CHAPTER 5
COMPUTING AND COMMUNICATIONS RESOURCES

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Learning Objectives

- Learn the components of computers.
- Learn about personal computing devices.
- Understand the implications of the rapid advances in information and communication technologies.
- Be familiar with input and output resources.
- Recognize the differences and advantages between storage media.
- Learn the advantages of prewritten software.
- Learn about different networking strategies between computers.
- Understand the differences between communications over the public telephone system and networks.
- Learn about network protocols.
- Distinguish between intranets, extranets, and the Internet.

Introduction

- Computer resources include all the hardware and software and files that you can access over a network
- The speed and cost of communications and computer processors impact the use of these resources
- As prices continue to drop, the use of computers and communications will keep growing

HARDWARE

- All general-purpose computers have the same types of components (see Table 5.1):
  - Processor
  - Memory
  - Storage
  - Input devices
  - Output devices
- Larger computers typically have more and faster components than their microcomputer cousins

Table 5.1

Major Computer Components

Component	Description
Processor (central processing unit or CPU)	Controls calculations, controls logical comparisons of data, directs and controls movement of data from one location within the computer to another.
Memory (random access memory or primary storage)	Memory located on the computer's main circuit board called the motherboard. Data in memory is lost when the power to the computer is turned off.
Storage (disk space or secondary storage)	Memory located on a device that is not on the main circuit board. Many types of storage are removable and can be taken from one computer to another. Data in storage is not lost when the power to the computer is turned off. Common storage devices are floppy disks and CDs.
Input devices	A device that captures data by a manual or electronic method and transmits the data to storage or memory. Common input devices are keyboards, mice, and scanners.
Output device	A device that presents and/or transmits data from the computer to the user. Common output devices are computer monitors, printers, CDs, and speakers.
Input/Output devices	A device that can perform both input and output functions. Examples would be a touch-screen monitor and storage disks (such as floppies, Zip disks, and rewritable CDs).

