

LECTURE 2 INTRODUCTION TO COMPUTER SYSTEM DR.HERLINA JAYADIANTI.ST.MT



This chapter will cover the following topics:

- Computer Hardware and Information Technology Infrastructure
 - The Computer System
 - How Computers Represent Data
 - The CPU and Primary Storage
 - Microprocessors and Processing Power
 - Multiple Processors and Parallel Processing
- Storage Input, and Output Technology
 - Secondary Storage Technology
 - Input and Output Devices
- Categories of Computers and Computer Systems
- Computer Software
- Programming Languange

COMPUTER HARDWARE AND INFORMATION TECHNOLOGY INFRASTRUCTURE

Components of IT infrastructure consist of software, data, and networks – require computer hardware for their storage or operation.

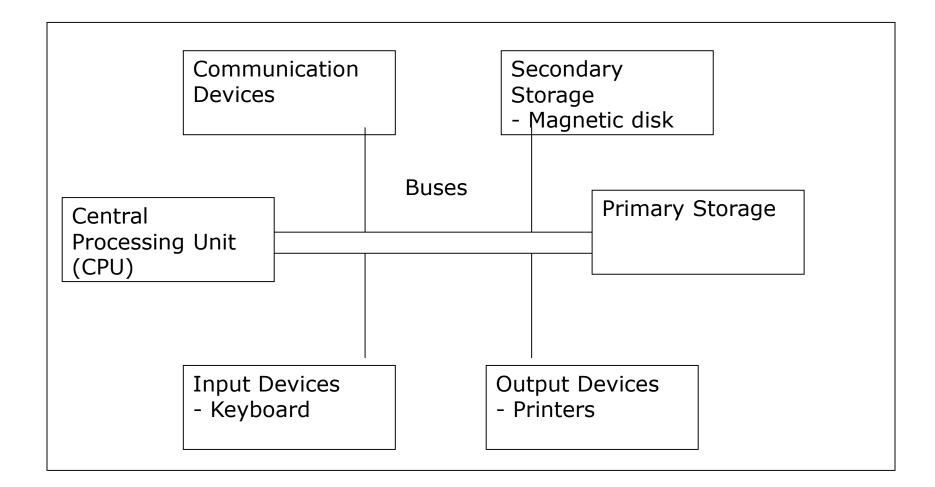
THE COMPUTER SYSTEM

Computer system consists of (see Figure 0.1):

- central processing unit (CPU)
- primary storage
- secondary storage
- input devices
- output devices

Communications devices.

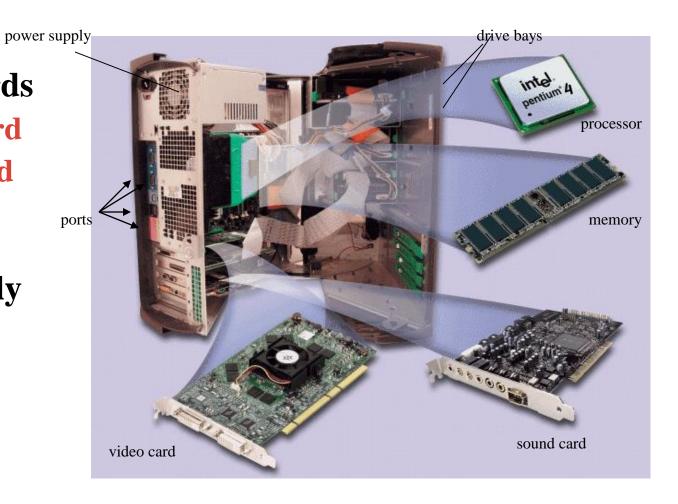
FIGURE 0.1: HARDWARE COMPONENT OF COMPUTER SYSTEMS



THE SYSTEM UNIT

What are common components inside the system unit?

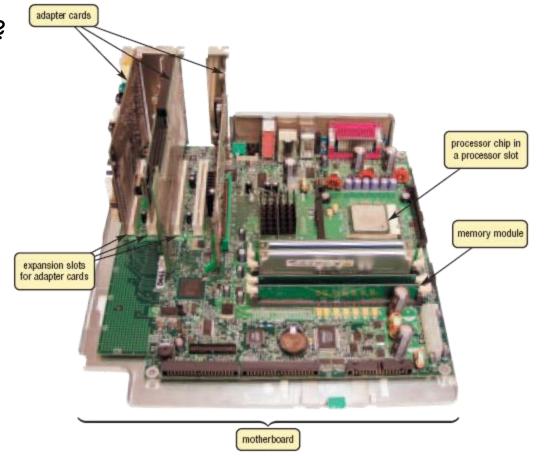
- > Processor
- > Memory
- > Adapter cards
 - Sound card
 - Video card
- > Ports
- > Drive bays
- > Power supply



THE SYSTEM UNIT

What is the motherboard?

- Main circuit
 board in system
 unit
- Contains adapter cards, processor chips, and memory chips
- Also called system board



The CPU

 manipulates raw data into more useful form and controls the other parts of the computer system.

Primary storage

temporarily stores data and program instructions during processing.

Secondary storage

devices store data and programs when they are not being used in processing.

Input devices

convert data and instructions into electronic form for input into the computer.

Output devices

 convert electronic data produced by the computer system and display them in a form that people can understand.

Communication devices

provide connections between the computer and communications networks.

Buses

• are circuitry paths for transmitting data and signals among the parts of the computer system.

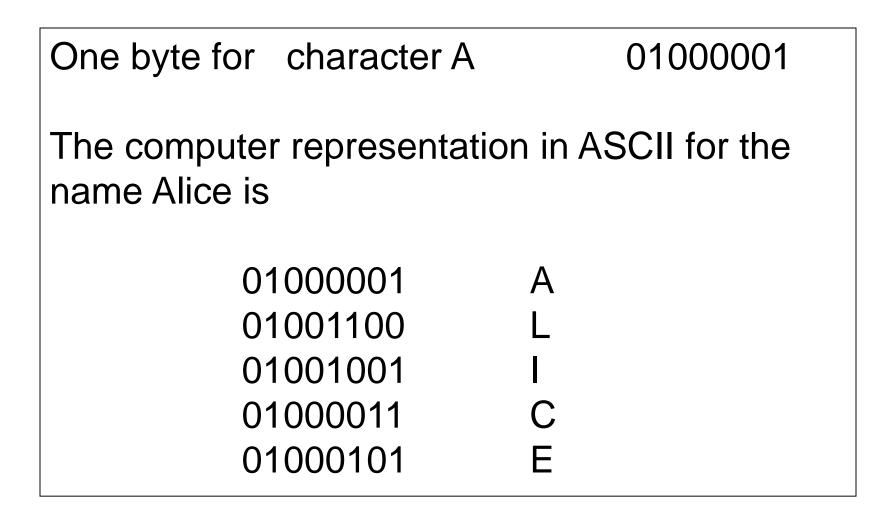
HOW COMPUTERS REPRESENT DATA

All symbols, pictures or words must be reduced to a string of binary digits.

