

CHAPTER 3

COMPUTER SYSTEM

What is a System?

- A System is a set of interrelated and interdependent components that work together to accomplish common goal
- The components of the system are called subsystems.
- A subsystem is a set of elements, which is a system itself, and a component of a larger system.
- E.g. Bank System, Ecosystem, **information systems**, Biological system, Judiciary system

THE COMPUTER SYSTEM

- The computer system is a group of components, consisting of subsystems or procedures that work in a coordination fashion to achieve some objective.
- A computer system composed of components that are classified as *Computer hardware* and *Computer software*.

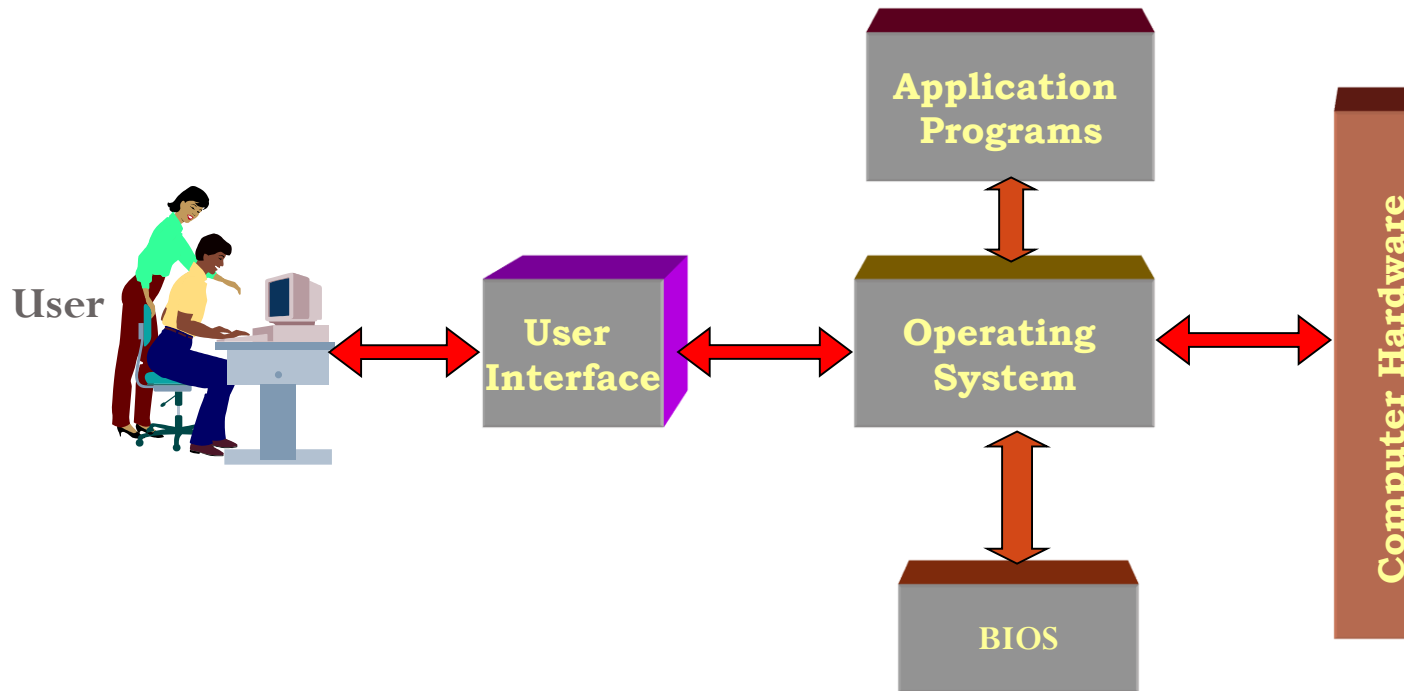
Hardware

- Hardware components are the physical that we can see , touch and directly interact with.
 - accept data & instructions from a user through **input device**
 - store the data and instructions on **storage unit**
 - manipulate the data according to the instructions using **processing unit**
 - store and/or output the results to the user by using **output device**

Software

- Program is a collection of computer instructions that tell the computer how to work
- a sequence of instructions to accomplish a result
- a computer processes information under the direction of a program

Hardware and Software Relationships



Computer Hardware

- The hardware part of a computer system is composed of a number of interacting physical parts based on the need of the information flow.
- Basic Computer Hardware:
 - System Unit
 - Monitor
 - Mouse
 - Keyboard
- Peripheral Devices
 - Printer/Plotter
 - Speaker
 - Scanner

Computer Hardware

- Computers hardware is organized from four basic functional units such as:
 - i. Input units
 - ii. Output units
 - iii. CPU (processing unit)
 - iv. Storage units
 - v. Communication Device (optional)

