

CSM 183

**INTRODUCTION TO
COMPUTERS**

Introduction

- ❖ A computer is an electronic machine that accepts data from the user, processes the data by performing calculations and operations on it, and generates the desired output results.
- ❖ Computer performs both simple and complex operations, with speed and accuracy.

Computer

- ▶ A computer is an electronic device that manipulates information or "data." It has the ability to store, retrieve, and process data.
- ▶ We may therefore define a computer as an *electronic device that is programmable to perform specialized tasks and equipped with an*
 - ❖ *Input Device*
 - ❖ *Output Device*
 - ❖ *Central Processing Unit or Microprocessor*
 - ❖ *Storage Device*

What Is a Computer?

- Again, A computer may also be defined as:
 - **Any electronic device operating under the control of instructions stored in its own memory**

Accepts data

Raw facts, figures, and symbols

Processes data into **information**

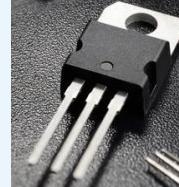
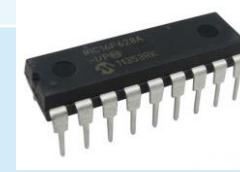
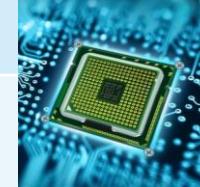
Data that is organized, meaningful, and useful

Produces and stores results

Generations of Computers

- ▶ The evolution of computer to the current state is defined in terms of the generations of computer.
- ▶ Each generation of computer is designed based on a new technological development, resulting in better, cheaper and smaller computers that are more powerful, faster and efficient than their predecessors.
- ▶ Currently, there are five generations of computer

Generations of Computers

Generation	Date	Main material used	Picture of material
First Generation	(1940 To 1955)	Vacuum Tubes	
Second Generation	(1954 To 1962)	Transistors	
Third Generation	(1963 To 1972)	Integrated Circuits	 
Fourth Generation	(1972 To 1984)	Microprocessors	
Fifth Generation	(Present And Beyond)	Artificial Intelligence	

Classification Of Computers

Computer can be classified based on three main categories.

- Classification based on data representation
- Classification based on area of application/purpose
- Classification based on size, processing power, storage capacity etc.

Classification Based Data Representation

A. Digital Computer

A digital computer uses distinct values to represent the data internally. All information are represented using the digits 0s and 1s. All quantities are expressed as discrete form.

B. Analog computer

Analog computer is another kind of a computer that represents data as variable across a continuous range of value.

Analog computers may be more flexible but generally less precise than digital computers.

Continued...

c. Hybrid Computers

Are computers that exhibit features of analog computer and digital computers. The digital component normally serves as the controller and provides logical operations, while the analog component normally serves as a solver of differential equations.

Classification Based On Purpose

A. Special Purpose Computers

A special purpose computer is designed only to meet the requirements of a particular task or application. The instructions needed to perform a particular task are permanently stored into the internal memory, so that it can perform the given task on a single command.

Classification Based On Purpose

B. General Purpose Computers

General Purpose computers are designed to meet the needs of many different applications. In these computers, the instructions needed to perform a particular task are wired permanently into the internal memory.

Classification Based On Size, Processing Power, Storage Capacity.

A. Supercomputer

- ▶ Supercomputers are the fastest and the most expensive machines. They have high processing speed compared to other computers. The speed of a supercomputer is generally measured in FLOPS (Floating point Operations Per Second).
- ▶ Supercomputers are used for highly calculation-intensive tasks, such as, weather forecasting, climate research etc.

Example: IBM Deep Blue

B. Mainframe computers

- Are multi-user, multi-programming and high performance computers.
- They operate at a very high speed, have very large storage capacity and can handle the workload of many users.
- The user accesses the mainframe computer via a terminal.
- A dumb terminal cannot store data or do processing of its own. It has the input and output device only.
- An intelligent terminal has the input and output device, can do processing, but, cannot store data of its own. Examples of mainframes are CDC 5500 and IBM ES000 series.

C. Minicomputers

Minicomputers are digital computers, generally used in multi-user systems.

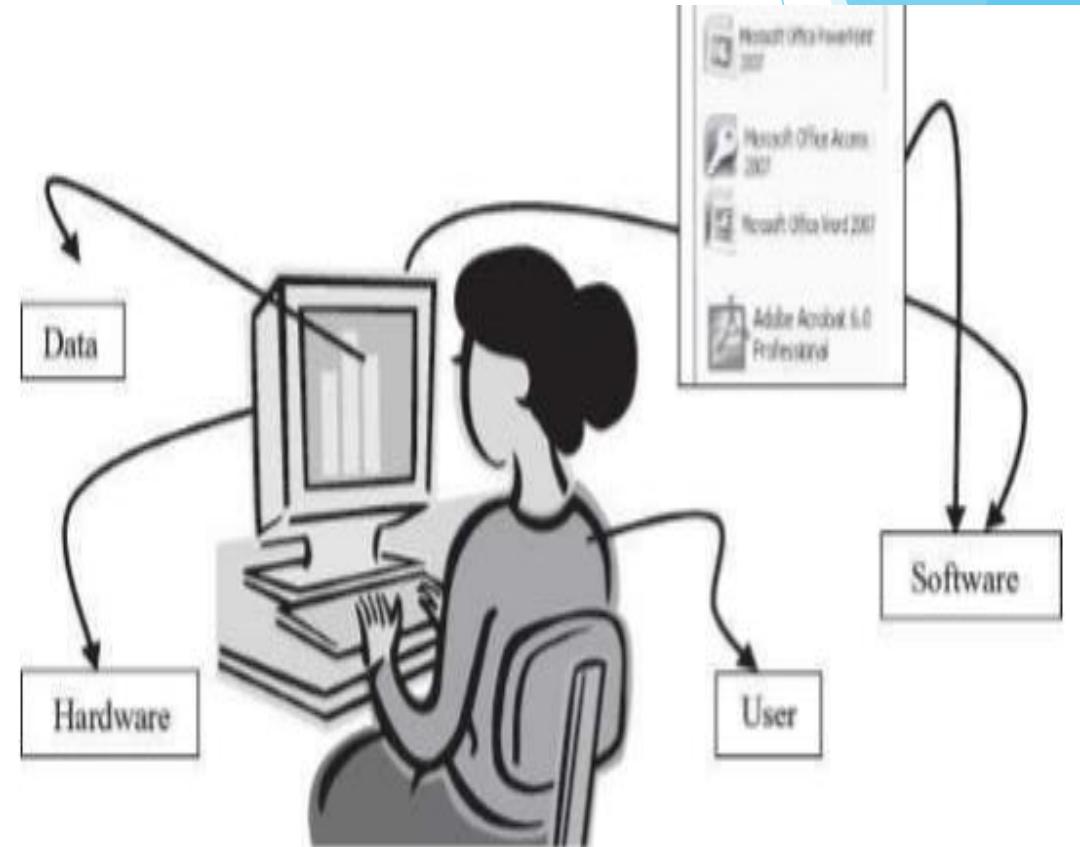
- They have high processing speed and high storage capacity than the microcomputers. Minicomputers can support 4-200 users simultaneously.
- The users can access the minicomputer through their PCs or terminal. They are used for real-time applications in industries, research centers, etc. **PDP 11, IBM (8000 series)** are some of the widely used minicomputers.

