

# STUDY UNIT TWELVE

## INFORMATION TECHNOLOGY II

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This study unit is the second of five covering information technology (IT).

### 12.1 HARDWARE

1. **Hardware** refers to the physical devices making up a computer system. Every computer, regardless of size, has certain common components.
2. The **central processing unit (CPU)** is the “brain” of any computer. In a desktop computer, it is often referred to as the microprocessor. Larger computers, such as servers and mainframes, can have more than one CPU.
  - a. The CPU coordinates all of a computer’s operations. Its most important functions are to
    - 1) Move data from storage to main memory
    - 2) Execute the instructions for manipulating the data
    - 3) Move the results from main memory back to storage
  - b. The speed of a CPU is measured by the number of instructions it can carry out per second, referred to as the clock rate.
    - 1) For a desktop computer CPU, the unit of measure is cycles per second, or hertz. The CPU of the original IBM Personal Computer in 1981 had a clock rate of 4.77 megahertz, or just over four and a half million cycles per second. Today, one model of the Intel Pentium 4 processor has a clock rate of 3 gigahertz, or three billion cycles per second.
    - 2) The speed of a mainframe CPU is usually measured in millions of instructions per second (MIPS). Some powerful current mainframe CPUs can run in the neighborhood of 20 billion instructions per second.
  - c. The CPU is usually the fastest component of any computer system. The speed of the computer as a whole is almost always limited by some other component (“there’s always a bottleneck somewhere”).
3. **Random access memory (RAM)** is also referred to as main memory or primary storage. RAM is a holding area for data before and after processing by the CPU.
  - a. The contents of RAM are “volatile,” meaning RAM is emptied when the power to the computer is shut off.
  - b. RAM is most often measured by its size rather than its speed. Laptop computers commonly have anywhere from half a billion to 4 billion bytes of RAM (i.e., 512 megabytes to 4 gigabytes).
4. **Read-only memory (ROM)** is permanent storage used to hold the basic low-level programs and data particular to a computer’s hardware, i.e., not part of any single application.
  - a. The contents of ROM are vital to operation of the hardware, and thus cannot be altered by the owner and are not affected when the power to the computer is shut off.

5. **Secondary storage devices** hold data and programs that are not currently being used by the CPU. Their key features are their large capacity and their ability to retain data after the power is shut off. Secondary storage comes in a wide variety of configurations.
  - a. **Hard drives** are the most common form of secondary storage. Current laptop hard drives often hold more than 60 gigabytes (60 billion bytes) of data. Mainframe disc storage is commonly measured in terabytes, or trillions of bytes of data.
    - 1) Hard drives consist of a stack of rigid platters connected by a central spindle. Each platter is coated on the top and bottom with a magnetic material.
    - 2) As the stack of platters spins at very high speed, read/write heads pass back and forth over the surfaces of the platters. When writing, the heads arrange the magnetic particles in patterns that represent data.
    - 3) The heads float very close to the platter's surface, but they never touch it. If a head comes in contact with the platter or if a piece of dust gets stuck in the microscopic space between the head and the platter, the hard drive completely ceases to operate, a situation referred to as a "crash."
  - b. **Optical drives** record and read data by means of a laser beam. The key distinction between optical and magnetic media is that an optical disc can be removed from the drive and inserted in another drive.
    - 1) The most common optical disc formats are the compact disc, or CD, which holds approximately 700 megabytes of data; and the digital versatile disc (originally called the digital video disc), or DVD, which holds about 4.7 gigabytes.
    - 2) Unlike magnetic discs, optical discs rotate at varying speeds.
  - c. **Flash drives**, also called jump drives or thumb drives, are small, highly portable memory modules that can store a gigabyte of data or more. Unlike hard and optical drives, flash drives have no moving parts.
    - 1) Flash drives' high level of convenience comes from the fact that they can be plugged into and unplugged from a computer while the computer is running.
  - d. Two older storage media that are still sometimes encountered are the **floppy disc**, which is slow and holds a mere 1.4 megabytes of data, and **magnetic tape**, which has a considerably higher capacity than a floppy disc but extremely slow access times.
6. **Input-output devices** are the hardware components that allow the user to input data into the computer and retrieve output.
  - a. The following is a list of commonly encountered input devices:
    - 1) Keyboard
    - 2) Mouse
    - 3) Scanner
    - 4) Touch screen
    - 5) Magnetic ink character reader (MICR)
    - 6) Optical character reader (OCR)
    - 7) Microphone (for voice recognition)
    - 8) Light pen
    - 9) Sensor (for gauging water levels, etc.)
  - b. These output devices allow the user to retrieve information from the computer:
    - 1) Monitor
    - 2) Printer
    - 3) Plotter
    - 4) Voice emulator