A binary digit is called a bit and represents either a 0 or a 1.

These are the only digits in the binary or base 2, number system used by computers.

A string of eight bits used to store one number or character in a computer system is called a byte (see Figure 0.2).



To represent the numbers 0 through 9 and the letters a through z and A through Z, computer designers have created coding systems consisting of several hundred standard codes.

In one code, for instance, the binary number 01000001 stands for the letter A.

Two common coding systems are Extended Binary Coded Decimal Interchange Code (**EBCDIC**) and American Standard Code for Information Interchange (**ASCII**). See Table 0.1.

EBCDIC represents every number, alphabetic character, or special character with eight bits, used primarily in IBM and other mainframe computers.

ASCII was originally designed as a seven-bit code, but most computers use eight-bit versions.

ASCII is used in data transmission, PCs and some larger computers.

The computers store a picture by creating a grid overlay of the picture.

Each single point in this grid, or matrix is called a pixel (picture element) and consists of a number of bits.

DATA REPRESENTATION

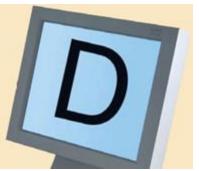
How is a letter converted to binary form and back?



Step 1. The user presses the capital letter D (shift+D key) on the keyboard.

Step 2.

An electronic signal for the capital letter **D** is sent to the system unit.



Step 4.

After processing, the binary code for the capital letter **D** is converted to an image, and displayed on the output device.

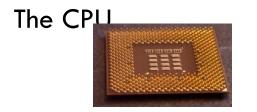


Step 3.

The signal for the capital letter **D** is converted to its ASCII binary code (01000100) and is stored in memory for processing.

THE CPU AND PRIMARY STORAGE

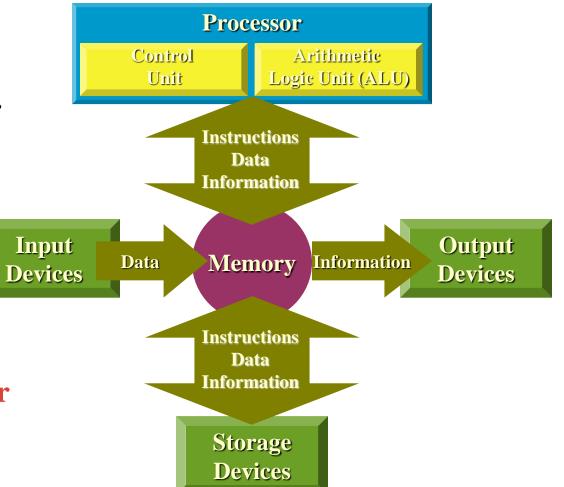
The CPU is the part of the computer system where the manipulation of symbols, numbers, and letters occurs, and it controls the other parts of the computer system.



PROCESSOR

What is the central processing unit (CPU)?

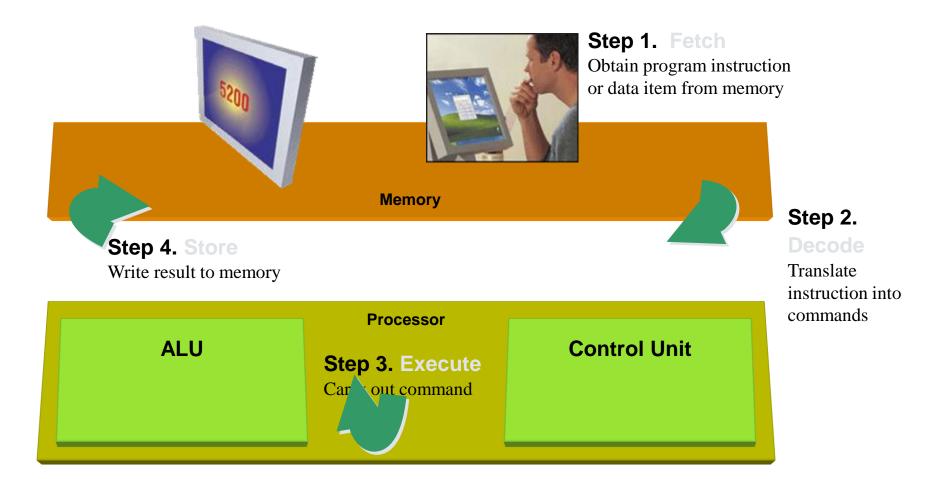
- Interprets and carries out basic instructions that operate a computer
 - Control unit directs and coordinates operations in computer
 - Arithmetic logic unit (ALU) performs arithmetic, comparison, and logical operations
- > Also called the processor



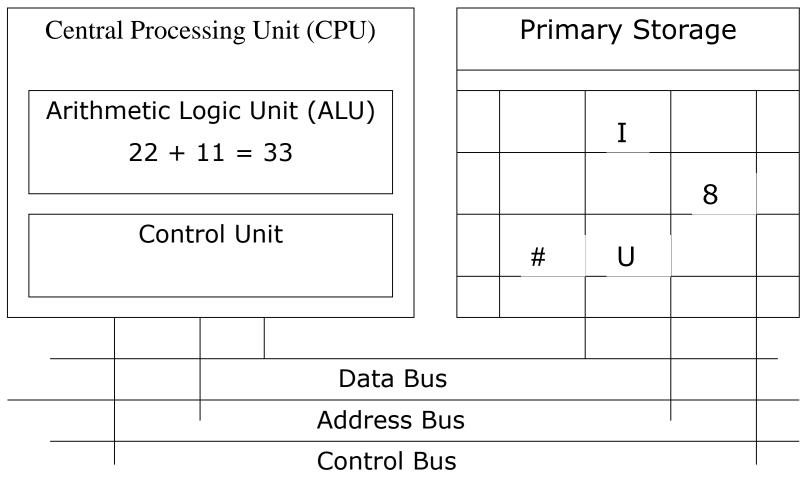
PROCESSOR

What is a machine cycle?

> Four operations of the CPU comprise a machine cycle



THE CPU AND PRIMARY STORAGE



Three kinds of busses linked between the CPU, primary storage and the other devices in the computer system:

- Data bus
 - Pass information in bi-directional.
- Address bus
 - Transmits signals for locating a given address in primary storage, indicating where data should be placed.
- Control bus
 - Transmits signal specifying whether to read or write data to or from primary storage address, input device or output device.