Computer Hardware



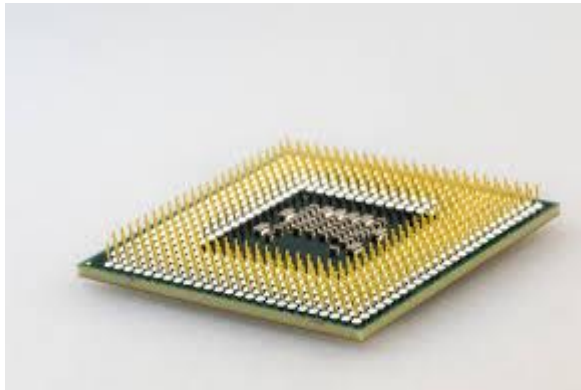
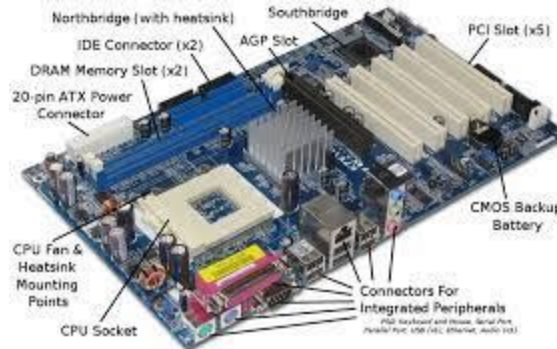
Components of Computer Hardware

- **System Unit:** - Houses all the major components of the computer
- **Motherboard:** - a board into which most of the basic components of the computer are built. It contains components such as **CPU, Expansion slot, RAM** and so on.
- **Expansion cards:** are small circuit boards that are used to upgrade a computer.
- **Expansion slot:** user to plug in expansion cards

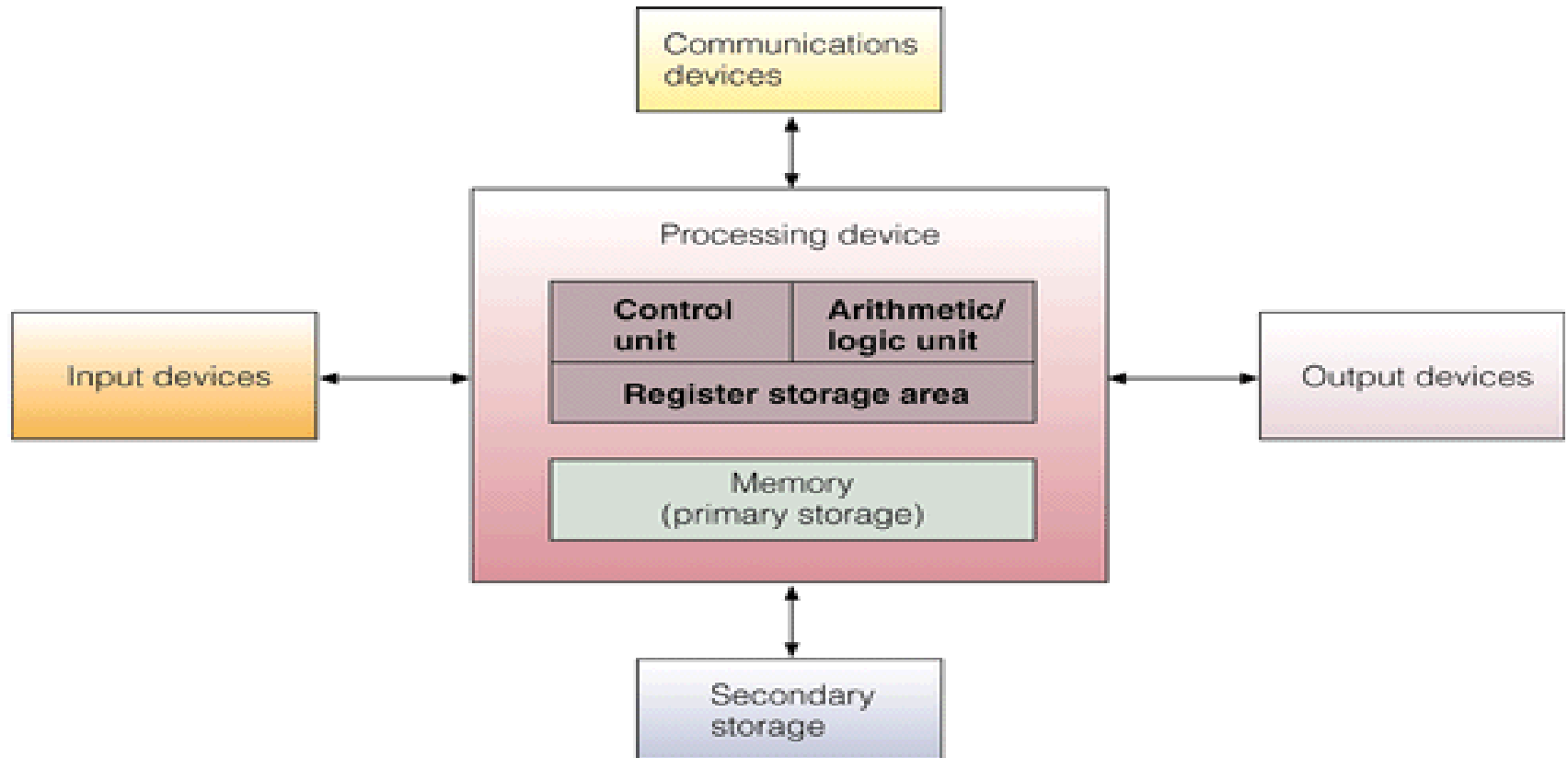
Components of Computer Hardware

- **CPU:** - central element in the system which is the brain of the computer. Connected number of peripheral devices to get data into and out of the computer and to store data and program.
- **RAM:** - a computer chip that temporarily store dynamic data to enhance computer performance while you are working.
- **Power Supply:** - converts alternating current (AC) into direct current (DC) electricity that can be used by computer. Also lowers voltage level.
- **Hard disk drive (HDD):**- is a non-volatile computer storage device containing magnetic disks or platters rotating at high speeds
- **CD/DVD drive:**