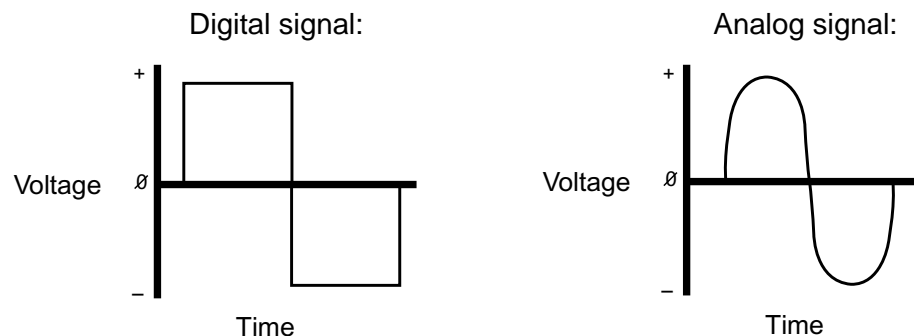
## 12.2 SOFTWARE

1. **Software** refers to the programs (i.e., sets of computer instructions) that are executed by the hardware. Software can be described from two perspectives: (a) systems vs. application software and (b) the programming language in which the software is written.
2. **Two Major Types of Software**
  - a. **Systems software** performs the fundamental tasks needed to manage computer resources. The two most common pieces of systems software are
    - 1) The operating system, which is the “traffic cop” of any computer system (see Subunit 13.1)
    - 2) Utility programs, which perform basic functions that are not particular to a certain application, such as file manipulation (copying, deleting, merging, and sorting data files) and file access control
  - b. **Application software** consists of programs that tell the computer what steps the user wants carried out. It may be purchased from vendors or developed internally.
    - 1) Examples of applications found on desktop computers include word processors, spreadsheets, graphics, and small databases.
    - 2) Applications found on larger computers are payroll, human resources, purchasing, accounts payable, general ledger, treasury, etc.
  - c. Software is written in **languages** that are comprehensible by the computer. The following is a description of types and development of computer languages.
3. **Programming Languages**
  - a. **First-generation languages** (also called machine languages) are written in binary code (a combination of ones and zeros; see Subunit 13.4) unique to each type of computer. Because they are in binary code, first generation languages are understood directly by the computer and require no translation process.
  - b. **Second-generation languages** (also called assembly languages) use mnemonic symbols to represent groups of binary ones and zeros. Assembly languages must be converted to machine languages in order for the computer to understand them.
  - c. **Third-generation languages** (also called procedural languages) consist of English-like words and phrases that represent multiple machine language instructions, making these languages much easier to learn. These languages must be converted to machine language in one of two ways: They are either compiled (the whole program is converted at once, then executed) or interpreted (the program is converted and executed one line at a time). Procedural languages have been deployed for decades with tremendous success. The following is a list of some of the better-known ones:
    - 1) COBOL (COMmon Business Oriented Language) has been enormously successful. It was designed in 1959 to be easy to read and maintain, and the standard has been extensively revised and updated over the years. Hundreds of millions of lines of COBOL are still in production.
    - 2) BASIC (Beginner’s All-purpose Symbolic Instruction Code) was developed to teach programming but is not used in large business application processing. Visual BASIC provides a graphical user interface to develop Microsoft Windows applications from code written in BASIC.
    - 3) C and C++ have been very popular languages since their introduction. C++ enables the technique called object-oriented programming.