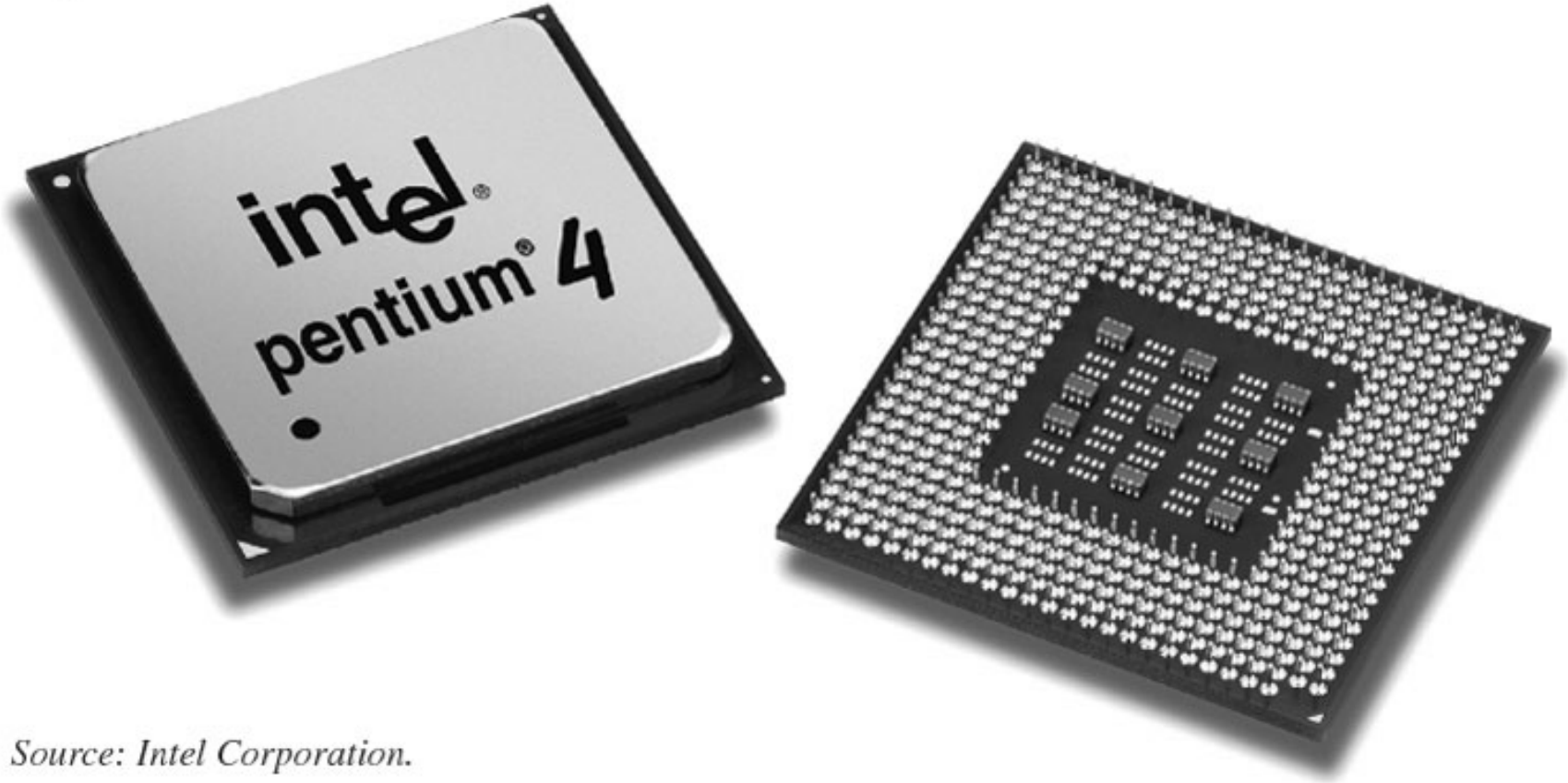
Processors

- The **processor** (also called the **central processing unit** or **CPU**), such as the one shown in Figure 5.1, controls the calculations and logical comparisons of data
- Processors also control and direct the movement of data between different locations within a computer and over a network

Processor Characteristics

- **Processor Speed** is measured by the number of processor cycles per second
- **Word Size** is the measure of the size of the processor's' registers, or how many bits may be moved with one cycle of the processor
- A **bit** is a single value of zero or one
- A **byte** is made of eight bits and each byte can store a single character
- **Processing power** combines word size and processor speed. Improvements in processor circuitry also allows operations (such as addition, comparison of data values, and others) to be performed in fewer cycles.