The characteristics of the CPU and primary storage are very important in determining a computer's speed and capabilities

THE ARITHMETIC-LOGIC UNIT AND CONTROL UNIT

An **arithmetic logic unit (ALU) and control unit** is one of the core components of all central processing units.

The ALU performs the computer's principal logical and arithmetic operations.

It adds, subtracts, multiples, and divides, determining whether a number is positive, negative, or zero.

ALU must be able to determine when one quantity is greater than or less than another and when two quantities are equal.

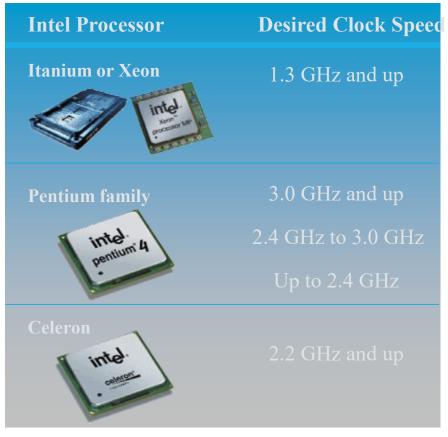
The control unit coordinates and controls the other parts of the computer system.

It reads a stored program, one instruction at a time and directs other components of the computer system to perform the program's required tasks.

PROCESSOR

Which processor should you select?

> The faster the processor, the more expensive the computer



PRIMARY STORAGE

Primary storage is a category of computer storage, often called main memory.

Has three functions:

- Stores all or part of the program that is being executed.
- Stores the operating system programs that manage the operation of the computer.
- Holds data that the program is using.

Data and program are placed in primary storage before processing, between processing steps and after processing has ended prior to being returned to secondary storage or released as output.

MEMORY^s memory measured?

> By number of bytes available for storage

| Term | Abbreviation | Approximate Size |
|----------|--------------|-------------------------|
| Kilobyte | KB or K | 1 thousand bytes |
| Megabyte | MB | 1 million bytes |
| Gigabyte | GB | 1 billion bytes |
| Terabyte | TB | 1 trillion bytes |

Modern primary storage devices include:

- Random access memory (RAM)
 - is used for short-term storage of data or program instructions. RAM is volatile. Its contents will be lost when the computer's electric supply is disrupted by a power outage or when the computer turned off.
- Read-only memory (ROM)
 - can only be read from. It cannot be written to. ROM chips come from the manufacturer with programs already burned in, or stored. ROM is used in general-purpose computers to store important or frequently used programs, such as computing routine for calculating the square roots of numbers.

What is random access memory (RAM)?

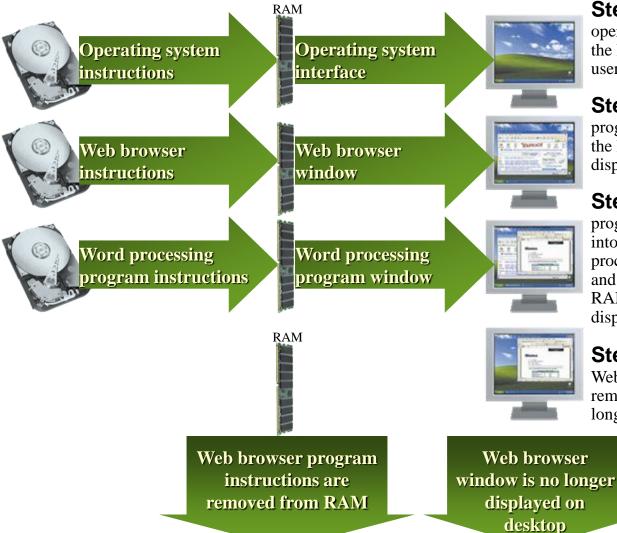


Memory chips that can be read from and written to by processor

Also called main memory or primary storage Most RAM is volatile, it is lost when computer's power is turned off

The more RAM a computer has, the faster it responds

How do program instructions transfer in and out of RAM?



Step 1. When you start the computer, certain operating system files are loaded into RAM from the hard disk. The operating system displays the user interface on the screen.

Step 2. When you start a Web browser, the program's instructions are loaded into RAM from the hard disk. The Web browser window is displayed on the screen.

Step 3. When you start a word processing program, the program's instructions are loaded into RAM from the hard disk. The word processing program, along with the Web Browser and certain operating system instructions are in RAM. The word processing program window is displayed on the screen.

Step 4. When you quit a program, such as the Web browser, its program instructions are removed from RAM. The Web browser is no longer displayed on the screen.

What are two basic types of RAM chips?



Newer Type: Magnetoresistive RAM
 (MRAM)

| Memory chips that store permanent data and instructions | mory (ROM)? | Nonvolatile memory, it is not lost when computer's power is turned off |
|---|-------------|---|
| or information | read | EEPROM (electrically e programmable -only memory)— Type of PROM ining microcode programmer can erase |

STORAGE, INPUT, AND OUTPUT TECHNOLOGY

Storage, input and output devices are called peripheral devices because they are outside the main computer system unit.

SECONDARY STORAGE TECHNOLOGY

Secondary storage is used for relatively long term storage of data outside the CPU.

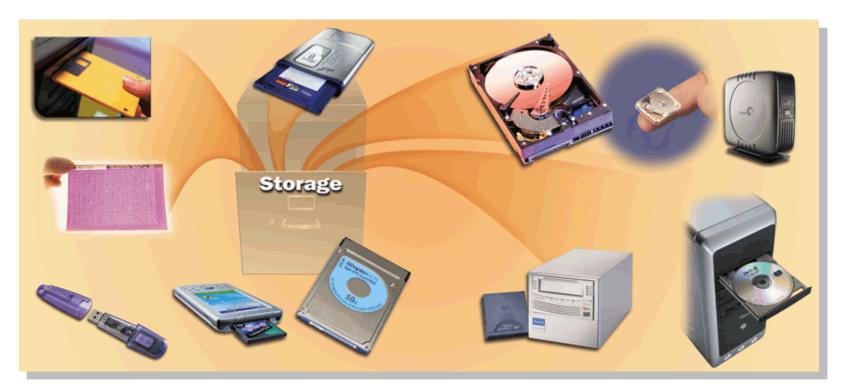
Secondary storage is nonvolatile and retains data even when the computer is turned off.

The most technologies are magnetic disk, optical disk and magnetic tape.

STORAGE

Holds data, instructions, and information for future use
 Storage medium is physical material used for storage

 Also called secondary storage



STORAGE

How does volatility compare?