- 4) Java is a high-level, object-oriented programming language developed by Sun Microsystems that, among other things, is used to write programs embedded in World Wide Web documents. It is designed to allow a user to download from a network only the data and the part of an application needed to perform a given task. When processing is complete, the data and software are erased.
  - a) Thus, software is stored on the network, and the user need not be concerned about compatibility of the software with the computer platform or with upgrades and installation.
  - b) Java is platform independent if each computer has a Java Virtual Machine, a program included in an operating system. It also may be incorporated into a browser. Java programs that run in a web browser are called applets, and Java programs that run on a web server are called servlets.
- d. **Fourth-generation languages** (also called problem-oriented or nonprocedural languages) provide still further simplification of programming. These interactive, English-like languages permit a nonspecialized user to describe the problem to, and receive guidance from, the computer instead of specifying a procedure.
  - 1) The best-known nonprocedural language is Structured Query Language (SQL), which enables the user to read, update, reorganize, and report on data contained in a relational database (see item 7. in Subunit 13.5).
  - 2) Generalized audit software (GAS), also known as computer-assisted audit techniques (CAAT), involves the use of computer software packages that may allow not only parallel simulation, but also a variety of other processing functions, such as extracting sample items, verifying totals, developing file statistics, and retrieving specified data fields. Audit Command Language (ACL®) and Interactive Data Extraction and Analysis (IDEA™) are the leading CAAT packages.
  - 3) Hypertext markup language (HTML) is the authoring software language commonly used to create and link websites. Its key features are hotlinking and graphics display.
  - 4) Extensible markup language (XML) is an open standard usable with many programs and platforms. Unlike HTML, XML uses codes that are extensible, not fixed, so if an industry can agree on a set of codes, software for that industry can be written by incorporating those codes. For example, XML allows the user to label the UPC (uniform product code), price, color, size, etc., of a product so that other systems will know exactly what the tag references mean.
  - 5) Extensible business reporting language (XBRL) is the specification developed by an AICPA-led consortium for commercial and industrial entities that report in accordance with U.S. GAAP. It is a variation of XML that is expected to decrease the costs of generating financial reports, reformulating information for different uses, and sharing business information using electronic media.

## 12.3 NETWORKS

1. Large **mainframe computers** dominated the electronic data processing field in its first decades.
  - a. Mainframes were arranged so that all processing and data storage were done in a single, central location.
  - b. Communication with the mainframe was accomplished with the use of **dumb terminals**, simple keyboard-and-monitor combinations with no processing power (i.e., no CPU) of their own.
2. The next stage in the evolution of networking was to connect computers not in different rooms of a building, but in separate buildings and eventually separate countries.
  - a. This required converting the **digital signal** used internally by the computer into an **analog signal** suitable for transmission over ordinary telephone lines.



- 1) This conversion is necessary because, when a digital signal travels more than about 10 feet, it starts to lose its shape and eventually resembles an analog signal. By that point, it has become completely unusable.
  - b. In all-digital networks, such as LANs (see item 4. on the next page) and connections between dumb terminals and mainframes, repeaters are placed every so often to revive the digital signal and return it to its full square-wave shape.
    - 1) This is obviously not an option with the existing telephone network and its hundreds of thousands of miles of wire.
    - 2) The solution is simply to convert the computer's digital signal into an analog signal (**modulation**), send it over the phone line, then reconvert it to a digital signal at the other end (**demodulation**).
    - 3) The device that performs these conversion and reconversion functions is a **modem** (short for modulator-demodulator).
  - c. The introduction of the modem allowed organizations to begin moving information between locations in purely electronic format, eliminating the need for the passage of physical documents. The potential for cost savings in this technology was obvious.
3. Improvements in technology have led to increasing **decentralization** of information processing.
    - a. The mainframe-style computer was the only arrangement available in the early days of data processing. International Business Machines (now called IBM) dominated the marketplace.
      - 1) Mainframes are still in use at large institutions, such as governments, banks, insurance companies, and universities. However, remote connections to them are usually through desktop computers rather than through dumb terminals.