Components of Computer Hardware



Computer System Component



Input Devices/Unit

- It is the unit used to enter data into the computer so that it can be processed.
- It converts information from a form suitable to human beings to one understandable by the computer.
- Common Input Devices are:



Input Devices

- Keyboard
- Mouse
- Joystick
- Scanner
- Microphone
- Bar code reader
- OCR (Optical Character Recognition)
- OMR (Optical Mark Recognition)
- MICR (Magnetic Ink Character Recognition)
- Web Camera
- Light Pen

Input Devices for Data

- **Keyboards** – most frequently input devices for notebooks and desktops to enter information and commands
- **Stylus** – most frequently used input devices for *PDA*s (*Personal digital assistant*) and tablet PCs to enter information and commands



Input Devices for Commands

- *Pointing Device* – used to input commands
 - *Mouse* – device you use to click on icons and buttons
 - *Trackball* – similar to a mechanical mouse, but with the ball on top



Input Devices for Commands

- *Touchpad* – dark rectangle you use to move the cursor with your finger
- *Pointing stick* – a little rod, used mostly on notebooks



Game Controllers

- *Game controller* – used for gaming to control screen action
- *Gaming wheel* – steering wheel and foot pedals for virtual driving



Scanners

- *Scanners* – used to convert information that exists in visible form into electronic form (Hardcopy to Softcopy)
 - *Image scanner* – captures images, photos, text, and artwork
 - *Bar code scanner (BCS)* – reads information in the form of vertical bars
 - *Optical mark reader(OMR)* – detects the presence or absence of a mark
 - *Optical character reader(OCR)* – reads characters that appear on paper or sales tag
 - *Biometric scanner* – scans a human physical attribute, like a fingerprint or iris, for security purposes

Scanners



Barcode



Biometric Scanner



Image Scanner



OMR



OCR

Digital Cameras

- *Digital camera* – captures still image or video as a series of 1s and 0s
 - *Digital still camera* – digitally captures still images in varying resolutions
 - *Digital video camera* – captures video digitally
 - *Webcam* – captures digital video for the Web



Microphone

- Allows the user to record sounds as input to their computer



Touch screen

- **Touch screen:** A transparent, pressure-sensitive covering that is attached to the screen of the monitor
- Users make selections and control programs by pressing onto the screen



OUTPUT Devices

- Used to get data out of a computer so that it can be examined, analyzed or distributed to others.
- Convert the result of the only-machine understandable form to a form understandable by human beings.
 - Monitor (LED, LCD, CRT)
 - Printer
 - Plotter
 - Speaker
 - Projector
 - Headphone

Monitors

- A display screen to provide “output” to the user
- It is where you view the information your are working on (LCD or CRT)
- *CRT* (*cathode ray tube*)— monitors that look like traditional TV sets
- *Flat-panel display* – thin, lightweight monitors that take up much less space than CRT.

LCD



CRT



Monitors

- Types of flat-panel displays
 - *Liquid crystal display (LCD) monitor* – sends electricity through crystallized liquid between layers of glass or plastic
 - *Gas plasma display (GPM)*– sends electricity through gas trapped between layers of glass or plastic
 - **Light-Emitting Diode (LED) Monitor.** LED computer **monitors** do not use cold-cathode technology and fluorescent technology. Instead, light diodes illuminate the screen in one of two different ways, or a combination of both.

Printers

- An output device that produces a hard copy on paper
- printer is a device that accepts text and graphic output from a computer and transfers the information to paper, usually to standard size sheets of paper.
- Printers vary in size, speed, sophistication, and cost.

Printers

- *Resolution of a printer* – the number of dots per square inch (dpi) it produces
- Types of Printers
 - *Inkjet printer* – makes images by forcing ink through nozzles
 - *Laser printer* – forms images using the same electrostatic process that photocopiers use
 - *Multifunction printer* – scan, copy, and fax, as well as print



Plotter

- A plotter is a printer that interprets commands from a computer to make line drawings on paper with one or more automated pens
- Unlike a regular printer, the plotter can draw continuous point-to-point lines directly from graphics