D. Microcomputers

- Microcomputers are small, low-cost and single-user digital computer.
- They consist of CPU, input unit, output unit, storage unit and the software. Although microcomputers are stand-alone machines, they can be connected together to create a network of computers that can serve more than one user.
- Examples are desktop computers, notebook computers **Examples of microcomputers** or laptop, tablet computer, handheld computer, smart phones etc.

The Computer System

- ▶ The computer system consists of four parts:
 - a. **Hardware**
 - b. **Software**
 - c. **Data**
 - d. **Users**



Hardware

- ▶ The hardware consists of physical devices of the computer.
- ▶ The devices are required for input, output, storage and processing of the data.
- ▶ **Keyboard, monitor, hard disk drive, floppy disk drive, printer, processor and motherboard** are some of the hardware devices.

Software

- ▶ A set of programs and documents are collectively called software.
- ▶ Software is a set of instructions that tells the computer about the tasks to be performed and how these tasks are to be performed.
- ▶ **Program** is a set of instructions, written in a language understood by the computer, to perform a specific task.

Data

- ▶ Data **are isolated values or raw facts**, which by themselves have no much significance.
- ▶ **Example:** the data ‘29, January, and 1994’ just represent values.
- ▶ The data is provided as input to the computer, which is processed to generate some meaningful information. **For example:** 29, January and 1994 are processed by the computer to give the date of birth of a person.

Users

- ▶ People who write computer programs or interact with the computer.
- ▶ They are also known as liveware, humanware or peopleware

The Input-Process-Output Concept

► Input

The computer accepts input data from the user via an input device like keyboard. The input data can be characters, word, text, sound, images, document, etc.

► Process

It performs some actions on the data by using the instructions or program given by the user of the data.

The action could be an arithmetic or logic calculation, editing, modifying a document, etc.

During processing, the data, instructions and the output are stored temporarily in the computer's main memory.

The Input-Process-Output Concept

► Output

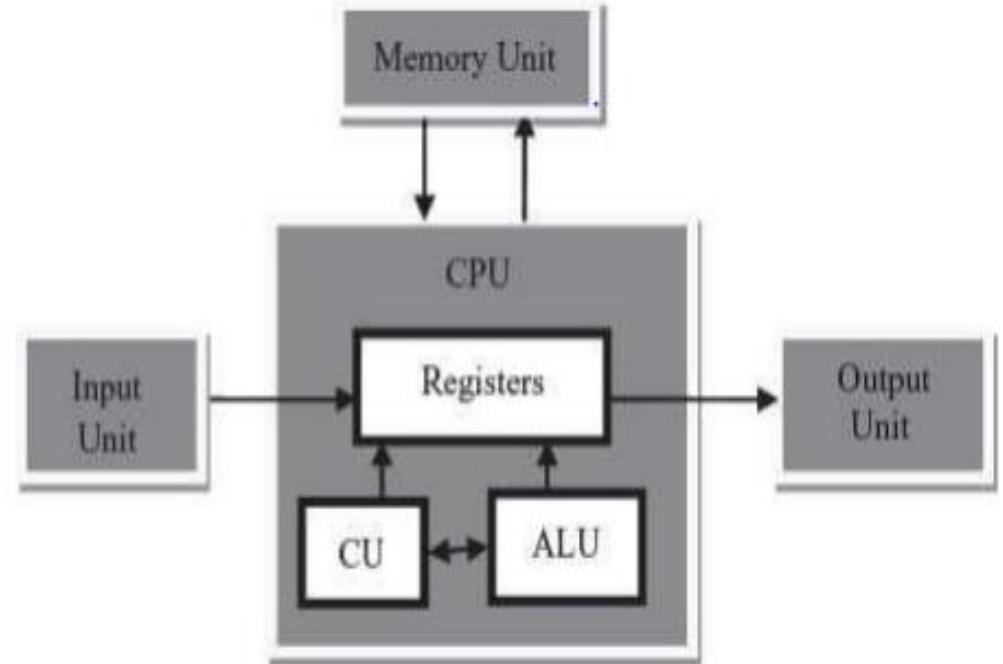
The output is the result generated after the processing of data. The output may be in the form of text, sound, image, document, etc. The computer may display the output on a monitor, send output to the printer for printing, play the output, etc.

► Storage

The input data, instructions and output are stored permanently in the secondary storage devices like disk or tape. The stored data can be retrieved later, whenever needed.

Components of Computer Hardware

- ▶ The computer system hardware comprises of three main components:
 - Input/output (I/O) Unit
 - Central Processing Unit (CPU)
 - Memory Unit.



Application of Computers

- ▶ Computers have proliferated into various areas of our lives. For a user, computer is a tool that provides the desired information, whenever needed.
- ▶ Education, Entertainment, Sports, Advertising, Medicine, Science and Engineering, Government, Home etc.
- ▶ The list of applications of computers is so long that it is not possible to discuss all of them here.

The Computer System

HARDWARE

Introduction

- ▶ **Computer architecture** refers to the structure and behavior of the computer, it includes the specifications of the components
- ▶ **Computer organization** focuses on the organizational structure. It deals with how the hardware components operate and the way they are connected to form the computer.
- ▶ **Computer design** focuses on the hardware to be used and the interconnection of parts.

Hardware

- ▶ A computer consists of three main components:
 - i. Input/Output (I/O) Unit
 - ii. Central Processing Unit (CPU)
 - iii. Memory Unit

Components of a Computer

Every Computer has two major components namely the HARDWARE and the SOFTWARE

- ▶ The HARDWARE refers to the physical components , that is the components that one can see and touch.

- ▶ The SOFTWARE are the application programs and the other operating information required by the Computer.

Input Devices

- ❖ These are the components of the Computer used in providing inputs (be it in text, sound, graphics or images, etc.) into the Computer.
- ❖ Most common input devices are as follows:
 - ▶ Keyboard if the inputs are to be typed
 - ▶ Microphone if the input is audio or sound
 - ▶ Scanner, Camera if the input is graphics

More about input devices

- ▶ Input devices include keyboards, pointing devices, and source-data entry devices like scanners and digital cameras as well as voice and audio/video input devices like microphones and video cameras.
- ▶ The most common input device and the one you will probably have to learn how to use is the keyboard.
- ▶ The computer keyboard unlike the ordinary typewriter keyboard converts letters, numbers, and other characters into electrical signals in machine language and can be processed by the computer processor.