- 2) In the 1980s, the **minicomputer** gave organizations the ability to perform data processing without the high cost and large dedicated facilities of a mainframe. Digital Equipment Corporation (DEC) and Hewlett-Packard (HP) dominated this market.
- 3) As minicomputers evolved, the concept of distributed processing arose.
  - a) **Distributed processing** involves the decentralization of processing tasks and data storage and assigning these functions to multiple computers, often in separate locations (see item 6. in Subunit 14.2).
  - b) This allowed for a drastic reduction in the amount of communications traffic because data needed locally could reside locally.
- 4) In 1981, IBM introduced the **Personal Computer (PC)**. This designation quickly lost its status as a brand name and became a generic term for almost any computer smaller than a minicomputer.
- b. During the 1980s, desktop computers, and the knowledge needed to build information systems, became widespread throughout the organization.
  - 1) In the early part of this period, the only means of moving data from one computer to another was through the laborious process of copying the data to a diskette and physically carrying it to the destination computer. This method of connecting computers was called **sneakernet**, after the footwear involved.
  - 2) It was clear that a reliable way of **wiring office computers together** would lead to **tremendous gains in productivity**.
4. This need led to the development of the **local area network (LAN)**. A LAN is any interconnection between devices in a single office or building.
  - a. Very small networks with few devices can be connected using a **peer-to-peer** arrangement, where every device is connected directly to every other.
    - 1) Peer-to-peer networks become increasingly difficult to administer with each added device.
  - b. The most cost-effective and easy-to-administer arrangement for LANs uses the client/server model.
    - 1) **Client/server networks** differ from peer-to-peer networks in that the devices play more specialized roles. Client processes (initiated by the individual user) request services from server processes (maintained centrally).
    - 2) In a client/server arrangement, **servers** are centrally located and devoted to the functions that are needed by all network users.
      - a) Examples include mail servers (to handle electronic mail), application servers (to run application programs), file servers (to store databases and make user inquiries more efficient), Internet servers (to manage access to the Internet), and web servers (to host websites).
      - b) Whether a device is classified as a server is not determined by its hardware configuration, but rather by the function it performs. A simple desktop computer can be a server.
  - 3) Technically, a **client** is any object that uses the resources of another object. Thus, a client can be either a device or a software program.
    - a) In common usage, however, "client" refers to a device that requests services from a server. This understanding of the term encompasses anything from a powerful graphics workstation to a personal data assistant (PDA), such as a Palm Pilot or a Blackberry.
    - b) A client device normally displays the user interface and enables data entry, queries, and the receipt of reports. Moreover, many applications, e.g., word processing and spreadsheet software, run on the client computer.

- 4) The key to the client/server model is that it runs processes on the platform most appropriate to that process while attempting to minimize traffic over the network. This is commonly referred to as the **three-tiered architecture** of client, application, and database.
  - 5) Security for client-server systems may be more difficult than in a highly centralized system because of the numerous access points.
5. **Classifying networks by geographical extent and function.** The range of networking has expanded from the earliest form (two computers in the same room) to the global reach of the Internet.
- a. A **local area network (LAN)** connects devices within a single office or home or among buildings in an office park. The key aspect here is that a LAN is **owned entirely by a single organization**.
    - 1) The LAN is the network familiar to office workers all over the world. In its simplest conception, it can consist of a few desktop computers and a printer.
  - b. A **metropolitan area network (MAN)** connects devices across an urban area, for instance, two or more office parks.
    - 1) This conception had limited success as a wire-based network but may make a comeback using microwaves [see item 7.d.3) on page 385].
  - c. A **wide area network (WAN)** consists of a conglomerate of LANs over widely separated locations. The key aspect here is that a WAN can be either **publicly or privately owned**.
    - 1) WANs come in **many configurations**. In its simplest conception, it can consist of a lone desktop computer using a slow dialup line to connect to an Internet service provider.
    - 2) **Publicly owned** WANs, such as the public telephone system and the Internet, are available to any user with a compatible device. The assets of these networks are paid for by means other than individually imposed user fees.
      - a) **Public-switched networks** use public telephone lines to carry data. This arrangement is economical, but the quality of data transmission cannot be guaranteed and security is highly questionable.
    - 3) **Privately owned** WANs are profit-making enterprises. They offer fast, secure data communication services to organizations that do not wish to make their own large investments in the necessary infrastructure.
      - a) **Value-added networks (VANS)** are private networks that provide their customers with reliable high-speed, secure transmission of data.
        - i) To compete with the Internet, these third-party networks add value by providing their customers with error detection and correction services, electronic mailbox facilities for EDI purposes, EDI translation, and security for email and data transmissions.
      - b) **Virtual private networks (VPNs)** emerged as a relatively inexpensive way to solve the problem of the high cost of leased lines.
        - i) A company connects each office or LAN to a local Internet service provider and routes data through the shared, low-cost public Internet.
        - ii) The success of VPNs depends on the development of secure encryption products that protect data while in transit.