Figure 5.1 Intel Pentium 4 Processor

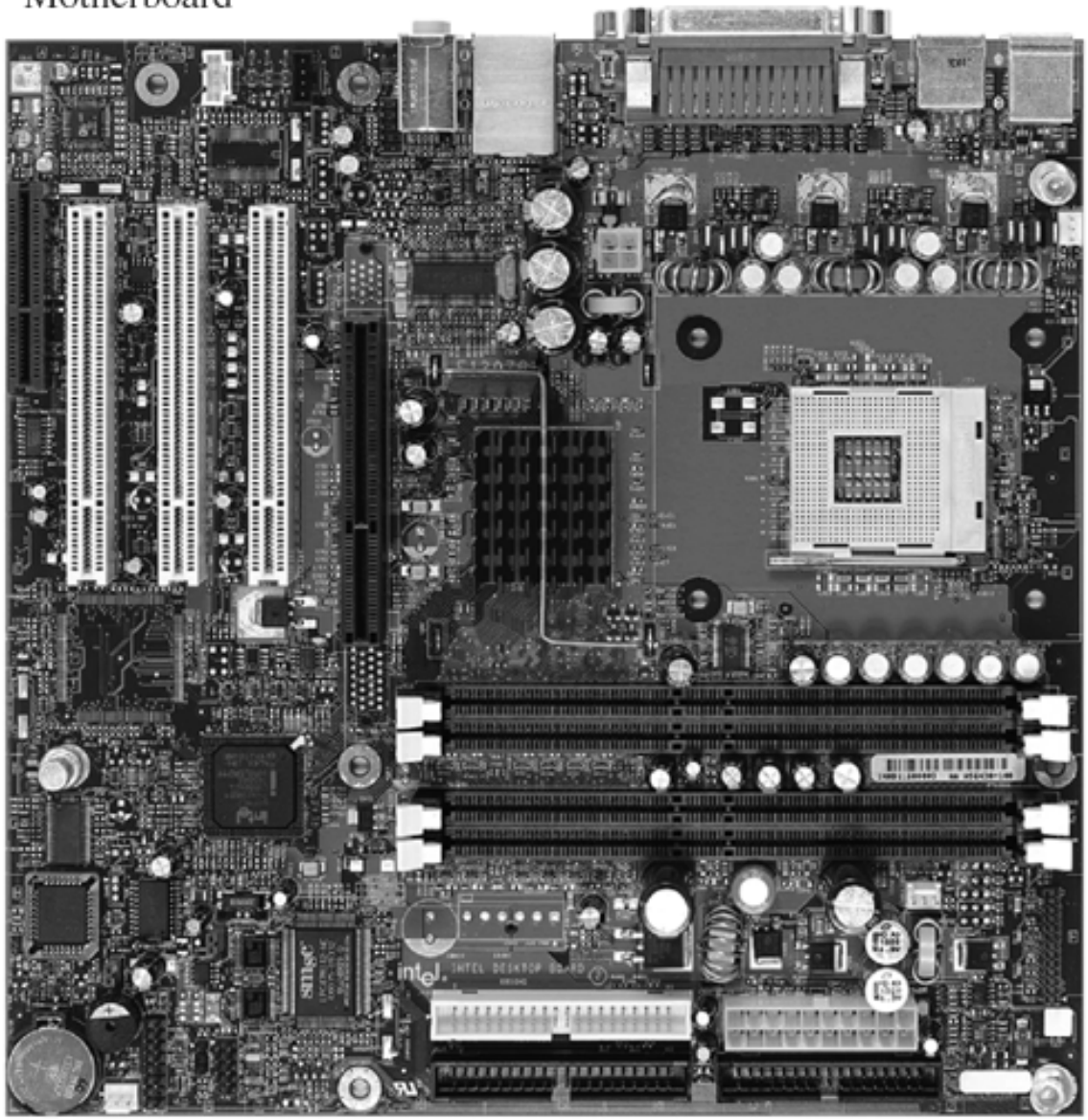


Source: Intel Corporation.

Memory

- **Memory**, also called **primary storage, main memory or random access memory (RAM)**, refers to the storage area on the computer's circuit board (aka the "motherboard," see Figure 5.2)
- Microcomputers commonly have 128 to 256 megabytes (MB) of memory while many microcomputers can accommodate 2 gigabytes (2 billion bytes) of memory
- Table 5.2 presents a table of byte, megabyte, gigabyte, terabyte, and petabyte conversions
- Memory has become more abundant and faster in order to keep up with the more powerful processors
- Table 5.3 briefly defines several types of memory

Figure 5.2 Microcomputer Circuit Board, Also Known As a Motherboard



Source: Intel Corporation Motherboard Photo courtesy of Intel Corporation.

Table 5.2

Conversion from Bits to Bytes and Further
1 bit = a single value of 0 or 1
8 bits = 1 byte = 1 character
2^{10} bytes = 1,024 bytes = 1 kilobyte (1 KB)
2^{20} bytes = 1 KB × 1 KB = 1,048,576 bytes = 1 megabyte (1 MB)
2^{30} bytes = 1,073,741,824 bytes = 1 gigabyte (1 GB)
2^{40} bytes = 1,099,511,627,776 bytes = 1 terabyte (1 TB)
2^{50} bytes = 1,125,899,906,842,624 bytes = 1 petebyte (1 PB)

Table 5.3

Brief Definitions of Different Memory Types

TYPE	DEFINITION
RAM	Random access memory, the type of memory most people mean when they use the term *memory*. Computer programs and data are loaded into RAM to be executed by the computer processor.
ROM	Read-only memory cannot be changed by the user and is unaffected by turning off the power. ROM holds information used by the operating system and processor when the computer is started.
DRAM	Dynamic RAM, allows some buffering of data (temporary storage while bits are being moved about the processor) and increases the efficiency of RAM.
SDRAM	Synchronous DRAM, runs much faster than most conventional memory because it synchronizes its cycles with the processor's cycles.
SIMM	Single in-line memory module that holds a set of 9 memory chips (only 8 for Macintosh personal computers) where the 9th chip is used for error checking. Transmits 32 bits of data per cycle.
DIMM	Dual in-line memory module, transmits 64 bits per data cycle.

Storage

- Storage for computers comes in the form of different media, each having different characteristics that make it better suited for certain tasks
- Although the media types vary from large computers to small, the types have similar characteristics
- **Fixed Storage** (**=hard drive**) refers to storage that is permanently installed in the computer (Figure 5.3)
- **Removable Storage** can be removed from one computer and inserted in another. Table 5.4 lists types of removable disks and their capacities

Figure 5.3 Fixed Disk for Data Storage

Source: Western Digital Corporation.

Table 5.4

Removable Disks and Their Storage Capacities
3½ inch floppy disk holds 1.44 MB of data
Zip disk (developed by Iomega Corp.) may hold 100 MB, 250 MB, or 750 MB of data depending on the model of Zip drive used
CD disks hold approximately 650 MB of data
DVD disks hold from 5 to 20 GB of data

Input Devices

- **Human captured data** refers to input captured by a person typing on a keyboard, clicking a mouse, touching a monitor, speaking into a microphone, or a similar interaction
- Figures 5.4, 5.5, and 5.6, depict human-captured input
- A **bar code** on products sold is an example of machine-readable data, that is used by **point-of-sale terminals (POS)**

Figure 5.4 Computer Keyboard

Source: Getty Images, Inc.