Input Devices

- ❖ Other devices that are commonly used in conjunction with the keyboard are pointing devices like the mouse.
- ❖ These devices control the position of the cursor -pointer on the screen. Pointing devices include:
 - ▶ Mice, trackballs, and joysticks
 - ▶ Light pens
 - ▶ Digitizing tablets
 - ▶ Pen-based systems

Keyboard

The keyboard is the commonest input device. It is usually connected to the system unit of the computer through a serial port with a cable.

The keys on the keyboard can be divided into four groups namely:

- ▶ Standard keys
- ▶ Cursor-movement keys
- ▶ Numeric keys
- ▶ Function keys

Keyboard



ComputerHope.com

Keyboard

- ▶ The *Standard typing keys* are similar to that of the typewriter with the familiar QWERTY arrangement of letter, number, and punctuation keys.
- ▶ QWERTY refers to the alphabets in the top left row on the standard typewriter keyboard.

- On the computer keyboard, it can be found on the third row.
- The Caps Lock, Shift, and Tab keys and also the Space bar work the same way as they do on a typewriter keyboard.
- The Caps Lock key is a toggle key

Keyboard

- ▶ *Cursor-movement keys*-sometimes called the arrow keys - are used to move the cursor around the text on the screen.
- ▶ The cursor is the blinking vertical bar on the screen that indicates insertion point or where data may be entered next.

- The cursor-movement keys move the cursor left, right, up, or down.
- Keys labeled Page Up and Page Down move the cursor the equivalent of one screen (page) up (backward) and down (forward) at a time respectively

Keyboard

- ▶ Numeric keys are laid out separately on the numeric keypad-a separate set of keys, 0 through 9 like those on a calculator -on the standard 101-key keyboard previously known as the AT-style keyboard
- ▶ The numeric keypad serves two purposes.

- With the Num Lock key off, the numeric keys duplicate as arrow keys for the movement of cursor and perform other functions such as Page Up and Page Down.
- And when the Num Lock is on, the keys may be used for entering numbers, as on a calculator.
- The Num Lock key is also a toggle key

Keyboard

- ▶ However, to maintain keyboard standard the numeric keys can also be found on the second row of keys with other special characters just like the typewriter keyboard.
- ▶ *Function keys* are the keys labelled F1, F2 through F12.

- These keys are not used for typing but rather for issuing commands.
- Desktops normally have 12 function keys while some portables like notebooks have only 10.
- The function that each of these keys perform are however software-specific.

Pointing Devices

- ▶ The principal pointing tools used with microcomputers are the mouse, the trackball, the joystick, and the touchpad.
- ▶ A mouse is a device that is rolled about on a desktop to direct a pointer on the monitor.



Examples of Joystick



Trackball

- The mouse pointer is the symbol that indicates the position of the mouse on the display screen.
- It may be an arrow, a rectangle, or even a representation of a person's pointing finger.
- It may change to an I-beam to indicate that it is a cursor identifying the place where text or other data may be entered.

Mouse

- ▶ The mouse is usually connected to the system unit by plugging it into a port or socket at the back of the unit using a cable.
- ▶ A ball under the mouse translates the mouse movement into digital signals and on top of the mouse are one to four buttons depending on the variation of the mouse.

Trackball

- ▶ A trackball is a movable ball, on top of a stationary device, that is rotated with the fingers or palm of the hand.
- ▶ It looks like the mouse turn upside down; instead of moving the mouse around, you move the trackball with the tips of your fingers.
- ▶ Trackballs are specially suited for portable computers like laptops which are often used in confined working environments such as airline tray tables.

Joystick

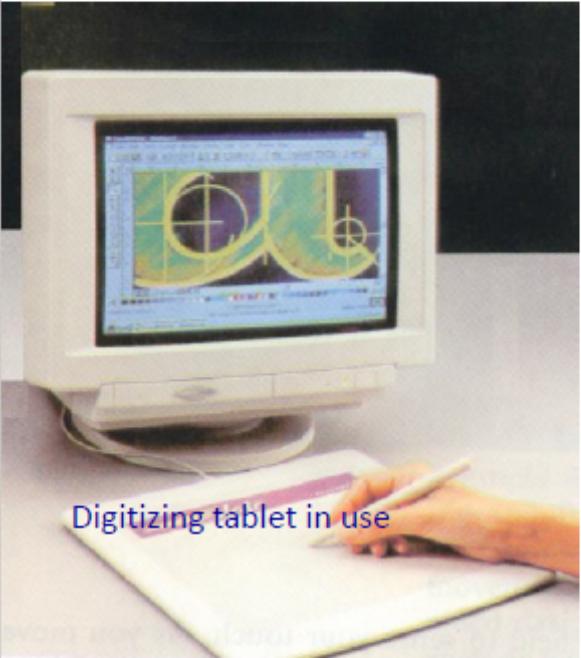
- ▶ A joystick is a pointing device that consists of a vertical handle like a gearshift lever mounted on a base with one or two buttons.
- ▶ Joysticks are principally used in some computer-aided (CAD) systems, computerized robot systems, and in video games.

- Mostly found on laptops, touch pads are flat-top rectangular devices that let you control the cursor/pointer by rubbing your finger on the surface of the pad.
- A click action is accomplished by tapping on the pad's surface

Light Pen

- ▶ The light pen is a light-sensitive device that is connected to the computer terminal.
- ▶ The user points to a desire location on the monitor and presses the pen which then sends the signal corresponding to the location to the computer.
- ▶ Light pens are used by graphic designers, engineers, and architects.

Digitizing tablets



- A digitizing device consists of a digital tablet that is connected to a stylus or a puck.
- A stylus is pen-like device that is used to sketch images in digitized form.
- A puck is a copying device that the user uses to copy or trace an image.

Digitizing Tablets

- ▶ A digitizing tablet used with a stylus enables the user to paint “naturally” and achieve effects similar to what an artist will achieve using pen, pencil, or charcoal.
- ▶ Alternatively, a digitized copy of a painting can be traced and stored into the computer by laying the painting or drawing on the tablet.
- ▶ Digitizing devices are used primarily by artists and graphic designers.

Scanning Devices

- ▶ Hardcopies of graphic images such as drawings and photos are translated into digital form by scanners using laser beams and reflected light.
- ▶ The images can be processed by a computer, displayed on a monitor, stored on a storage device, or communicated to another computer.

- Types of scanners include Bar-code readers, Mark-and character-recognition devices, Fax machines, and Imaging systems.