Speaker

- Used to generate or reproduce voice, music, and other sounds



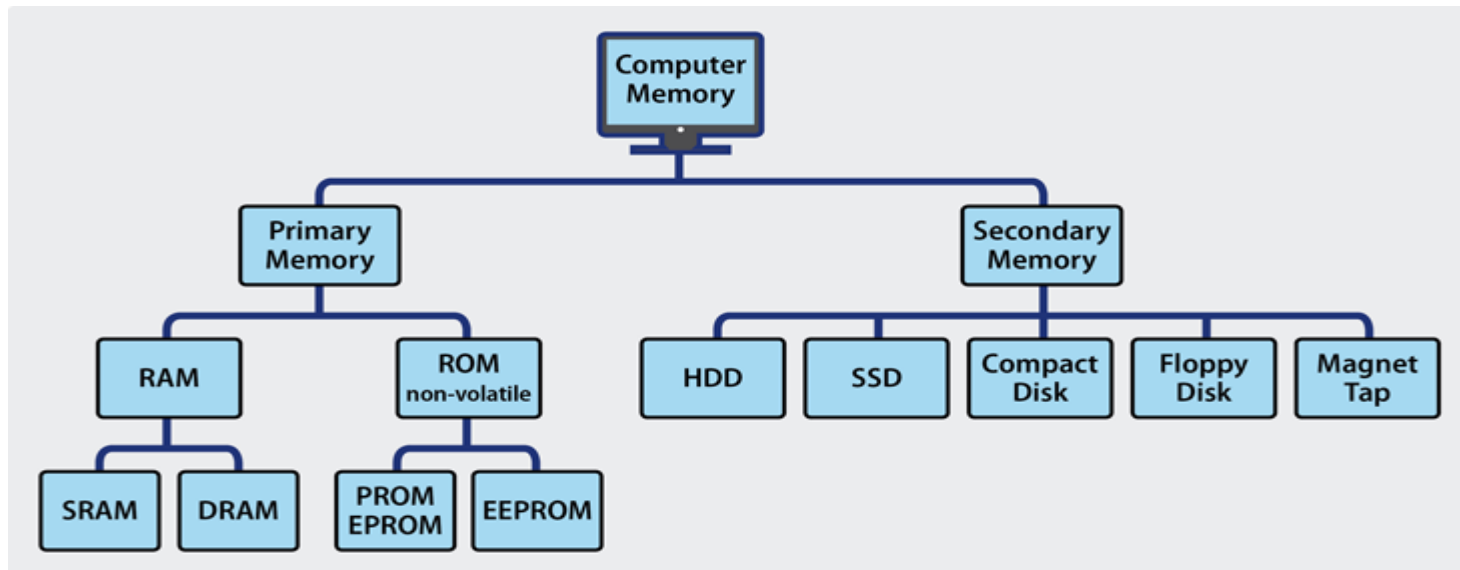
Projector

- **Projector** is used to project for displaying video, images or computer data on a screen or other flat surface
- It is a modern equivalent of the slide projector or overhead projector
- To display images, LCD projectors



MEMORY SYSTEM IN A COMPUTER

- A personal computer must have a means of storing information and instructions so that it can perform processing tasks on the data.
 - **Primary/main Memory**
 - **Secondary/Auxiliary Memory**



Main Memory/Primary Memory

RAM-Random Access Memory

- referred to as random access memory (RAM) because it is possible to randomly select and use any location of the memory directly store and retrieve data.
- The storage of **data** and instructions inside the primary storage is temporary.
- It disappears from RAM as soon as the power to the computer is switched off.
- The memories which lose their content on failure of power supply are known as **volatile** memories .
- RAM is volatile memory that temporarily stores the files you are working on.

Main Memory or Primary Memory

- Holds instructions and data elements which are currently being used by the computer.
- It is the memory which is directly accessible by the control unit and ALU.



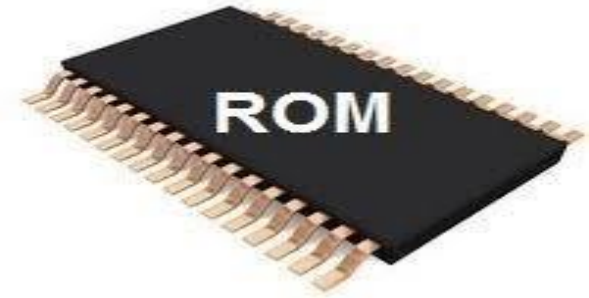
ROM - Read only memory

- ROM is integrated into the circuitry of the computer and can not be altered without altering the computer circuitry.
- The memories, which do not lose their content on failure of power supply, are known as **non-volatile** memories.
- ROM is non-volatile memory.
- The storage of **program** and instructions in the ROM is permanent.
- The ROM stores some standard processing programs supplied by the manufacturers (BIOS) to operate the personal computer.
- The ROM can only be read by the CPU but it cannot be changed.
- The basic input/output program is stored in the ROM that examines and initializes various equipment attached to the PC when the switch is made ON.

ROM

- ROM provides startup instructions when the computer is turned on.
- You can not store any data in ROM.
- The instructions in ROM are set by the manufacturer and cannot be changed by the user.
- ROM is non-volatile memory that permanently stores instructions for your computer.
- Every computer needs an operating system.
- This is a special computer program that must be loaded into memory as soon as the computer is turned on.

- ROM is Pre-programmed and now technology allows



- PROM: programmable ROM
 - Only written once
- EPROM: erasable PROM
 - Use ultraviolet light to erase data
- EEPROM: electronically EPROM
 - Can be erased using electronic impulses (higher voltages)

SECONDARY STORAGE DEVICE/SSD

- A secondary storage device refers to any non-volatile storage device that is internal or external to the computer. It can be any storage device beyond the primary storage that enables permanent data storage
- Alternatively referred to as external memory, secondary memory, and auxiliary storage, a secondary storage device is a non-volatile device that holds data until it is deleted or overwritten

Secondary Storage Device

- Most widely used secondary storage devices are magnetic tapes and magnetic disk.
- Storage devices hold data, even when the computer is turned off.
- Data can be accessed in **Direct** or **Sequential** way.