Figure 5.5 Computer Mouse

Source: Microsoft Corporation. Reprinted with permission from Microsoft Corporation.

Figure 5.6 Touch Screen Monitor

Source: Stock Boston, © Bob Daemmrich.

Output Devices and Multimedia

Output Devices

- Two of the most familiar output devices are the computer screen, (=a **monitor),** and a **printer**

Multimedia

- Input and output devices are evolving in the direction of **multimedia**, or the use of more than a single medium at a time; and also refers to the increased use of graphics and video

Figure 5.7 Standard Computer Monitor

Source: ViewSonic Corporation

Figure 5.8 Flat Panel Computer Monitor

Source: Getty Images, Inc.

PERSONAL COMPUTING DEVICES

- Today, **personal computing** is becoming associated with portable devices such as:
  - **handheld PCs;**
  - **pocket PCs;**
  - **tablet PCs;**
  - **personal digital assistants (PDAs);**
  - and cell phones with **interactive messaging** capabilities
- Even wearable computing devices like those in Figure 5.9 are also beginning to appear

Figure 5.9 Wearable Computing Devices from the MIThril Research Project Underway at the Massachusetts Institute of Technology Media Lab

Tablets, Handheld and Pocket PCs

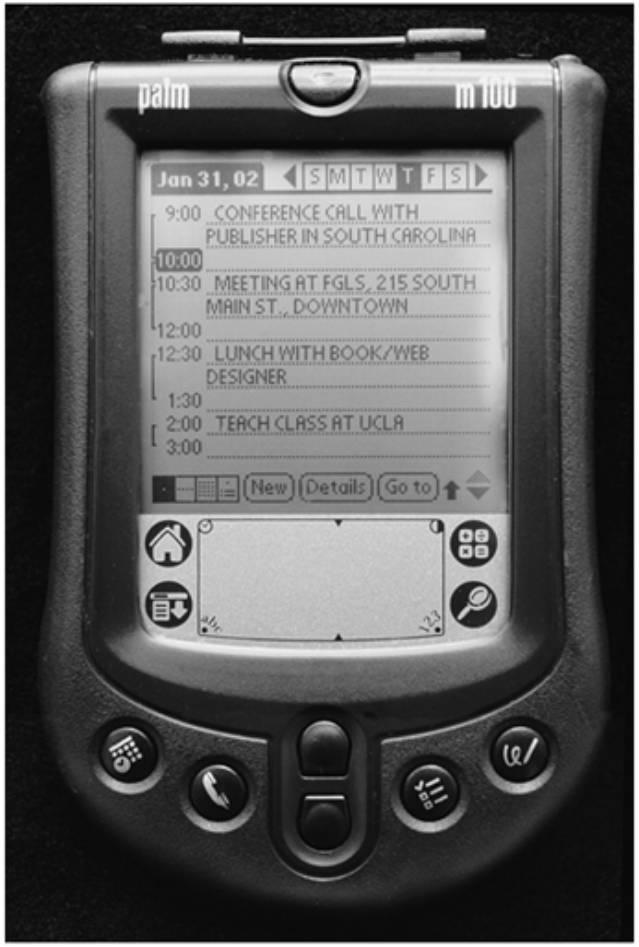
- **Personal computing devices** (Figure 5.10) are rapidly coming together as a single product
- Most use a version of Microsoft word processing, presentation, and spreadsheet software
- Internet browser software, calendars, e-mail, and other software often also comes with these devices
- Their key feature is mobility. Most are now manufactured with wireless network capabilities as well

Figure 5.10 **Examples of Personal Computing Devices: (a) Compaq Tablet PC-TC100 series; (b) iPAQ Pocket PC-h5450 Series; (c) hp Jornada 728 Handheld PC**

Personal Digital Assistants

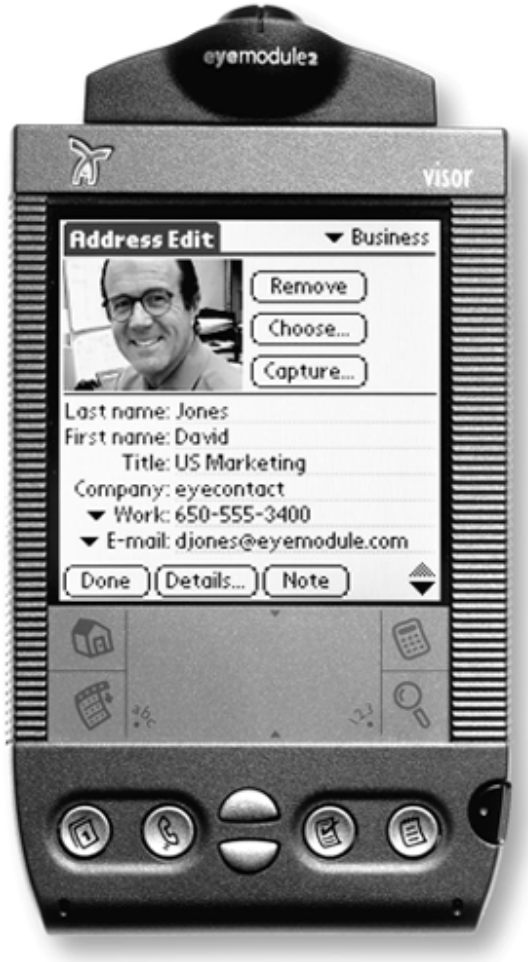
- Generally called **PDAs**, these devices are mainly used for personal organization tasks
- Calendars, contact lists, and notes are features most people associate with PDAs
- Fig. 5.11 shows some of the popular brands
- PDAs are pocket size and have battery lives that last days to months without being recharged