- c) A **private branch exchange (PBX)** is a specialized computer used to handle telephone traffic.
      - i) A PBX can carry both voice and data and can switch digital data among computers and office equipment, e.g., printers, copiers, and fax machines. A PBX uses telephone lines, so its data transmission capacity is limited.
- 6. **Equipment used in networks.** Networks consist of (a) the hardware devices being connected and (b) the medium through which the connection is made.
  - a. **Client devices.** Devices of all sizes and functions (mainframes, laptop computers, personal digital assistants, MP3 players, printers, scanners, cash registers, ATMs, etc.) can be connected to networks.
    - 1) Connecting a device to a network requires a **network interface card (NIC)**. The NIC allows the device to speak that particular network's "language," that is, its protocol (see item 7. on page 382).
    - 2) A development in the late 1990s called the **thin client** explicitly mimics the old mainframe-and-terminal model.
      - a) A typical thin client consists merely of a monitor, a keyboard, and a small amount of embedded memory. The key is that it has **no local hard drive**.
      - b) Essentially all **processing and data storage** is done on the **servers**. Just enough of an application is downloaded to the client to run it.
      - c) An advantage of this architecture is the large amount of IT staff time and effort saved that formerly went to configuring and troubleshooting desktop machines. A disadvantage is that there must be 100% server availability for any work to be done by users.
      - d) The thin client architecture has not met with widespread use because the cost of hard drives has continued to steadily decrease, defying predictions.
  - b. **Types of media.** The medium that connects the devices on a network can take many forms.
    - 1) **Bandwidth** is the signal-carrying capacity of a transmission medium. It is a rough indication of the highest "speed" that data can attain when traveling through it.
      - a) A medium that can carry only one signal is called **baseband**. A medium that can carry multiple signals is called **broadband**.
    - 2) On a **wired LAN**, the choice of cabling depends on speed requirements.
      - a) **Twisted pair** wiring is graded into categories, each of which denotes a different bandwidth. Twisted pair is fundamentally a **baseband** medium.
        - i) Twisted pair takes its name from the continuous weaving of the strands of wire around each other within the cable.
          - A magnetic field is produced around any wire through which current is passed. These fields can disrupt the transmission of electrical signals, a phenomenon known as **electromagnetic interference**.
          - Twisting the strands of copper around each other within a cable has the effect of canceling the magnetic fields.
          - Twisted pair comes in shielded (STP) and unshielded (UTP) varieties. Shielded twisted pair carries extra protection against electromagnetic interference.