- Storage medium is nonvolatile—contents retained when power is off
- Memory is volatile—holds data and instructions temporarily

| tomporany | ON | OFF |
|--|---|---------------------------------|
| Screen Display | Display appears | Display disappears |
| Memory (most RAM) (chips on motherboard) | Data and instructions available to user | Data and instructions erased |
| Storage Medium (floppy disks, Zip disks, hard disks, CDs) | Contents available to user | Contents retained |

Volatile

MAGNETIC DISK

There are two kinds of magnetic disk:

- floppy disks
- hard disks

Magnetic Disks permit direct access to individual records so that data stored on the disk can be directly accessed regardless of the order in which the data were originally recorded.

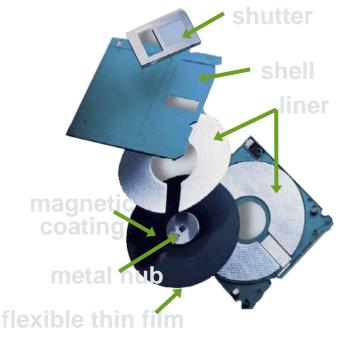
Disk storage is often referred to as a direct access storage device (DASD).

MAGNETIC DISKS

What is a floppy disk?



 Portable, inexpensive storage medium (also called diskette) Thin, circular, flexible film enclosed in 3.5" wide plastic shell



- What is a floppy disk drive?
 - Device that reads from and writes to floppy disk
 - One floppy drive, named drive A
 - Also called secondary storage



MAGNETIC DISKS²

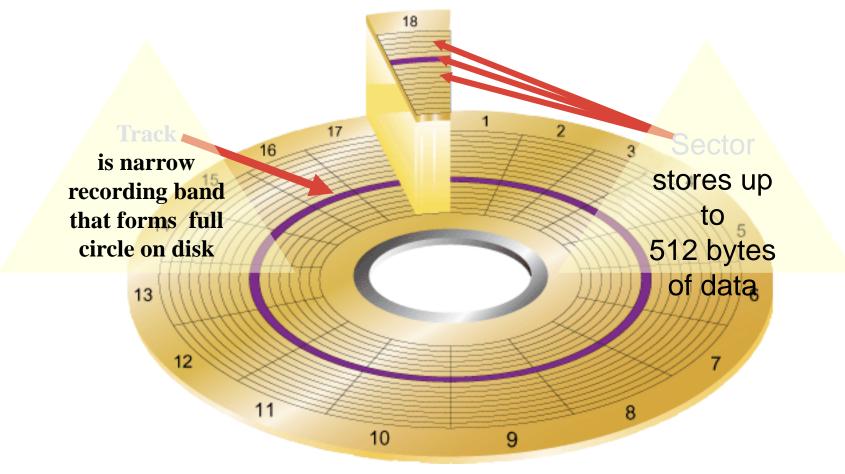
- High-capacity storage
- Consists of several inflexible, circular platters that store items electronically
- items electronically – Components enclosed in airtight, sealed case for protection



hard disk installed

MAGNETIC DISKS

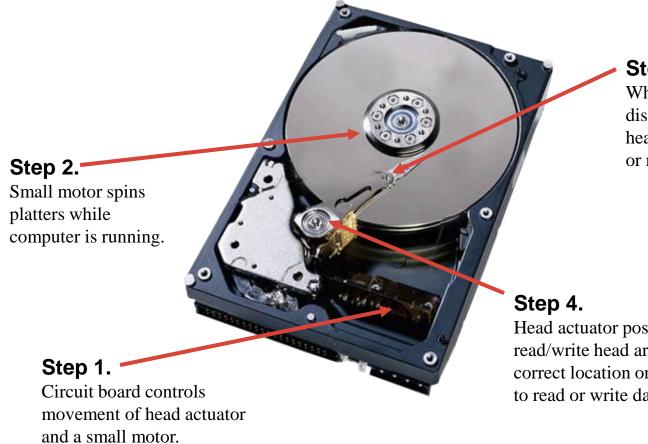
What are tracks and sectors?



Formatting prepares disk for use and marks bad sectors as unusable

MAGNETIC DISKS

How does a hard disk work?



Step 3.

When software requests a disk access, read/write heads determine current or new location of data.

Head actuator positions read/write head arms over correct location on platters to read or write data.

OPTICAL DISK

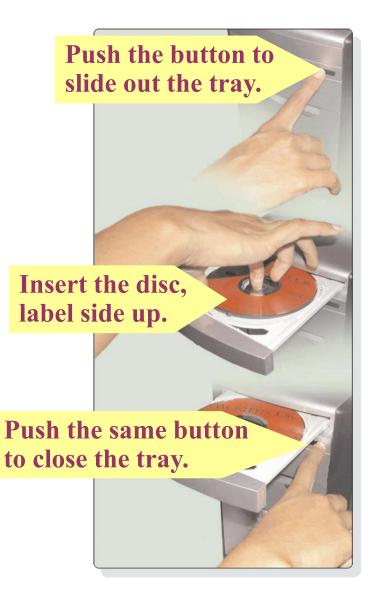
Also called compact disks or laser optical disks, used laser technology to store data at densities many times greater than those of magnetic disks.

The most common optical disk system used with PCs called CD-ROM (compact disk read only memory).

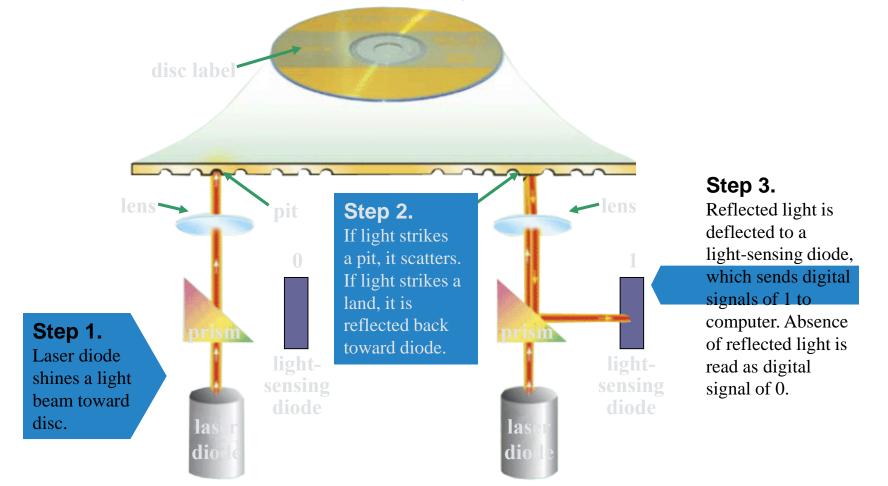
CD-ROM is read-only storage.