Figure 5.11a Examples of Popular Personal Digital Assistants: Palm m500 PDA



Source: PhotoEdit

Figure 5.11b Examples of Popular Personal Digital Assistants: Handspring Visor Pro



Source: Handspring, Inc.

Figure 5.11c Examples of Popular Personal Digital Assistants: Blackberry Wireless Handheld Devices

Source: Steve Marcus/Reuters Corbis Bettman.

Cell Phones with Interactive Messaging

- Cell phone manufacturers are now building an ability to display text messages and small images on their phone's display screens, blurring the distinction between cell phones and PDAs
- Current cell phones still only have a rudimentary computing capacity, however, and their keypad and display screens are limited as input and output devices
- Cell phones acting as computer terminals will likely be the next step in the evolution of these devices

SOFTWARE

- There are two basic types of software:
- **System software** performs fundamental tasks that all users of a particular computer require
  - The **operating system** which manages the computer's processes, functions as the interface connecting the user, the application software, and the hardware. It is the main form of systems software in use
- **Application software** processes user's data and can be obtained in a prewritten form or produced in a custom fashion for a particular user

Application Software

- In the first generation of computers, programmers would enter a series of 0s and 1s into the computer's memory to control its operations but this was very time-consuming
- Programming languages (such as COBOL, C and C++, Java, and Visual Basic) were developed to provide an easier way to create and run a user application.
- 3GL were developed in conjunction with database programming applications to further simplify the task of programming.
- A **fourth generation language (4GL)** is one that expresses what is to be done by the computer without explicitly defining how the tasks will take place

Prewritten Application Software

- **Prewritten application software**, aka **off-the-shelf software**, is written and produced by suppliers and allows users to utilize software without either hiring programmers or learning how to program themselves
- Prewritten software has two very important benefits over custom software:
  - It's already written
  - It's cheap

Custom Application Software

- There are occasions when a business organization has operations that are unique
- In such cases, the business may have its own programmers or hire a consulting group to write the application software it needs

The Role of User Friendly Software

- Computer software that is simple and intuitive to use is said to be **user friendly**
- This means the application has been carefully engineered to accommodate a wide range of users
- Widespread use of computer-based resources is achieved when the application software is designed so that these users can apply their business expertise without special training

COMMUNICATIONS---PUBLIC TELEPHONE SYSTEM

- The speed of data transmission between computers that takes place over public telephone systems is often slower than when computers are connected through dedicated networks
- The wire making the connections is similar;yet most computer networks operate 100x faster than connections routed through the public telephone system because the protocols (the specification for formatting data to be transferred) were established for voice grade communication when the quality and speed of communication lines did not need to be high

Public Connections

- Protocols for the public telephone system were established to meet the minimum criteria of voice transmissions - low grade analog transmissions - and that quality for voice communications is significantly below the needs of computer data transmission
- The theoretical limit for telephone modems is 64kbps but because of technical requirements for administering the transmission, telephone modems have a top transmission speed of 56kbps
- Data rates for other communications types are listed in Table 5.5

Table 5.5

Connecting to the Internet

Connection	Speed	Description
Telephone modem	56 Kbps	Device to connect computers over standard telephone lines.
Cable modem	2 Mbps (warning, see description)	Device that connects to the coaxial cable provided by a cable TV provider to a computer for Internet access. Speeds of these modems vary greatly with 2 Mbps being a frequently published speed advertised by the cable TV providers. However, 11 Mbps is the capability of most currently available cable modems although providers usually limit the communications speed to the customer to 2 Mbps and sometimes to 512 Kbps.
Integrated services digital network (ISDN)	128 Kbps to 1.5 Mbps	A connection using standard telephone lines as separate channels communicating at 64 Kbps each. The channels are bundled together so that the "basic" bundle of two channels results in the 128 Kbps communications rate. The most frequent bundling is 23 lines which results in a communications rate of 1.5 Mbps.
digital subscriber line (DSL)	32 Mbps	Technology similar to ISDN but more sophisticated in taking advantage of the communications speed capabilities of the telephone line. Newer versions, xDSL, can achieve speeds up to 52 Mbps