Data Access Methods

The way the device allows access to the data stored on it.

- Sequential Access Method
 - Data is stored sequentially
 - Search for data is slow
 - Used with magnetic tape, Punched cards
- Direct/Random Access Method
 - Where a reading device can directly go to the data
 - Search for data is faster

Random Processing Medias

✓ Magnetic Disk

- Hard Disk
- Floppy Disk
- Zip disk

✓ Optical Storage Media

- CD
- DVD
- Blu-ray

✓ Flash Memory media

- Flash Memory Drive
- Flash Memory cards

Magnetic Tape

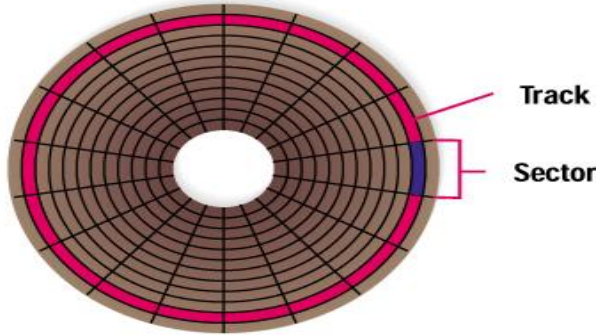
- Magnetic Tape is a recording medium that used for recording analogue or digital data.
- The capacity of tape media are generally on the same order as hard disk drives (The largest being about 5 Terabytes in 2011).
- Magnetic Tapes generally transfer data a bit slower than hard drives, however magnetic tapes are cheaper and are more durable.



Hard Disk

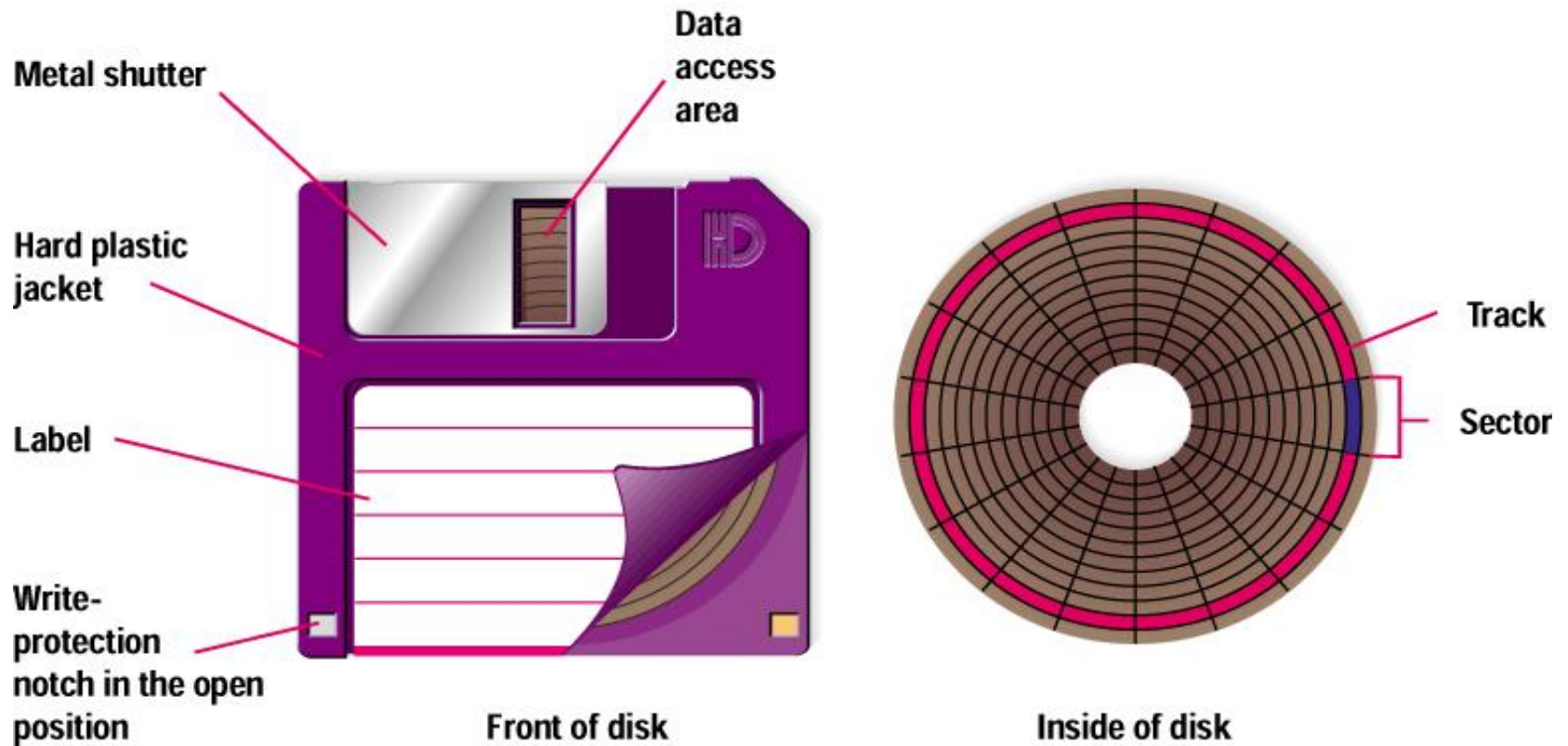
- Hard disk is a magnetic storage with one or more thin metal platters sealed inside the drive
- The hard disk drive is the main, the largest and the fastest data storage device in a computer.
- It is a non-volatile, random access digital magnetic data storage device.
- Largest storage capacity, approximately the same as Magnetic Tapes.
- Hard drives can be used internally and externally in a computer system.