Output Devices

- ▶ Monitor: Produces soft copies. The two main types are cathode ray tube (CRT) and liquid crystal display (LCD) monitors.
- ❖ The CRT monitor is big, like a tube television, and takes up a lot of desk space; however, it is the least expensive monitor option.

- ❖ The LCD monitor is thin and saves energy, but costs more.

Over the years you can expect to see fewer CRT monitors if not completely eliminated as LCD monitors become the standard

Types of Monitors



CRT Monitor



LCD Monitor

Printers and Plotters

- ▶ Printer for hardcopies
- ▶ There are two types namely impact and non-impact.
- ▶ Impact printers (e.g. Dot Matrix) are very cheap and getting out of the market while the non-impact (laser, bubble jet, etc.) are expensive and produce quality output
- ▶ Speaker for sound or audio output

Plotters

A **plotter** is a computer hardware device much like a printer that is used for printing vector graphics. Instead of toner, plotters use a pen, pencil, marker, or another writing tool to draw multiple, continuous lines onto paper rather than a series of dots like a traditional printer



An HP Large Format Plotter

- Plotters can work on very large sheets of paper while maintaining high resolution.
- They can print on a wide variety of flat materials including plywood, aluminum, sheet steel, cardboard, and plastic.
- Plotters are more expensive than traditional printers

Microprocessor/Central Processing Unit

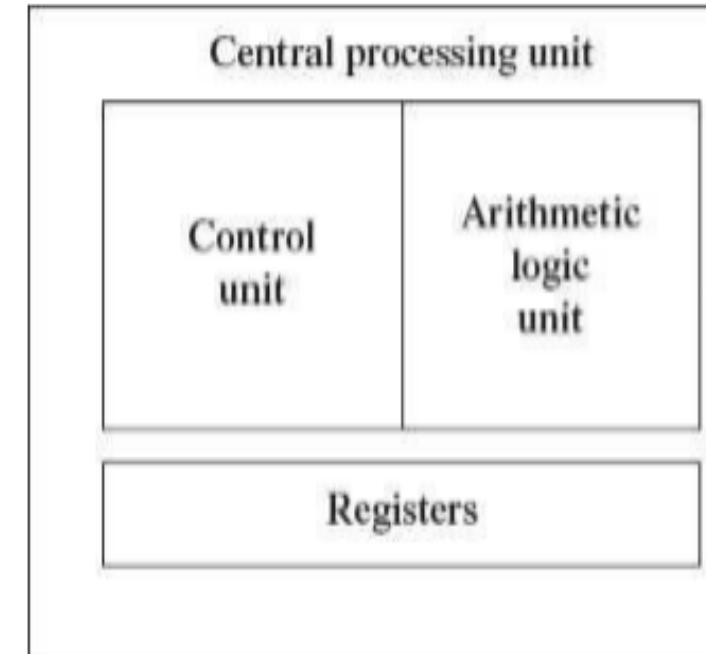
- ▶ The Central Processing Unit (CPU), also called a processor, is located inside the computer case on the motherboard.
- ▶ It is often called the brain of the computer, or the computer's engine.
- ▶ Its main function is to interpret the various instructions in a given program.
- ▶ There are many processor manufacturers for personal computers including Intel, Cyrix, VIA, and AMD.

- Today, the clock speed of a processor is measured in gigahertz (GHz).
- The processor with the higher clock speed will execute instructions faster than the one with a lower clock speed.
- The processor has three main components namely the Arithmetic-Logic Unit (ALU), the control Unit (CU) and registers.

Microprocessor/Central Processing Unit

Central Processing Unit (CPU) or the processor is also often called the brain of computer. CPU consist of:

- ▶ Arithmetic Logic Unit (ALU)
- ▶ Control Unit (CU)
- ▶ Registers



Arithmetic Logic Unit

ALU performs **Arithmetic** and **Logic Operations**, and uses registers to hold the data that is being processed. It consists of arithmetic unit and logic unit.

The **Arithmetic Unit** performs arithmetic operations on the data that is made available to it, such as addition, subtraction etc.

The **Logic Unit** is responsible for performing logic operations. It performs comparisons of numbers, letters and special characters

Control Unit

- The control unit organizes the processing of data and instructions.
- It acts as a supervisor and, controls and coordinates the activity of the other units of computer.
- CU coordinates the input and output devices of a computer.

Control Unit Continued...

- It directs the computer to carry out stored program instructions by communicating with the ALU and the registers.
- CU uses the instructions in the Instruction Register (IR) to decide which circuit needs to be activated.
- It also instructs the ALU to perform the arithmetic or logic operations.

Register

- ▶ Registers are high-speed storage areas within the CPU, but have the least storage capacity.
- ▶ They are often referred to as the CPU's working memory.
- ▶ Registers store data, instructions, addresses and intermediate results of processing.

Some Registers and their uses

- ▶ **Accumulator (ACC)** stores the result of arithmetic and logic operations.
- ▶ **Instruction Register (IR)** contains the current instruction most recently fetched.
- ▶ **Program Counter (PC)** contains the address of next instruction to be processed.
- ▶ **Memory Address Register (MAR)** contains the address of next location in the memory to be accessed.

Registers Continued...

- ▶ Memory Buffer Register (MBR) temporarily stores data from memory or the data to be sent to memory.
- ▶ Data Register (DR) stores the operands and any other data.



Continued...

- The number of registers and the size of each (number of bits) register in a CPU helps to determine the power and the speed of a CPU.
- The size of register, also called **word size**, indicates the amount of data with which the computer can work at any given time. The bigger the size, the more quickly it can process data. The size of a register may be 8, 15, 32 or 54 bits.

Memory Unit

- ▶ Memory unit consists of cache memory and primary memory. Primary Memory/Main Memory of the computer is used to store the data and instructions during execution of the instructions.
- ▶ Random Access Memory (RAM) and Read Only Memory (ROM) are the primary memory.

- ▶ Secondary memory is another kind of storage device, it is non-volatile and is used for permanent storage of data and programs.
- ▶ A program or data that has to be executed is brought into the RAM from the secondary memory.

Cache Memory

- ❖ Cache memory is a **very high speed memory** placed in between RAM and CPU.
- ❖ Cache memory is a **storage buffer** that stores the data that is **used more often**, temporarily, and makes them **available to CPU** at a fast rate.

Cache Memory continued

- ❖ Cache memory is built into the processor, and may also be located next to it on a separate chip between the CPU and RAM. Cache built into the CPU is faster than separate cache.
- ❖ Cache memory is very expensive, so it is smaller in size. Generally, computers have cache memory of sizes 255 KB to 2 MB

Primary Memory

- Primary memory is the main memory of computer.
- Primary memory is of two kinds—**Random Access Memory (RAM)** and **Read Only Memory (ROM)**.
- RAM is **volatile** and stores data and instructions during the execution of **instructions**. Information stored in RAM gets erased when the computer is turned off.