Kbps = thousands of bits per second
Mbps = millions of bits per second

Private Lines

- A **private (leased or dedicated) line** is a circuit that is always open to carry communication traffic
- Provided by the common carrier, the telephone company, your organization pays a fixed monthly fee to use the line. The more use the line receives, the smaller the cost is per-unit of data transmitted

Virtual Private Network (VPNs)

- VPNs give users the security and speed of a private line along with the low cost of using the Internet
- **Tunneling software** establishes VPN through a set of intermediary locations that host the data while its being transmitted
- Tunneling is conceptually similar to establishing a private, secure circuit while the data is being sent

COMMUNICATIONS - NETWORKS

- The International Organization for Standardization (www.iso.ch), founded in 1946, established the **Open Systems Interconnection (OSI)** standard architecture for network connections.
- OSI consists of a seven-layer model (Table 5.6) and the levels are detailed so that the exact function for each layer of communication can be plainly defined
- Two or more levels may be used by a single piece of communications hardware, while end- to- end communications involve all layers of the model
- Common networking devices are listed in Table 5.7.

Table 5.6

Open Systems Interconnect (OSI) Reference Model

LAYER	NAME	PURPOSE
7	Application layer	Perform application-to-application communication
6	Presentation layer	Manage data representation conversions
5	Session layer	Establish and maintain communication channel
4	Transport layer	Guarantee end-to-end integrity of data transmission
3	Network layer	Route data from one network address to another
2	Data link layer	Move data from one network address to another
1	Physical layer	Put data onto and off of the network media

Table 5.7

Communications Network Hardware

NAME	DESCRIPTION
HUB	A device that receives a data packet from a computer at the end of one spoke of the star topology and copies the contents to all other devices. As vendors have tried to differentiate their products, the capabilities of hubs have increased. Some are "manageable" in that they monitor and control the flow of data among the spokes.
ROUTER	A device to connect LANs together. Routers do not simply rebroadcast data; they process control information contained in communications packets in order to determine which LAN should receive the data. Because there may be many possible paths through a network to connect two computers, the router is key to determining which path will be efficient for data transfer.
SWITCH	A device that connects LANs together. Switches perform router tasks and more. Switches filter data from a network path when that path will not contain the destination computer. As a result of filtering, switches eliminate unnecessary data traffic and make communications more efficient.