- A Hard Disk is divided into tracks and sectors.
- Data on this hard disk is positioned into these tracks and sectors



Floppy Disk

Floppy disk – removable storage medium that holds 1.44 MB



Zip disk

- *Zip disk* – high capacity (100 MB, 250 MB, and 750 MB) removable storage medium



Optical/Laser Disks

- *Optical storage media* – plastic discs on which information is stored, deleted, and changed using laser technology
- Optical disk is an electronic data storage medium from which data is read and written to by using a low-powered laser beam.
- There are three basic types of optical disks:
 - Read-only
 - Write once read many
 - Rewritable
- Three main types of optical disks are:
 - CD
 - DVD
 - Blu-ray



CD-Compact Disk

- A standard data storage capacity up to 700 MB of data, or about 70 minutes of audio.
- There are three types of CD:
 - CD-ROM (CD-Read Only Memory)
 - These disk can only be read
 - CD-R
 - CD-Recordable of the type of **W**rite **O**nce **R**ead **M**any times(WORM)
 - CD-RW
 - CD-Rewritable, these disks can be erased and rewritten at any time.

DVD-Digital Versatile/Video Disk

- An optical disc storage media format that can be used for data storage.
- The DVD supports disks with capacities of 4.7 GB to 17 GB.
- There are three types of DVD's:
 - DVD-ROM
 - DVD-Read Only Memory and they function the same way Read Only Memory Does
 - DVD-R
 - DVD-Recordable of the type of Write Once Read Many times (WORM)
 - DVD-RW
 - DVD-Rewritable, these disks can be erased and rewritten at any time.



Blu-ray

- New standard in storage
- Blu-Ray
 - New disks use **blue laser light** instead of the **red laser light** used in traditional CD/DVD players
 - Disks may ultimately hold
 - Over 30GB on one-sided disks
 - Over 50GB on two-sided disks



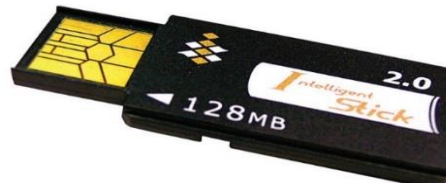
Flash Drive/USB

- A flash drive is a small external storage device, typically the size of a human thumb that consists of flash memory.
- USB flash drives are removable and rewritable reads and writes to flash memory.
- They are inexpensive and durable.
 - USB Flash drives vary in sizes from 8 Megabytes to 512 Gigabytes. More commonly used sizes vary from 2 Gigabytes -64 Gigabytes.



Flash Memory cards

- Flash memory is an EEPROM non-volatile computer storage chip. These Memory cards currently vary in sizes between 1GB -32GB



Storage Capacity

- Byte – The amount of space in memory or on a disk needed to store one character.
 - 0 or 1=bit
 - 8 bits = 1 Byte
 - Kilobyte= 10^3 bytes=1000 bytes
 - Megabyte= 10^6 bytes
 - Gigabyte= 10^9 bytes
 - Terabyte= 10^{12} bytes
 - Petabyte= 10^{15} bytes
 - Exabyte= 10^{18} bytes
 - Zettabyte=
 - Yottabyte=

Central Processing Unit (CPU)

- CPU is the brain of any computer system. It makes all sorts of calculations and directs different parts of the computer functions by activating and controlling the operations.
- The task of performing operations like arithmetic and logical operations is called processing.
- CPU takes data and instructions from the storage unit and makes all sorts of calculations based on the instructions given and the type of data provided. It is then sent back to the storage unit

CPU-Central Processing Unit

- CPU is the most important component of the computer system
- Consists of the Control Unit & Arithmetic Logic Unit
- The two parts work together to electronically control the function of the computer.
- The different parts of the CPU are inter connected by a cable like device called **BUS**, which is used to facilitate communications between the parts. Buses are used to transfer data, address and control code (signal).

Central processing unit (CPU)

Consists of Three components

- ALU-Arithmetic logic unit
- CU-Control unit
- Register



ALU-Arithmetic Logic Unit

- After you enter data through the input device it is stored in the primary storage unit (RAM).
- Data is transferred to ALU from storage unit when required.
- After processing the output is returned back to storage unit for further processing or getting stored.
- The actual processing of the data and instruction are performed by Arithmetic Logical Unit.