Primary Memory continued

- ROM is **non-volatile memory**, but is a read only memory.
- The storage in **ROM is permanent in nature**, and is used for storing **standard processing programs** that permanently reside in the **computer**.
- ROM comes programmed by the **manufacturer**.



Examples of ROM chips

ROM

- ▶ The Read Only Memory (ROM) chips also called **firmware**, cannot be written on or erased by the computer -as the name suggests, its content can only be read.
- ▶ **Firmware is the term that is used for software permanently stored on a chip -microprogrammed.**
- ▶ If we say that RAM chips temporarily remembers (information supplied by the user or software), then ROM chips can be said to permanently remember (information supplied by the manufacturer).

Read Only Memory

- ▶ ROM does not lose its content when the power is switched off.
- ▶ Has only read capability and no write capability
- ▶ Stores the **basic input output system (BIOS)**. BIOS provides the processor with the information required to boot the system.
- ▶ **Power On Self Test (POST)** is a program that runs automatically when the system is booted
- ▶ **Bootstrap Loader** is a program whose purpose is to start the computer software for operation when the power is turned on.

Kinds Of ROM

There are three variations of ROM chips that are used in special situations. The three variations are PROM, EPROM, and EEPROM.

► PROM

Programmable Read-Only Memories are blank chips on which instructions or programs are written using special equipment. Once the program is written, it cannot be erased.

► EPROM

Erasable Programmable Read Only Memories are like PROM chips **except that the contents can be erased**, using **special equipment** and new data or instructions can be **written**. A special device that uses ultraviolet light is used to erase its content.

► EEPROM

EEPROM: Electronic Erasable Programmable Read-Only

Memory can be reprogrammed using special electrical

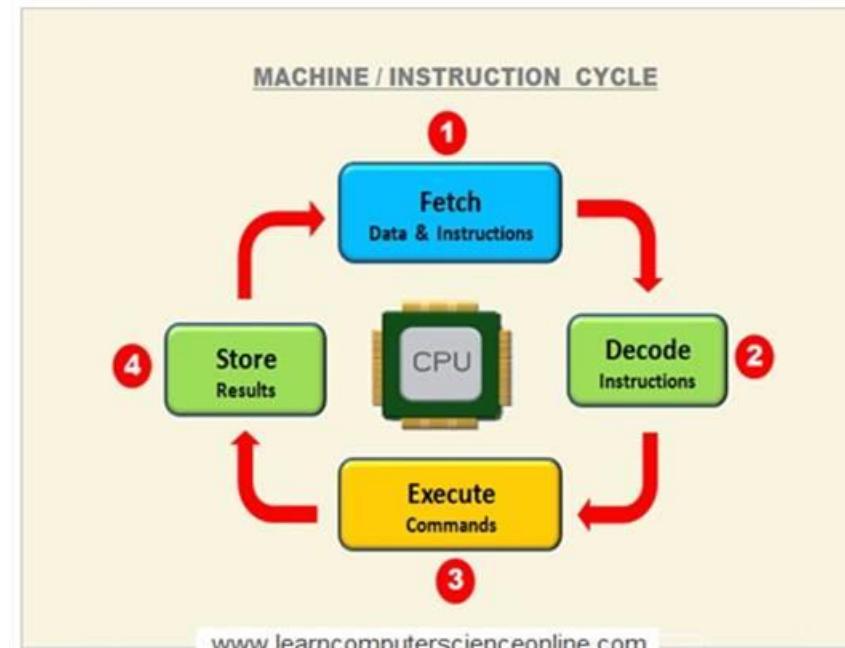
impulses. The advantage of EEPROM chips is that they

need not be removed from the computer to be

reprogrammed.

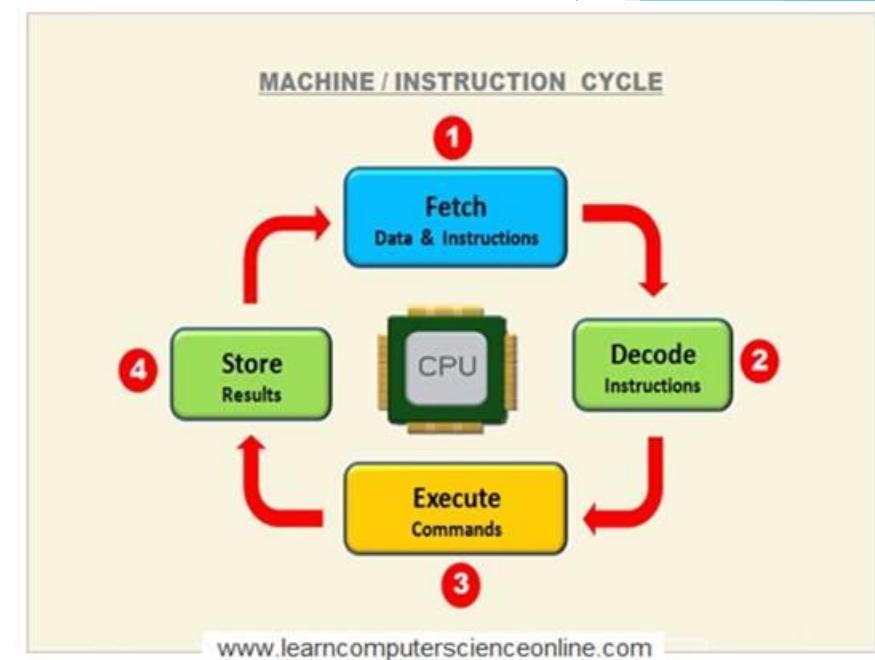
Instruction Cycle

- ▶ The series of steps that the CPU follows execute instruction is called the Instruction Cycle.
- ▶ The instruction cycle involves four steps:
 - ▶ **Fetching** The processor fetches the instruction from the memory and placed in the Instruction Register(IR).