- ii) **Category 1** twisted pair is unshielded. It is usually referred to as regular telephone wire.
  - iii) **Category 3** comes in both shielded and unshielded varieties and can support a higher bandwidth than Category 1.
  - iv) **Category 5** also comes in both shielded and unshielded varieties and can support a higher bandwidth than Category 3.
- b) **Coaxial cable** is a commonly used medium for LANs. Coax, as it is called, is also the familiar transmission medium of cable TV.
  - i) Generally, coax is necessary when **broadband** transmission is desired.
  - ii) This cable design is named coaxial because one signal conductor surrounds the other, giving them a common “axis.”
- 3) Wired LANs depend on two basic types of **networking devices** to connect the cabling.
  - a) **Hubs** are, in computing terms, very simple (“dumb”) and serve only to broadcast messages to every other device on the network.
    - i) The device for which the message is intended will keep it and process it. The other devices will discard it.
  - b) **Bridges** improve traffic flow by dividing LANs into **segments**. Bridges are more “intelligent” than hubs.
    - i) Instead of simply broadcasting messages as hubs do, bridges read the destination address and isolate the message to the segment where the destination device is located, greatly reducing unnecessary traffic on the network.
  - c) Separate LANs are connected by either specialized bridges, called **remote bridges**, or by **gateways**.
- 4) On a **wireless LAN**, the NIC uses an antenna instead of a cable to connect to the hub or router through the air. The differences in wireless networks are best discussed in the context of communication protocols (see item 7.d. on page 384).
- 5) **WANs**, with their greater traffic requirements, need higher-capacity media.
  - a) **Fiber-optic cable** consists of extremely fine threads of glass or plastic.
    - i) The electrical signal is converted to **pulses of light**, which are sent through the optical medium at much higher speeds than electrical signals can travel through copper wire.
    - ii) The light pulses do not travel straight down the fiber. They are deliberately aimed into the fiber at an angle with respect to the cable’s insulation (called cladding).
      - This angling causes the light pulses to **continuously bounce** from one side of the fiber to the other as they travel down the length of the cable.
      - This bouncing phenomenon is an aid in separating the various signals when they arrive at the other end.

- iii) Fiber optics has **two major advantages** over wire in addition to drastically greater bandwidth.
        - The light pulses used in fiber optics are not subject to electromagnetic interference.
        - Interception by unauthorized parties is impossible because the light pulses cannot be “tapped” as electrical signals can. Also, the cut end of an optical fiber becomes a mirror, immediately alerting the administrator that there is a problem with the cable.
    - b) **Microwave transmission** involves propagating electrical signals through air and space instead of through metal wire or optical fiber.
      - i) **Satellite relay** involves transmitting the microwave signal to a satellite in orbit, which retransmits the signal to the destination back on Earth. This medium offers very high speeds and wide geographic coverage.
      - ii) **LOS (line-of-sight) microwave** transmission is an older technology still in use in some places. It consists of beaming the signals from one tower to another from horizon to horizon.
        - Almost all long-distance voice telephone calls in the United States were transmitted by LOS microwave between the 1960s and the advent of fiber-optic cable in the 1980s.
      - iii) Both satellite relay and LOS microwave systems have the advantage of not having to secure rights-of-way for the laying of physical cable over long distances.
7. **Classifying networks by protocol.** A protocol is a set of standards for message transmission among the devices on the network.
- a. **LAN Protocols**
    - 1) **Ethernet** has been the most successful protocol for LAN transmission. The Ethernet (capitalized because it is a trademark) design breaks up the flow of data between devices into discrete groups of data bits called “frames.”
      - a) **ANALOGY:** Ethernet follows the “polite conversation” method of communicating.
        - i) Each device “listens” to the network to determine whether another conversation is taking place, that is, whether the network is busy moving another device’s message.
        - ii) Once the network is determined to be free of traffic, the device sends its message.
      - b) Inevitably, frames collide on Ethernet networks constantly. When this happens, the two contending devices wait a random (and extremely brief) length of time, then transmit again. Eventually, both messages will hit the network at a moment when it is free.
      - c) This design, while seemingly inefficient in accepting such a high number of collisions and retransmissions, has been extraordinarily successful. Over the years, Ethernet has proven to be secure, adaptable, and expandable.