What are optical discs?

- Flat, round, portable metal discs made of metal, plastic, and lacquer
- Can be read only or read/write
- Most PCs include an optical disc drive



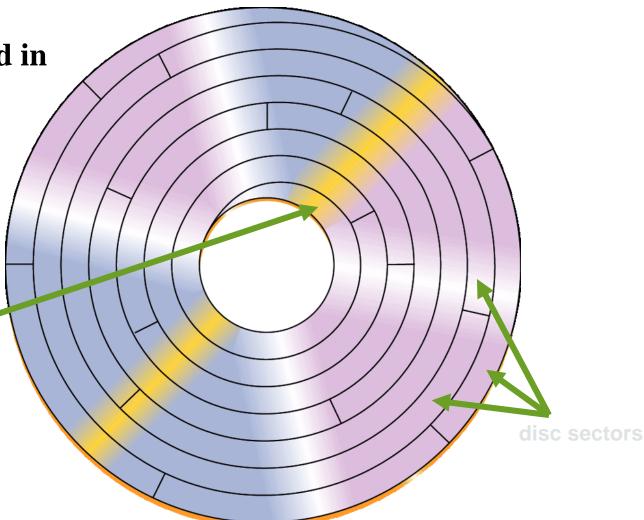
How does a laser read data on an optical disc?



How is data stored on an optical disc?

- Typically stored in single track
- Track divided into evenly sized sectors that store items

single track spirals to edge of disc



WORM (write once/read memory) or CD-R (compact diskrecordable) optical disk systems allow users to record data only once on an optical disk.

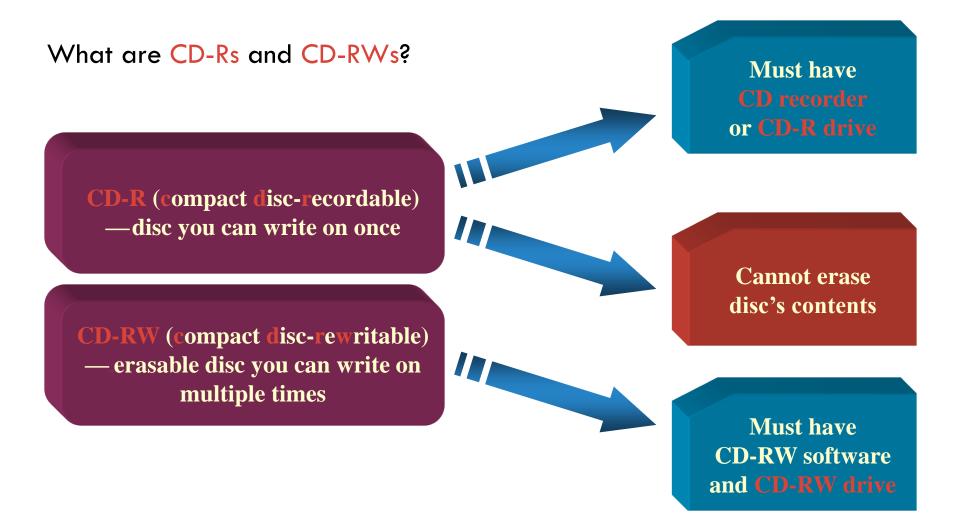
New CD-RW (CD-Rewritable) technology has been developed to allow users to create rewritable optical disks.

Digital-video disks (DVDs) also called digital versatile disks are optical disks the same size as CD-ROMs but of even higher capacity (minimum of 4.7 gigabytes of data).

What is a CD-ROM?

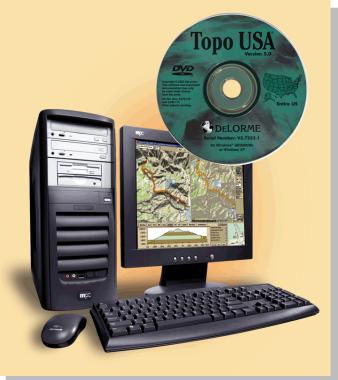
- Compact disc read-only memory
- Cannot erase or modify contents
- > Typically holds 650 MB to 1 GB
- > Commonly used to distribute multimedia and complex software





What is a DVD-ROM (digital versatile disc-ROM or digital video disc-ROM)?

- High capacity disc capable of storing 4.7 GB to 17 GB
- Must have DVD-ROM drive or DVD player to read DVD-ROM
- Stores databases, music, complex software, and movies



How does a DVD-ROM store data?

- Two layers of pits are used, lower layer is semitransparent so laser can read through
- Some are double-sided
- Blu-Ray discs currently have a storage capacity of up to 27 GB

| Sides | Layers | Storage Capacity |
|-------|--------|------------------|
| 1 | 1 | 4.7 GB |
| 1 | 2 | 8.5 GB |
| 2 | 1 | 9.4 GB |
| 2 | 2 | 17 GB |

DVD-ROM STORAGE CAPACITIES

MAGNETIC TAPE

Magnetic tape is an older storage technology that still used for secondary storage of large volumes of information.

- The principle advantages
- its inexpensiveness, its relative stability and its ability to store very large quantities of information.

The disadvantages

 its sequentially stored data and its relative slowness compared to the speed of secondary storage media.

TAPE

 Magnetically coated plastic ribbon capable of storing large amounts of data at low cost

- Primarily used for backup



PC CARDS

What is a PC Card?

- Adds capabilities to computer
- Credit-card-sized device commonly used in notebook computers

PC CARDS

| Category | Thickness | Use |
|----------|-----------|--|
| Type I | 3.3 mm | RAM, SRAM, flash memory |
| Type II | 5.0 mm | Modem, LAN, SCSI, sound, TV tuner, hard disk, or other storage |
| Type III | 10.5 mm | Rotating storage such as a hard disk |



INPUT AND OUTPUT DEVICES

Input devices

- Input devices gather data and convert them into electronic form for use by the computer.
- Keyboard
 - The principal method of data entry for entering text and numerical data into a computer

Pointing Devices

- A computer mouse is handheld device with point-and-click capabilities that is usually connected to the computer by a cable.
- Touch screens allows users to enter limited amounts of data by touching the surface of a sensitized video display monitor with finger or a pointer.

Source Data Automation

- Captures data in computer-readable form at the time and place they are created.
- Optical Character Recognition (OCR) devices translate specially designed mark, characters, and codes into digital form.
- Magnetic ink character recognition (MICR) technology is used primarily in check processing for the banking industry, which the bottom of typical check contains characters identifying the bank, checking account, and check number that are preprinted using a special magnetic ink.