ALU- Arithmetic Logic Unit

- The major operations performed by the ALU are addition, subtraction, multiplication, division, logic and comparison.
 - Arithmetic logic unit
 - Arithmetic Unit
 - Performs mathematical calculations
 - Addition, Subtraction, Division.....
 - $1+2*3-4^2/2$
 - Logic Unit
 - logical comparisons.
 - Is used to make a decision on the logical operation
 - AND,OR,>,<,>=,<=,==,! =

Control Unit (CU)

- CU performs all the control functions of the computer.
- The control unit determines the sequence in which computer programs and instructions are executed.
- CU coordinates the activities of input/output devices
- Therefore it is the manager of all computer operations
- The CU directs the operation of the memory, ALU and input and output devices how to respond to the instructions that have been sent to the processor

Machine Cycle

- The steps performed by the computer processor (CPU) for each machine language instruction received.
- The machine cycle is a 4 process cycle that includes reading and interpreting the machine language, executing the code and then storing that code

Instruction phase

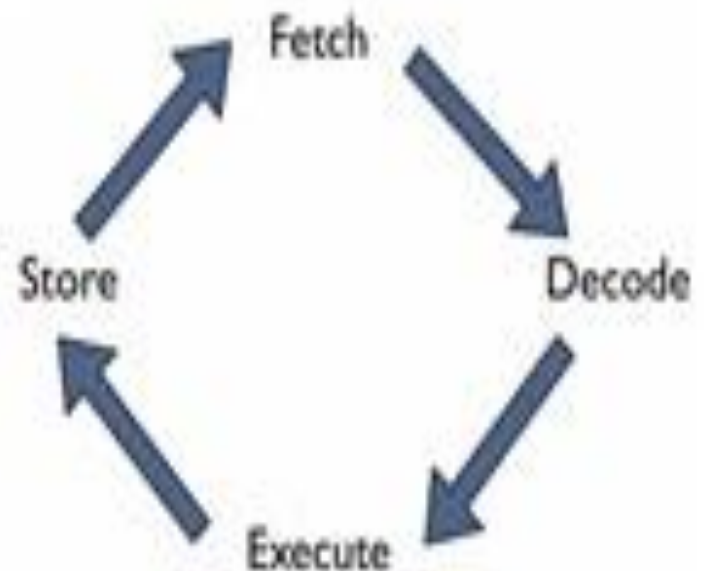
Step 1: Fetch instruction

Step 2: Decode instruction

Execution phase

Step 3: Execute the instruction

Step 4: Store the results



- **In the Instruction phase**

- ✓ The computer's CU fetches the instruction to be executed from main memory (RAM).
- ✓ Then the instruction is decoded/interpreted by the CU so the central processor unit can understand what is to be done.

- **In the Execution phase**

- ✓ The ALU does what it is instructed to do.
- ✓ Then the results are stored in the registers/memory.

- The Instruction and Execution phases together make up one machine cycle.

Word length

- Data is moved within a computer system in units called **bits**, which is a binary digit (0 or 1)
- **The number of bits the CPU can process at one time**, or the word length of the CPU is factor affecting overall system performance.
 - CPUs have evolved to 8, 16, 32, and 64 bits
- Bits (**Binary Digits**): smallest form of data in a computer
 - Bits, can be “0” or “1”, “true” or “false”, “yes” or “no”, or “on” or “off”.
- Word: number of bits that can be processed as a unit

Measuring the speed of CPU

- Hertz or per second is used as unit to measure the processing capability of CPU.
 - Kilo = KHz ~ 1000Hz
 - Mega = MHz = 10^6 Hz
 - Giga = GHz
 - Terra = THz
 - Peta = PHz

Computer Software

- The finite set of instructions (steps) that the computer follow to perform a given job is called a software (*program*).
- The software give precise instructions to the hardware in order to solve problem. Software and Hardware have to work together to produce meaningful result.
- Software makes the interface between the user and the computer hardware.
- Any program to be executed first, it should loaded in the main memory (ROM).
- The process of software development is called *programming*.

TYPES SOFTWARE

- System Software
- Application Software

Application Software

- Application software is software developed to do **user specific tasks** such as word processing, spreadsheet and database management.
- **Application software** (app for short) is **software** designed to perform a group of coordinated functions, tasks, or activities for the benefit of the user.
- It is developed using the programming language

Examples of Application Software

- Microsoft word, MS-Access, Microsoft Excel
- Auto CAD
- Media Players
- Peachtree
- Animation and 3D Graphics
- Website Creation and Management
- Financial Management
- Internet browsers
- Video Editing
- Educational Games and Tutorials

System software

- The system software handles the computer hardware so that the user can operate the computer with little knowledge about the computer hardware.
- The system software checks the free space of the hard disk before copying files
- It Constitutes those programs which facilitates the work of the computer hardware.
- It organizes and manages the machine's resources, handles the input/output devices.

System software

- It controls the hardware by performing functions that users shouldn't have to or are unable to handle.
- System programs make complex hardware more user friendly.
- It acts as intermediate between the user and the hardware.
- It enables the computer understand programming languages i.e. it serves as means of communication between user and a computer.

Types of System software

- Operating system
- Language software
- Utilities

Operating system (OS)

- An operating system is a program that acts as the link between you, the computer's software and hardware resources.
- OS is the foundation software onto which all other application programs are loaded.
- OS is the master program of your system that allows you to run application programs.