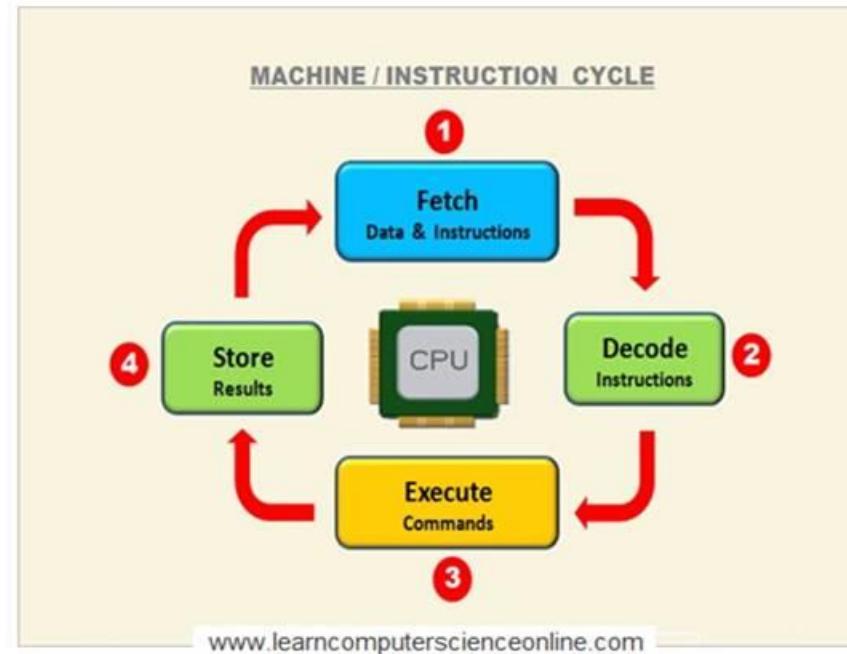
Instruction Cycle continued

- ▶ **Decoding** The instruction that is fetched is broken down into parts or decoded. The instruction is translated into commands so that they correspond to those in the CPU's instruction set.
- ▶ **Executing** The decoded instruction or the command is executed. CPU performs the operation implied by the program instruction. For example, if it is an ADD instruction, addition is performed.



Continued

- ▶ Storing the CPU writes back the results of execution, to the computer's memory.



Processor speed

- ▶ Processor speed is measured in three ways with respect
- ▶ to the frequency of its system clock (in megahertz),
- ▶ the number of instructions processed per second and
- ▶ floating-point operation per second.

- Every computer contains an **internal timing device** that is switched on when the power of the computer is turned on.
- This device is called the **system clock**. The system clock controls the pace at which all operations take place.
- The faster the clock, the faster the processing.

Processor Speed

- ▶ Microcomputer processing speeds are often measured in megahertz (MHz), with 1 MHz equal to 1 million machine cycle or beats per second.
- ▶ Processing speed of Workstations and Mainframes are often measured in number of instructions processed per second (IPS) which currently runs into millions.
- ▶ Thus, MIPS (million of instruction per second) is a measure of computer processing speed.

- ▶ For Supercomputers, processing speed is often measured in flops -floating-point operation per second.
- ▶ Floating-point operation is a special kind of mathematical calculations.
- ▶ This measure is often expressed in megaflops (millions of floating-point operations per second), gigaflops (billions of floating-point operations per second) and teraflops (trillions of floating-point operations per second).

Interconnecting The Units Of A Computer

- ▶ **Bus** is a set of electronic signal pathways that allows information and signals to travel between components inside or outside of a computer.

The different components of computer, i.e., CPU, I/O unit, and memory unit are connected with each other by a bus.

- ▶ The data, instructions and the signals are carried between the different components via a bus.

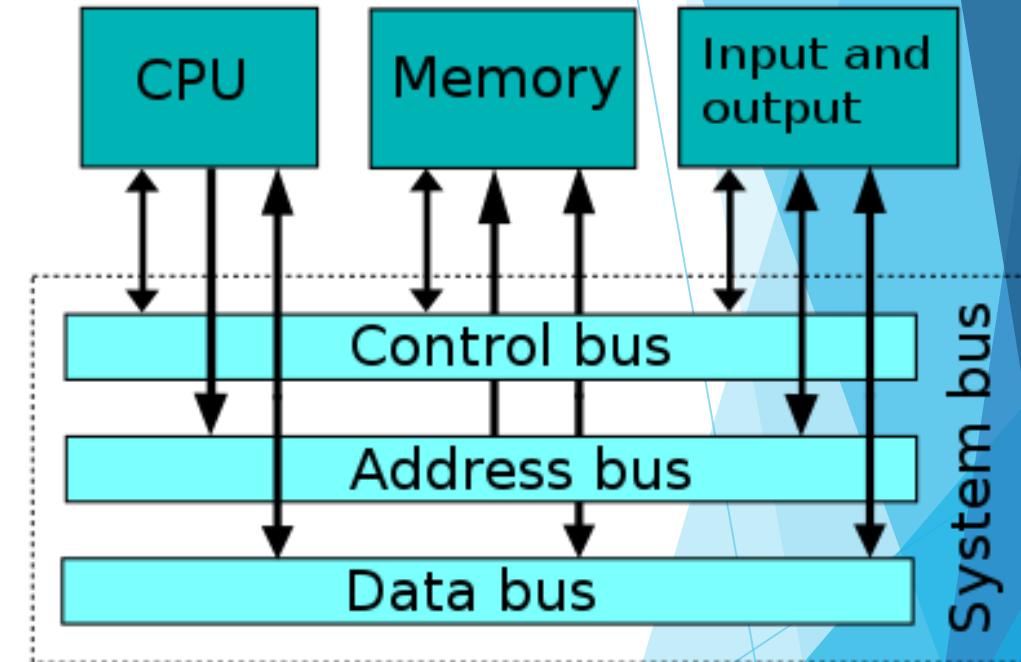
Features and Functions of a Bus

- ✓ A bus is a set of wires used for interconnection, where each wire can carry one bit of data.
- ✓ A bus width is defined by the number of wires in the bus.
- ✓ A computer bus can be divided into two types Internal Bus and External Bus.
- ✓ The Internal Bus connects components inside the motherboard like, CPU and system memory. It is also called the System Bus.

Interaction between CPU And Memory

The interaction of CPU with memory and I/O devices involves all the three buses.

- The command to access the memory or the I/O device is carried by the **control bus**.
- The address of I/O device or memory is carried by the **address bus**.
- The data to be transferred is carried by the **data bus**.



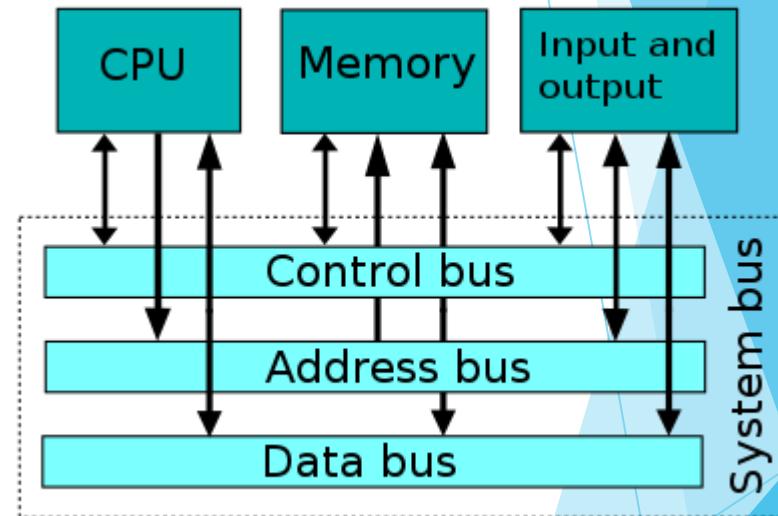
System Bus

The functions of data bus, address bus and control bus, in the system bus, are as follows:

Data Bus transfers data between the CPU and memory.