- A MICR reader translates these characters into digital form for the computer.
- Handwriting-recognition devices such as pen-based tablets, notebooks, and notepad are promising new input technologies.
- These pen-based input devices convert the motion made by an electronic stylus pressing on a touch-sensitive tablet screen into digital form.
- Digital scanners translate image such as pictures or documents into digital form.
- Voice input devices convert spoken words into digital form for processing by the computer.
- Sensors are devices collect data directly from the environment for input into a computer system.

WHAT IS INPUT?

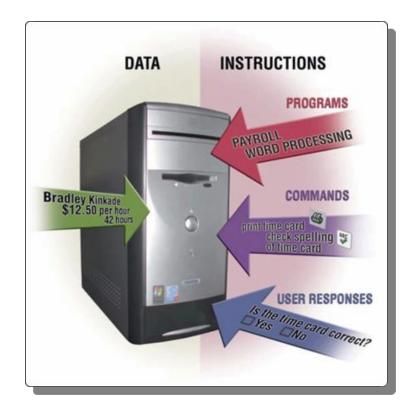
- > Data or instructions entered into memory of computer
- Input device is any hardware component that allows users to enter data and instructions



WHAT IS INPUT?

What are the two types of input?

- > Data
 - Unprocessed text, numbers, images, audio, and video
- Instructions
 - Programs
 - Commands
 - User responses



THE KEYBOARD

- > Typing area
- Numeric keypad
- Function keys, special keys that issue commands

How is the keyboard divided?

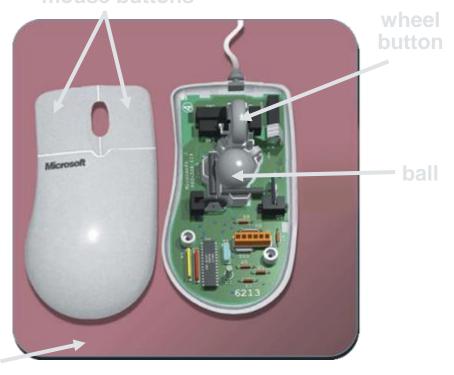


POINTING DEVICES

> Pointing device that fits under palm of hand

- Pointing device controls movement of pointer, also called mouse pointer
- Mechanical mouse
 has rubber or metal
 ball on underside

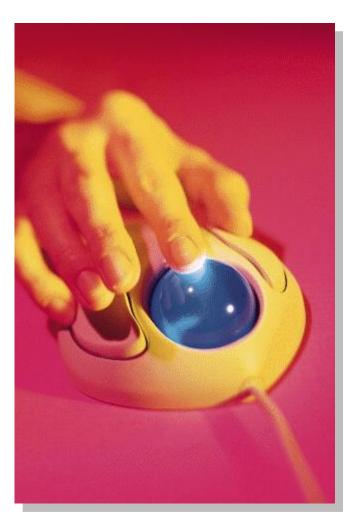
What is a mouse?



mouse pad

What is a trackball?

- Stationary pointing device with a ball on its top or side
- To move pointer, rotate ball with thumb, fingers, or palm of hand



What are a touchpad and a pointing stick?

- Touchpad is small, flat, rectangular pointing device sensitive to pressure and motion
- Pointing stick is pointing device shaped like pencil eraser positioned between keys on keyboard





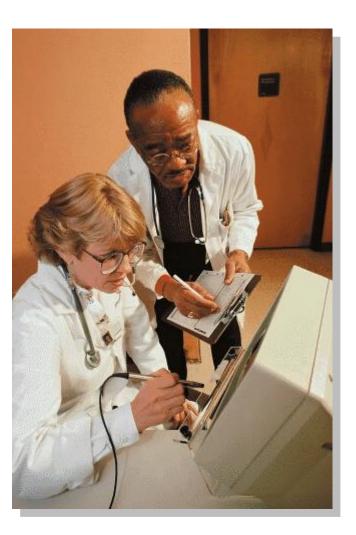
What are a joystick and a wheel?

- Joystick is vertical lever mounted on a base
- Wheel is steering-wheel-type input device
 - Pedal simulates
 car brakes and
 accelerator



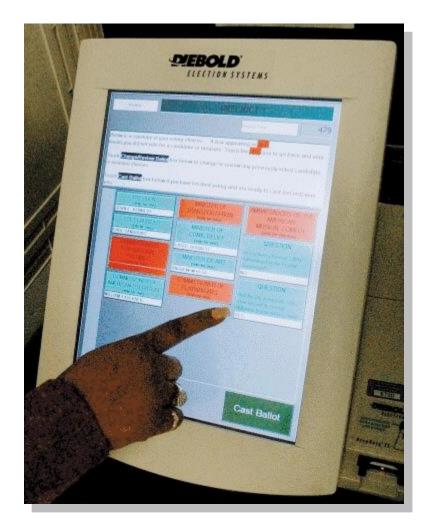
What is a light pen?

- Handheld input device that can detect light
 - Press light pen against screen surface and then press button on pen



What is a touch screen?

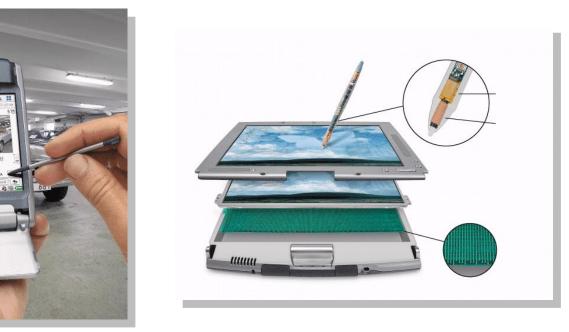
- > Often used with kiosks
- Touch areas of screen with finger



KEYBOARD AND POINTING DEVICES

- Looks like a ballpoint pen, but uses pressure to write text and draw lines
- > Used with graphics tablets, flat electronic boards

What is a stylus and a digital pen?



VOICE INPUT

How does voice recognition work?

Step 1. A user dictates text into a microphone.



Step 2. An analog-to-digital converter (ADC) translates sound waves into digital measurements computer can process. Measurements include pitch, volume, silences, and phonemes. Phonemes are sound units such as *aw* and *guh*.

ADC 10010111010110101100001101

Step 4. To narrow a list down, software presents user with a list of choices or uses a natural language component to predict most likely match. User may correct any selection made by software.

Natural Language Engine



Step 3. Software compares spoken measurements with those in its database to find a match or list of possible matches.

Matches

your, you're right, write

VOICE INPUT

What is a MIDI (musical instrument digital interface)?

External device, such as electronic piano keyboard, to input music and sound effects



DIGITAL CAMERAS

How does a digital camera work?

Step 1. Point to the image to photograph and take picture. Light passes into the lens of the camera.

