.
  - Advantage of P2P:
    - Easy and inexpensive (often free) to set up and use.
  - Disadvantage of P2P:
    - Lack of security controls or other common management functions.

8. **Discuss organization networks including Internet technologies (intranets and extranets) and network security (firewalls, proxy servers, intrusion detection systems, and virtual private networks.**

- **Organizational Networks**
  - **Intranet Technologies**
    - A private network within an organization that resembles the Internet.
    - Uses browsers, Web sites, and Web pages.
    - Organizations use intranets to provide information to their employees such as electronic telephone directories, e-mail addresses, internal job openings, and more.
    - Accessible only to those within the organization.

  - **Extranet**
    - A private network that connects more than one organization.
    - Many organizations use Internet technologies to allow suppliers and others limited access to their networks.
    - Main purpose is to increase efficiency and reduce costs.

  - **Network Security** - Securing large corporate networks requires specialized technology. Three technologies commonly used to ensure network security include:
    - **Firewalls**
      - A security system designed to protect an organization's network against external threats.
      - Consists of hardware and software that control access to a company's intranet or other internal networks.
      - Sometimes organizational firewalls include a special computer or software called a **proxy server.** This system is a gatekeeper. All communications between the company's internal networks and the outside world must pass through it.

    - **Intrusion detection systems (IDS)**
      - Works with firewalls to protect an organization's network.
      - Uses sophisticated statistical techniques to analyze all incoming and outgoing network traffic.
      - Uses advanced pattern matching and heuristics to recognize signs of a network attack and disable access before an intruder can do damage.

    - **Virtual private networks (VPN)**
      - Create a secure private connection between a remote users and an organization's internal network.
      - Connection is heavily encrypted