Address Bus connects CPU and RAM with set of wires similar to data bus.

Control Bus specifies whether data is to be read or written to the memory, etc.



Expansion Bus

- ▶ The expansion bus connects external devices to the rest of computer.
- ▶ **Data Bus** is used to transfer data between I/O devices and CPU.
- ▶ The exchange of data between CPU and I/O devices is according to the industry standard data buses.
- ▶ The most commonly used standard is **Extended Industry Standard Architecture (EISA)** which is a 32-bit bus architecture.

Expansion Bus Continued...

- ▶ Some of the common bus technologies are:
 - Peripheral Component Interconnect (PCI) bus
 - Accelerated Graphics Port (AGP) bus
 - Universal Serial Bus (USB)
- ▶ **Address Bus** carries the addresses of different I/O devices to be accessed like the hard disk, CD ROM, etc.
- ▶ **Control Bus** is used to carry read/write commands, status of I/O devices, etc.

External Ports

- ❖ The connections to the bus from the peripheral devices are made via the ports and sockets.
- ❖ The different ports and sockets facilitate the connection of different devices to the computer.

- ❖ Some of the standard port connections available on the outer sides of the computer are port for mouse, keyboard, monitor, network, modem, and, audio port, serial port, parallel port and USB port.
- ❖ The different ports are physically identifiable by their different shapes, size of contact pins and number of pins.

Performance of a Computer

- ▶ A number of factors are related to the CPU and have an effect on the overall speed and performance of the computer. Some of the factors include:
- ▶ **Registers** The size of the register (word size) indicates the amount of data with which the computer can work at any given time. The bigger the size, the more quickly it can process data.

Performance of a Computer Continued...

- ▶ **RAM** It is used to store data and instructions during execution of the instructions. If RAM is less, then the CPU waits each time the new information is swapped into memory from the slower devices. The larger the RAM size, the better it is.
- ▶ **System Clock** The clock speed of a CPU is defined as the frequency with which a processor executes instructions or the data is processed. Higher clock frequencies mean more clock ticks per second. Performance is in **MIPS** or **BIPS**

Performance of a Computer Continued...

- ▶ ***Bus Data*** bus is used for transferring data between CPU and memory. The data bus width affects the speed of computer. The bus speed is measured in MHz Higher the bus speed the better it is.
- ▶ PCs nowadays have a bus speed varying from 100 MHz to 400 MHz.
- ▶ ***Cache Memory*** Two of the main factors that affect a cache's performance are its size (amount of cache memory) and level L1, L2 and L3. Larger the size of cache, the better it is

Inside the Microcomputer

For now let us concern ourselves with the following parts of the system unit:

- ▶ Power supply
- ▶ Motherboard
- ▶ Microprocessor
- ▶ RAM chips
- ▶ ROM chips
- ▶ Other forms of memory -cache, VRAM, flash
- ▶ Expansion slots and boards
- ▶ Buses, PC slots and cards

Power Supply Unit

- ▶ The power supply is the device that converts power from AC to DC to run the computer.
- ▶ The electricity available from a standard wall outlet is an alternating current (AC) but microcomputers run on direct current (DC).
- ▶ The on/off switch in the computer turns on or shut off the electricity to the power supply.



An HP power supply unit

- ▶ As electricity generates lots of heat, a fan is provided to cool the components and prevent them from getting too hot.
- ▶ For precaution sake, it is advisable to connect your computer to an uninterrupted power supply (UPS) or surge protectors instead of connecting it directly to the electricity power outlet

Motherboard

► Motherboard

The computer is built up around a motherboard. It is a large Printed Circuit Board (PCB), having many chips, connectors and other electronics mounted on it.

The motherboard may be characterized by the form factor, chipset and type of processor socket used.

Form factor refers to the motherboard's geometry, dimensions, arrangement and electrical requirements

Motherboard

- ▶ Also known as the system board, the motherboard is the main circuit board in the system unit.
- ▶ It's a thin plate that holds the CPU (Central Processing Unit), RAM, ROM chips and other forms of memory, connectors for the hard drive and optical drives.

- ▶ It also houses the expansion cards to control the video and audio, as well as various external ports and peripherals.
- ▶ The motherboard connects directly or indirectly to every part of the computer.

Motherboard Continued...

The Basic Input Output System (BIOS) and Complementary Metal-Oxide Semiconductor (CMOS) are present on the motherboard.