Step 2. Image is focused on a chip called a *charge-coupled device* (*CCD*).



Step 7. Using software supplied with the camera, images are viewed on screen, incorporated into documents, edited, and printed.



Step 3. CCD generates an analog signal that represents the image.

Step 4. Analog signal is converted to digital signal by analog-to-digital converter (ADC).

Step 5. Digital signal processor (DSP) adjusts quality of image and usually stores digital image on miniature mobile storage media in the camera.

Step 6. Images are transferred to a computer's hard disk by plugging one end of the cable into a camera and the other end into a computer; or images are copied to hard disk from storage media used in the camera.



- > Sharpness and clarity of image
- > The higher the resolution, the better the image quality, but the more expensive the camera
- Pixel (picture element)
 is single point in
 electronic image
 - Greater the number of pixels, the better the image quality





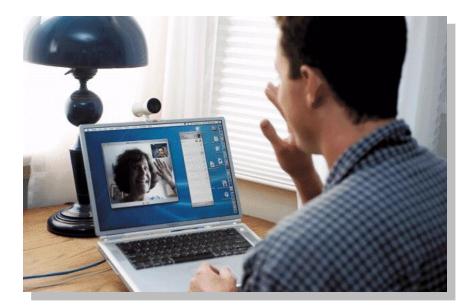
- Process of entering full-motion images into computer
- Video capture card is adapter card that converts analog video signal into digital signal that computer can use
- Digital video (DV)
 camera records video as digital signals



VIDEO INPUT

What are a PC video camera and a Web cam?

- PC video camera—DV camera used to capture video and still images, and to make video telephone calls on Internet
 - Also called PC camera
- Web cam—video camera whose output displays on a Web page



What is a scanner?

- Light-sensing device that reads printed text and graphics
 - Used for image processing, converting paper documents into electronic images





Pen or Handheld

Flatbed



Sheet-fed



Drum

SCANNERS AND READING DEVICES How does a flatbed scanner work?

Step 1. Document to be scanned is placed face down on the glass window.

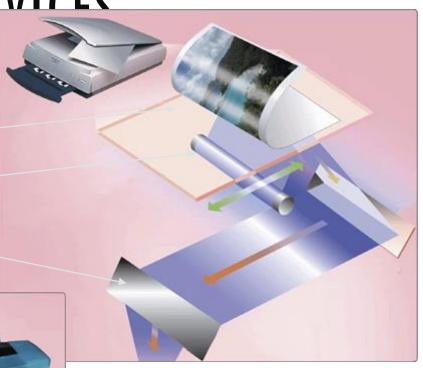
Step 2. Bright light moves underneath scanned document.

Step 3. Image of the document is reflected into a series of mirrors.

Step 4. Light is converted to analog electrical current that is converted to digital signal by an analog-to-digital converter (ADC).



Step 5. Digital information is sent to memory in the computer to be used by illustration, desktop publishing, or other software; or it is stored on disk.



Step 6. Users can print image, e-mail it, include it in a document, or place it on a Web page.

What is an optical reader?

- Device that uses light source to read characters, marks, and codes and then converts them into digital data
 - Optical character recognition (OCR) reads characters in OCR font
 - Optical mark recognition (OMR) reads hand-drawn pencil marks, such as small circles

```
ABCDEFGHIJKLM
NOPQRSTUVWXYZ
1234567890
-=∎;',./
```

What is a bar code reader?

> Uses laser beams to read bar codes





What is a magnetic-ink character recognition (MICR) reader?

- Can read text printed with magnetized ink
- Banking industry almost exclusively uses MICR for check processing

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BIOMETRIC INPUT

What is biometrics?

 Authenticates person's identity by verifying personal characteristic



- Fingerprint scanner captures curves and indentations of fingerprint
- Hand geometry system measures shape and size of person's hand



BIOMETRIC INPUT

What are examples of biometric technology?

- Voice verification system compares live speech with stored voice pattern
- Signature verification system recognizes shape of signature
- Iris recognition system reads patterns in blood vessels in back of eye
 - Biometric data is sometimes stored on smart card, which stores personal data on microprocessor embedded in card





Output Devices

- Display data after they have been processed.
- Cathode Ray Tube (CRT)
 - The most popular form of information output.
 - It works much like a television picture tube, with an electronic gun shooting a beam of electrons to illuminate the pixels on the screen.

Printers

- Produce a printed hard copy of information output.
- Include impact printers (dot-matrix printer), and non-impact printers (laser, inkjet, and thermal transfer printers).

Plotters

- To created high-quality graphics documents with multicolored pens to draw computer output.
- Slower than printers but are useful for outputting large-size charts, maps or drawing.

Voice output devices

Converts digital output data into intelligible speech.

Speakers

• To deliver an audio output such as music, that is connected to the computer.

WHAT IS OUTPUT?

- > Data that has been processed into a useful form,
 - **Output device** is any hardware component that can convey information to user







DISPLAY DEVICES

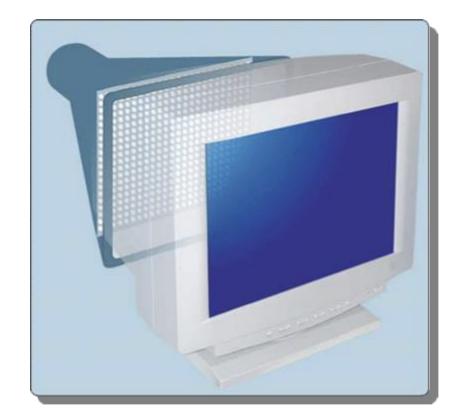
What is a display device?

- Output device that visually conveys information
 - Information on display device sometimes called soft copy
- Monitor houses display device as separate peripheral

CRT MONITORS

What is a CRT monitor?

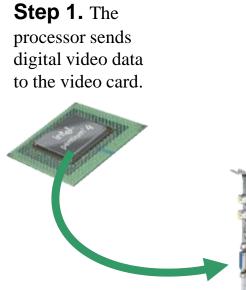
- Contains cathode-ray tube (CRT)
- Screen coated with tiny dots of phosphor material
 - Each dot consists of a red, blue, and green phosphor
- Common sizes are 15, 17, 19, 21, and 22 inches
 - Viewable size is diagonal measurement of actual viewing area



CRT MONITORS

How does video travel from the processor to a CRT monitor?

Video card (also called a graphics card) converts digital output from computer into analog video signal



Step 3. The analog signal is sent through a cable to the CRT monitor.



Step 2. The video card's digital-to-analog converter (DAC) converts the digital video data to an analog signal.

Step 5. Electron guns fire the three color signals to the front of the CRT.