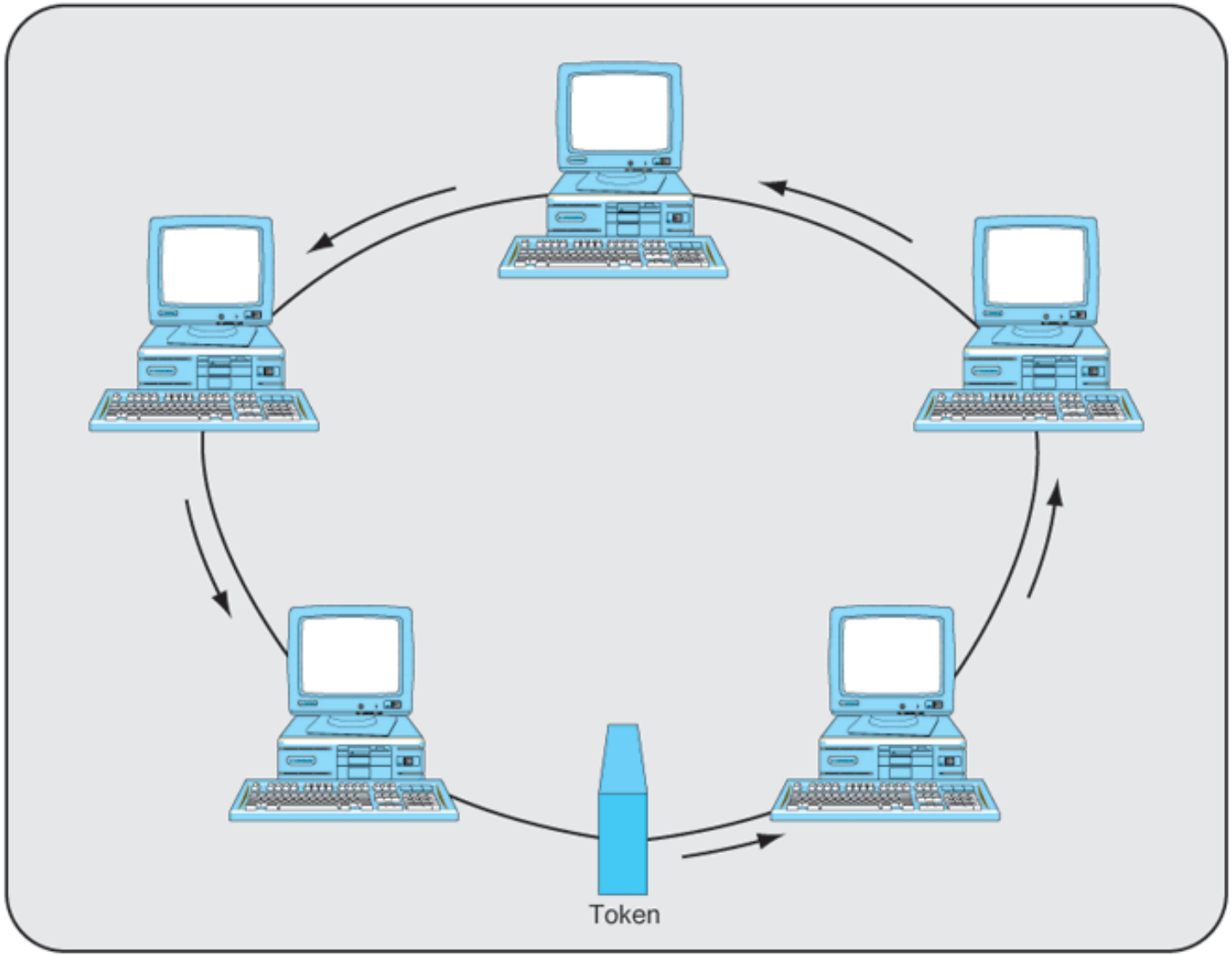
Protocols for Computer Communication

- Computers ("mainframes") were initially designed to share data with **terminals** that had no storage or processor and to simply provide a means for entering and displaying data from the computer
- In response to the communications limitation, IBM and others began developing communications protocols
- An **open protocol** is a format whose specifications are open to the public and can be used at no cost

Proprietary Protocols

- **System Network Architecture (SNA)**, established by IBM as a proprietary protocol in 1974, requires a main host computer that polls other computers connected by the network in a sequence, much like taking turns
- If a polled computer has data to send, the data is transferred, otherwise the next computer is polled
- IBM was the first to develop a **peer-to-peer protocol** that allows each computer to act as its own controller, called **Token Ring** (Figure 5.12)
- In token ring, a logical token is passed between computers. The computer with the token is the computer is in control of communications

Figure 5.12 Token Ring Protocol Example



Ethernet

- Xerox in cooperation with Intel and Digital Equipment Corporation, developed a different open protocol peer-to-peer communications architecture in the late 1970s called **Ethernet**
- Unlike Token Ring, Ethernet works over a bus, rather than a ring and doesn't use tokens
- Instead, if a computer on the network wishes to send data over the communications medium it simply checks to see if data is currently being transmitted. If not, it sends its message

Packets

- For large data transfers, messages need to be broken into smaller pieces so that the message from one computer does not dominate the communications medium
- These smaller entities are called **packets**
- The most important packet- switching protocol is the one used by the Internet, **Transmission Control Protocol/Internet Protocol (TCP/IP)**
- TCP/IP handles packetization and also decides how the packets are best routed through the network from source to destination computer

Internet Network Addresses

- In order to route packets through the network, each computer handling packets of data must have a unique address
- This is called the **IP address**
- IP addresses are made up of a set of four 1-byte numbers, each between 0 to 255, separated by periods
- They are often written in dotted decimal notation, such as: 128.64.32.218
- The left part of this number represents the number of the network the computer is on, while the right part is the host number of that specific computer