- 2) The **token ring** protocol originally had a much higher speed than Ethernet.
  - a) Each device is directly connected to the next device in a ring configuration. A special frame called the token is passed continuously around the ring from one device to the next.
  - b) When a device wishes to send a message, it attaches the message to the token. The token drops off the message when it arrives at the destination device.
  - c) Token ring, though heavily promoted by IBM, is expensive and difficult to expand, and its early speed advantage has been eclipsed by advances in Ethernet.

b. **Switched Networks**

- 1) As described in item 5.a. on page 379, in a **LAN**, all the devices and all the transmission media belong to **one organization**.
  - a) This single ownership of infrastructure assets plus the ability to unify all communication on a single protocol make for great **efficiency and security**.
- 2) When communication must **cross organizational boundaries** or travel **beyond a limited geographical range**, this single ownership principle no longer applies. A WAN is the applicable model.
  - a) A WAN, with its hundreds of users and much greater distances, could never function using the collision-detection-and-retransmission method of Ethernet. To overcome this, the technique called **switching** is used.
- 3) Switching takes two basic forms:
  - a) In **circuit switching**, a single physical pathway is established in the public telephone system, and that pathway is reserved for the full and exclusive use of the two parties for the duration of their communication.
    - i) An example is an ordinary landline telephone call or a dialup connection from a modem. This is obviously a slow and insecure alternative for data transmission.
  - b) In **packet switching**, the data bits making up a message are broken up into “packets” of predefined length. Each packet has a header containing the electronic address of the device for which the message is intended.
- 4) **Switches** are the networking devices that read the address on each packet and send it along the appropriate path to its destination.
  - a) **ANALOGY**: The machinery for a new plant is mounted on several 18-wheelers for transport to the plant site. The trucks leave the machinery vendor’s factory headed to the destination.
    - i) As each truck arrives at a traffic light, it stops while vehicles going in other directions pass through the intersection.
    - ii) As the trucks arrive at the plant site, they are unloaded and the machinery is installed.
- 5) By allowing message flow from many different organizations to pass through common points, switches **spread the cost** of the WAN infrastructure.
  - a) **Frame relay** and **ATM (asynchronous transfer mode)** are examples of fast packet switched network protocols.

### c. Routed Networks

- 1) **Routers** have more intelligence than hubs, bridges, or switches.
  - a) Routers have **tables** stored in memory that tell them the **most efficient path** along which each packet should be sent.
  - b) ANALOGY: The trucks leave the machinery vendor's factory with the same destination.
    - i) As the trucks stop at each intersection, traffic cops redirect them down different routes depending on traffic conditions.
    - ii) As the trucks arrive in unknown sequence at the plant site, they are held until the machinery can be unloaded in the correct order.
- 2) Routing is what makes the **Internet** possible.
  - a) **Transmission Control Protocol/Internet Protocol (TCP/IP)** is the suite of routing protocols that makes it possible to interconnect many thousands of devices from dozens of manufacturers all over the world through the Internet.
  - b) **IP addressing** (also called dotted decimal addressing) is the heart of Internet routing. It allows any device anywhere in the world to be recognized on the Internet through the use of a standard-format IP address.
    - i) Each of the four decimal-separated elements of the IP address is a numeral between 0 and 255.  
EXAMPLE: 128.67.111.25
  - c) **Dynamic host configuration protocol (DHCP)** allows tremendous flexibility on the Internet by enabling the constant reuse of IP addresses.
    - i) Routers generally have their IP addresses hardcoded when they are first installed. However, the individual client devices on most organizational networks are assigned an IP address by DHCP from a pool of available addresses every time they boot up.

### d. Wireless Networks

- 1) The **Wi-Fi** family of protocols supports client devices within a radius of about 300 feet around a wireless router. This usable area is called a **hotspot**.
  - a) Wi-Fi **avoids the collisions** inherent in Ethernet by constantly searching for the best frequency within its assigned range to use.
  - b) Security was a problem in early incarnations of Wi-Fi. Later versions alleviated some of these concerns with encryption.
- 2) The **Bluetooth** standard operates over a much smaller radius than Wi-Fi, about 30 feet. This distance permits the creation of what has come to be called the **personal area network** or **PAN** (i.e., a network of devices for a single user).
  - a) A prominent example is the in-ear device that allows the wearer to make telephone calls hands-free or to listen to a personal music player in wireless mode. Wireless keyboards and mice also employ the Bluetooth standard.
  - b) Bluetooth is considerably slower than Wi-Fi.