Operating system

- Operating System software manages most of your computer's activities, including the allocation of computer resources, maintenance of files, and running of application software.
- The first segment of the operating system software is contained in the ROM of your computer. This software tests the internal components and circuitry of the computer when it is turned on.

Types of OS

- Windows Operating System
 - Most popular operating system.
 - Supports a vast array of application software and peripheral devices.
- Example of MS OS
- MS-DOS (Disc Operating System)
 - MS-DOS 1.x
 - MS-DOS 2.x – Support for 10 MB hard disk drives
 - MS-DOS 3.x
 - MS-DOS 4.0 (multitasking) and MS-DOS 4.1

Microsoft Windows operating system

- Windows 1.0 (1985)
- Windows 2.0 (1987)
- Windows 3.x (1990, 1992)
- Windows 95 (1995)
- Windows 98 (1998)
- Windows 2000 (2000)
- Windows ME (2000)
- Windows XP (2001)
- Windows Vista (2006)
- Windows 7 (2009)
- Windows 8 (2012)
- Windows 8.1 (2013)
- Windows 10 (2015)
- Windows 10 (Anniversary Update)(2016)

Linux OS

- Developed by Linus Torvalds in 1991
- Open-source product
- Only the kernel of an OS
- Several distributions available with capabilities/applications that form a complete OS

Examples:

- Caldera
- OPENSUSE
- MINT
- UBUNTU
- FEDORA
- Slackware
- RedHat Linux
- CentOS
- Debian

Mac OS

- For Macintosh computers.
- Proprietary system.
- Mac OS X
 - Jaguar (OS X.2)
 - Panther (OS X.3)
 - Tiger (OS X.4)
 - Yosemite
 - Mavericks
 - Mountain Lion
 - Lion
 - Snow Leopard



Function of Operating system

An operating system has the following functions

- ✓ Coordinates, or supervises the activity of the computer system.
- ✓ Decides where programs and data should be stored in the computer memory.
- ✓ Handles communications among the computer components, applications software and the user.
- ✓ Controls the saving and retrieving of files to and from disks in the disk drive.
- ✓ It performs all its controlling tasks without the involvement or awareness of the user.
- ✓ Handles the process of preparing a disk for use, the copying, renaming, erasing task of a file.

Utilities

- Help to perform maintenance or correct problems with a computer system
- Utilities includes device drivers and Troubleshooting capabilities.
- Utilities provide file management capabilities such as copying, moving or renaming a file.
- Norton Utilities includes an undelete function that can recover deleted files.
- Virus-detection and recovery utilities
- Spam and pop-up blocker utilities
- Network and Internet utilities

Programming Language (Language Software)

- Language software are used by programmers to develop application software and translate programs to machine code.
- Basic building blocks of any software.
- Programming languages allow a programmer to write instructions that a computer can understand.
- Language software is a generic name consisting of various programs that serve as editors & translators to develop programs in a number of programming languages.

Language Software (Programming Languages)

Programming languages

- Machine language
- Assembly language
- High level language

Machine Language (Low-level language)

- A computer's machine language consists of strings of binary numbers and is the only language that the CPU directly understands.
- Machine language uses machine codes (strings of binary digits) to write computer programs. Early computer programs were written using machine language.
- Each instruction tells the CPU what to do, the length, and location of the data fields that are involved in the operation
- Typical operation involve reading, adding, subtracting, writing.

Assembly Language (low level language)

- Assembly language is a bit higher than machine language, but it is still 'low' in the sense that the programmer must spend some time thinking of the instructions that the particular computer can execute, rather than spending all his time in solving the problem.
- This language lies between high-level languages and machine languages

High Level Programming Language

- It is human Oriented Language because it is more related with human language. It is machine independent. A programmer may not be needed to know the details of the internal logical structure of a computer.
- It is block structured that composed of blocks starting with BEGIN and terminating with END. It can be used for scientific and file processing applications.
- The high level programming languages are **problem oriented** unlike the machine language, which is **machine oriented** programming language.

Language Software Translators

- **Translator**:-is a program that converts one or more languages to another language. The three types of translators are **assemblers**, **Compilers** and interpreters.
 1. **Assemblers**:- is a program that translates assembly languages into machine code.
 2. **Compiler**:-is a program that translates a high level language into machine code. (PASCAL, FORTRAN, COBOL)
 3. **Interpreter**:- is a program that translates each instruction of high level language & executes the instruction before translating the next instruction

Summary

- Computer system: combination of hardware and software
- Computer hardware: input devices, central processing unit, storage devices, and output devices
 - Input devices
 - Keyboard based
 - Optical and audio
 - Graphical
 - CPU: ALU, CU, and Register
 - Storage devices: primary and secondary
 - Primary: RAM, ROM
 - Secondary: hard disk, magnetic tape, CD, DVD, blue-ray, ... (Magnetic and optical)
 - Output devices: monitor, scanner, plotter (Graphical, textual (soft and hard copy))
- Computer software: system software and application software
 - System software: operating system such as windows, UNIX, ... and utility software (diagnostic tools) such as antivirus
 - Operating system is the soul of the computer, and a computer without operating system is dead
 - Application software: word, excel, PowerPoint, CAD, ... are installed on top of the operating system;
 - Application software are task specific