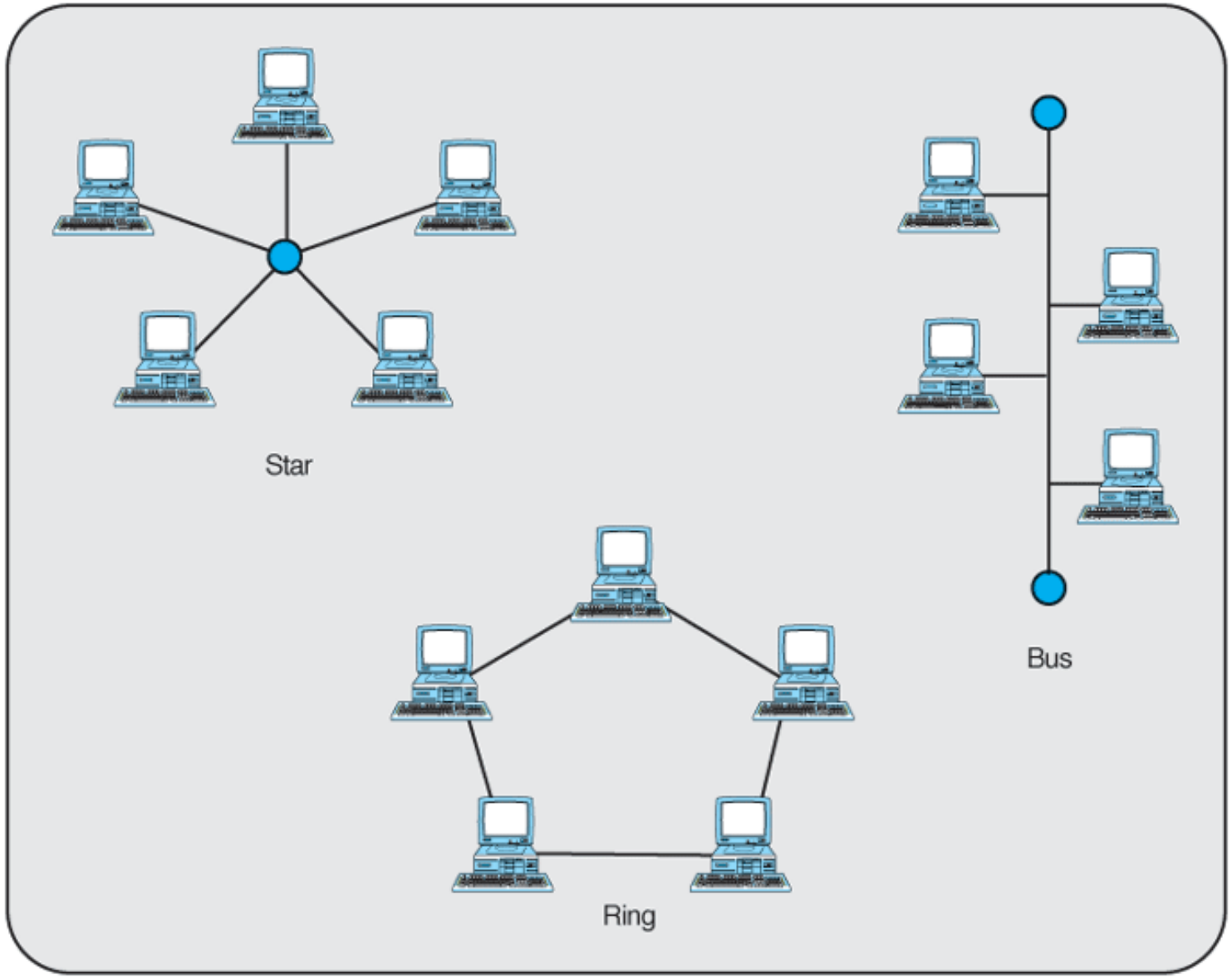
NETWORK TYPES

- Understanding the different types of networks is important since plays a different role in a firm's communications strategy.
- Different network types can effectively compartmentalize communications
- Computers on local area networks are connected using devices called **network interface cards (NICs)**.

Local Area Networks

- A **local area network (LAN)** is a group of computers and other devices (such as printers) that are connected together by a common networking medium
- LANs typically join together computers that are in physical proximity, such as in the same room or building
- LANs can be connected together using one of three different configurations, called topologies (Figure 5.13)

Figure 5.13 Three Common Local Area Network Configurations



Metropolitan Area Networks and Wide Area Networks

- A **Metropolitan Area Network (MAN)** is one that has a physical distance limit of roughly 30 miles and typically links several buildings of an organization together
- **Wide Area Networks (WANs)** are used to connect computers and other devices when the distance exceeds constraints of LANs and MANs and uses the public telephone system. For practical purposes, WANs have been replaced by the Internet

Internet

- The scale of interconnection is the difference between an internet and the Internet
- An **intranet** uses the same network protocols as the Internet but limits accessibility to computer resources to a select group of persons in the organization
- When an intranet is expanded to include users outside the firm it is called an **extranet**
- Only trusted customers and business partners are allowed extranet access because this may allow access to proprietary corporate information

CONVERGENCE OF COMPUTING AND COMMUNICATIONS

- Computing devices and communications devices are each incorporating features of the other into themselves
- Some of the limits to the possibilities of convergence relate to battery life, communication speed and security, size of display and keyboard, and the user's imagination
- The convergence process is now well underway, although it will take several years to complete

END OF CHAPTER 5