- 3) The **WiMax** standard uses microwaves to turn an entire city into a hotspot, reviving the old MAN model. The radius is about 10 miles and the speed is quite fast.
  - a) Providers of wired networks can bill individual customers for use of the network. However, since anyone with the right device could access a WiMax network, the initial investment in infrastructure would have to be financed through a means other than user fees, making WiMax's widespread deployment unlikely in the near future.

## 12.4 INTERNET AND INTRANET

1. The **Internet** is a **network of networks** all over the world.
  - a. The Internet is descended from the original ARPANet, a product of the Defense Department's Advanced Research Projects Agency (ARPA), introduced in 1969. The idea was to have a network that could not be brought down during an enemy attack by bombing a single central location.
    - 1) ARPANet connected computers at universities, corporations, and government.
    - 2) In view of the growing success of the Internet, ARPANet was retired in 1990.
  - b. The Internet facilitates inexpensive communication and information transfer among computers, with gateways allowing mainframe computers to interface with personal computers.
    - 1) Very high-speed Internet backbones carry signals around the world and meet at network access points.
  - c. Most Internet users obtain connections through Internet service providers (ISPs) that in turn connect either directly to a backbone or to a larger ISP with a connection to a backbone.
    - 1) The topology of the backbone and its interconnections may once have resembled a spine with ribs connected along its length, but it is now almost certainly more like a fishing net wrapped around the world with many circular paths.
  - d. **TCP/IP (Transmission Control Protocol/Internet Protocol)** is a suite of communications protocols used to connect computers to the Internet. It is also built into network operating systems.
2. The Internet was initially restricted to email and text-only documents.
  - a. In the 1980s, English computer scientist Tim Berners-Lee conceived the idea of allowing users to click on a word or phrase (a **hyperlink**) on their screens and having another document automatically be displayed.
  - b. Berners-Lee created a simple coding mechanism called **hypertext markup language (HTML)** to perform this function. He also created a set of rules called **hypertext transfer protocol (HTTP)** to allow hyperlinking across the Internet rather than on just a single computer. He then created a piece of software, called a **browser**, that allowed users to read HTML from any brand of computer. The result was the **World Wide Web** (often simply called "the Web").
    - 1) As the use of HTML and its successor languages spread, it became possible to display rich graphics and streaming audio and video in addition to text.

- 2) **Extensible markup language (XML)** was developed by an international consortium and released in 1998 as an open standard usable with many programs and platforms.
  - a) XML codes all information in such a way that a user can determine not only how it should be presented but also what it is; i.e., all computerized data may be tagged with identifiers.
  - b) Unlike HTML, XML uses codes that are extensible, not fixed. Thus, if an industry can agree on a set of codes, software for that industry can be written that incorporates those codes.
- c. With the explosive growth of the World Wide Web in the 1990s, whole new distribution channels opened up for businesses. Consumers can browse a vendor's catalog using the rich graphics of the Web, initiate an order, and remit payment, all from the comfort of their homes.
  - 1) An organization's presence on the Web is constituted in its website. The website consists of a home page (the first screen encountered by users) and subsidiary web pages (screens constructed using HTML or a similar language).
  - 2) Every page on the World Wide Web has a unique address, recognizable by any web-enabled device, called a **uniform resource locator (URL)**. However, just because the address is recognizable does not mean it's accessible to every user -- security is a major feature of any organization's website.
3. An **intranet** permits sharing of information throughout an organization by applying Internet connectivity standards and Web software (e.g., browsers) to the organization's internal network.
  - a. An intranet addresses the connectivity problems faced by organizations that have many types of computers. It is ordinarily restricted to those within the organization and to outsiders after appropriate identification.
  - b. An **extranet** consists of the linked intranets of two or more organizations, for example, of a supplier and its customers. It typically uses the public Internet as its transmission medium but requires a password for access.