Step 4. The CRT monitor separates the analog signal into red, green, and blue signals.

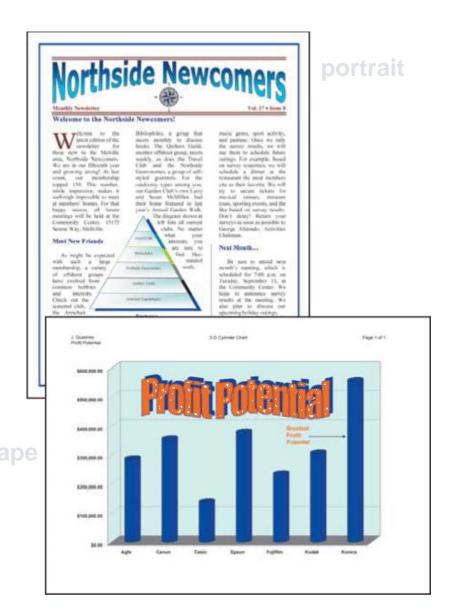


Step 6. An image is displayed on the screen when the electrons hit phosphor dots on the back of the screen.

PRINTERS

What is a printer?

- Output device that produces text and graphics on paper
- Result is hard copy, or printout
- Two orientations: portrait and landscape

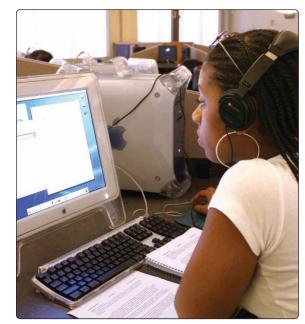


SPEAKERS AND HEADSETS

- Computer component that produces music, speech, or other sounds
- > Speakers and headsets are common devices



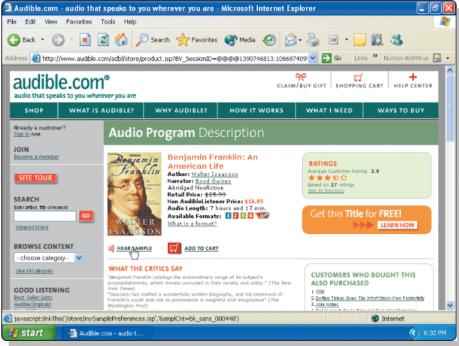
What is an audio output device?



SPEAKERS AND HEADSETS

What is voice output?

- > Computer talks to you through speakers on computer
- Internet telephony allows you to have conversation over Web
 Audible.com audio that speaks to you wherever you are Microsoft Internet Explorer



CATEGORIES OF COMPUTERS AND COMPUTER SYSTEMS

Computers are classified into two:

- A special-purpose computer
- A general-purpose computer

Special-Purpose Computers

- Is a computer designed for a particular function, executing the same stored set of instructions whenever requested.
- For example
 - microwave ovens
 - washing machine
 - medical diagnostic equipment

General-Purpose Computers

- Is a computer that can be used for solving many different types of problems.
- Available in many sizes and a wide range of capabilities.
- Can be classified as follows:
 - 1. Microcomputers
 - a. Laptop computers
 - b. Desktop computers
 - c. Workstations
 - 2. Minicomputers
 - 3. Mainframe computers
 - 4. Supercomputers

MICROCOMPUTERS

Sometimes referred to as a personal computer (PC), is one that can be placed on a desktop or carried from room to room.

The smallest microcomputers are known as laptop computers or notebook computers.

Desktop computers are compact microcomputer systems that fit on a desk and are designed for use by individuals.

A workstation is the largest type of microcomputer and is generally used in scientific and engineering applications.

MINICOMPUTERS

More powerful and more expensive than microcomputers.

Are smaller and cheaper compared to mainframes.

Also can be server, which is used for managing internal company networks or Web sites.

Server computers are specifically optimized to support a computer network enabling users to share files, software, peripheral devices (such as printers), or other network resources.

MAINFRAME COMPUTER

The largest computer, a powerhouse with massive memory and e extremely rapid processing power.

It is used for very large business, scientific or military application where a computer must handle massive amounts of data or many complicated processes.

SUPERCOMPUTER

Is highly sophisticated and powerful computer that is used for tasks requiring extremely rapid and complex calculations with hundreds of thousands of variable factors.

Used in many areas of scientific research, weather prediction, aircraft design, nuclear weapon and so on.

COMPUTER SOFTWARE

Application Software

- Refers to programs that are developed to solve some specific problems.
- There are two types of application software:
 - application program to solve special classes of problems
 - Application programs that you can write to solve your own problems.
- Examples of application software:
 - word processing
 - database programs
 - spreadsheets
 - graphic programs

System Software

- Refers to programs that make the computer usable and accessible to the developers and programmers of applications software.
- Examples of system software:
 - Operating systems
 - Language translator
 - Linker
 - Loader
 - Preprocessors

PROGRAMMING LANGUAGES

Programming Language is an agreed upon format of symbols that allow a programmer to instruct a computer to perform certain predefined tasks.

Provide features to support the data processing activities, which include declaring variables, evaluating numeric expressions, assigning values to variables, reading and writing data to devices, looping and making decisions.

a. Machine Languages

- Is the natural language of a computer.
- Does not need to translate and is ready for immediate execution.
- Machine language instruction is a binary string of 0s and 1s.
 - 010 1 1000 0001 0000 1100 0000 0001 0000
- Are machine-dependent each computer type has its own machine language.
- Programs written in machine languages are not portable because programs written in for one type of computer cannot be run on another type

Assembly Languages

- Consists of English-like abbreviations.
- Easier to understand.
 - L 1, GROSSPAY
 - S 1, TAX
 - ST 1, NETPAY
- Program written in assembly languages cannot be directly processed by a computer.
- Must use language translators, called assemblers, to convert them to machine code.
- Disadvantages:
 - In general, each assembly language instruction corresponds to one machine language instruction. Therefore, the programs written in them are lengthy.
- Because of variations in assembly languages, programs written using them are not portable.

High-Level languages

- Instructions are quite English-like, and a single instruction can be written to correspond to many operations at the machine level.
- For example, the assembly language program can be written in highlevel languages as follows:
 - Netpay = gross pay tax
- Are easier to learn than machine or assembly languages.
- Have to be converted to machine languages before they can be executed using compilers, system software that translates a source program into an almost executable object program

For example:

- COBOL developed in the 1960s for business transactions.
- FORTRAN developed for mathematic calculations.
- Pascal is a structured high-level language.
- C is designed to support only procedure-oriented programming. Popular language for developing system applications such as operating system and compilers.
- Java is an object-oriented language.
- C++ is extension of C programming language that support object oriented programming and procedure-oriented approach.