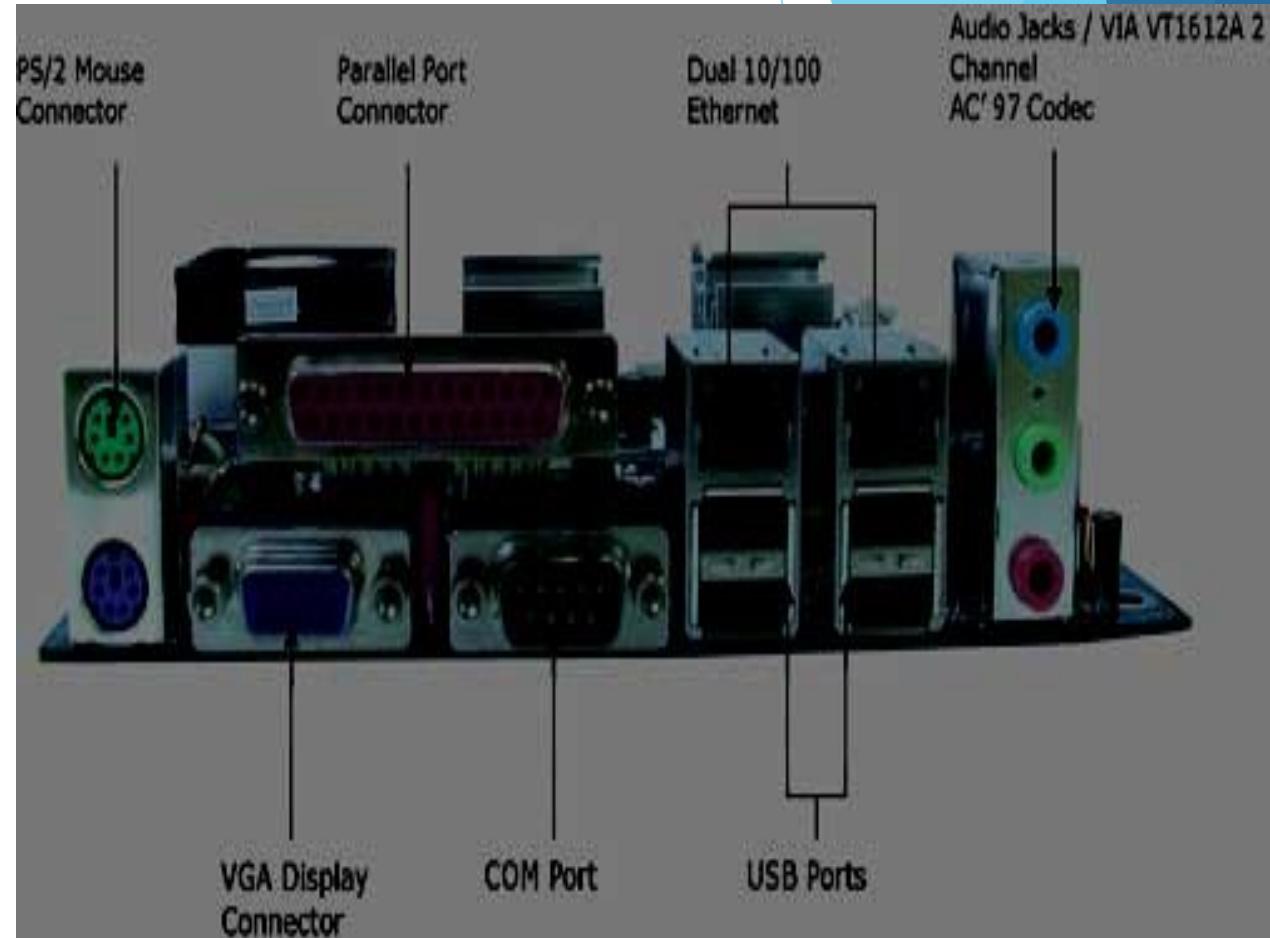


Motherboard Continued...

- ▶ **BIOS** It is the basic program used as an interface between the operating system and the motherboard. The BIOS is stored in the ROM and cannot be rewritten. It performs a Power On Self Test (POST) that checks that the hardware is functioning properly and the hardware devices are present.
- ▶ **CMOS Chip** CMOS chip saves some system information, such as time, system date and essential system settings. CMOS is kept powered by a button battery located on the motherboard.

Ports And Interfaces

- ▶ Motherboard has a certain number of I/O sockets that are connected to the ports and interfaces found on the rear side of a computer and connect external devices to the ports and interfaces, to the motherboard



Ports and Interfaces

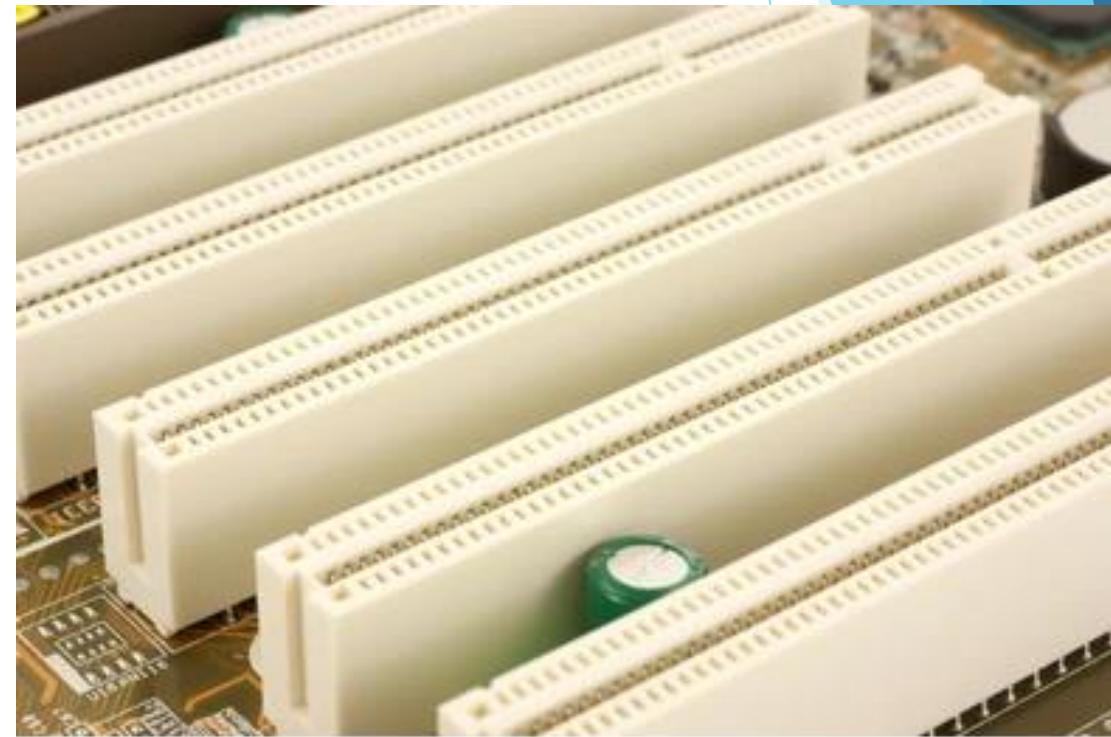
- ▶ **Serial Port** to connect old peripherals.
- ▶ **Parallel Port** to connect old printers.
- ▶ **USB Ports** to connect newer peripherals like cameras, scanners and printers
- ▶ **Firewire** is another bus, used today mostly for video cameras and external hard drives.
- ▶ **RJ45 connector** (called LAN or Ethernet port) is used to connect the computer to a network

Ports and Interfaces Continued...

- ▶ **VGA connector** for connecting a monitor. This connector interfaces with the **built-in graphics card**.
- ▶ **Audio plugs** (line-in, line-out and microphone), for connecting sound speakers and the microphone. This connector interfaces with the **built-in sound card**.
- ▶ **PS/2 port** to connect **mouse and keyboard** into PC.
- ▶ **SCSI port** for connecting the **hard disk drives and network connectors**.

Expansion Slots

- ▶ The expansion slots are located on the motherboard.
- ▶ The expansion cards are inserted in the expansion slots.



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Ribbon Cables

- Ribbon cables are flat, insulated and consist of several tiny wires molded together that carry data to different components on the motherboard.
- There is a wire for each bit of the word or byte and additional wires to coordinate the activity of moving information.



A ribbon cable

Ribbon Cable

- They also connect the floppy drives, disk drives and CD-ROM drives to the connectors in the motherboard.
- Serial Advanced Technology Attachment (SATA) cables have replaced the ribbon cables to connect the drives to the motherboard.

Memory Chips

- ▶ The main memory or the RAM (random access memory), is the temporary work space for the processor.
- ▶ It is a temporal or versatile memory
- ▶ It temporary holds data and instructions that will be needed shortly by the processor.

RAM CHIPS

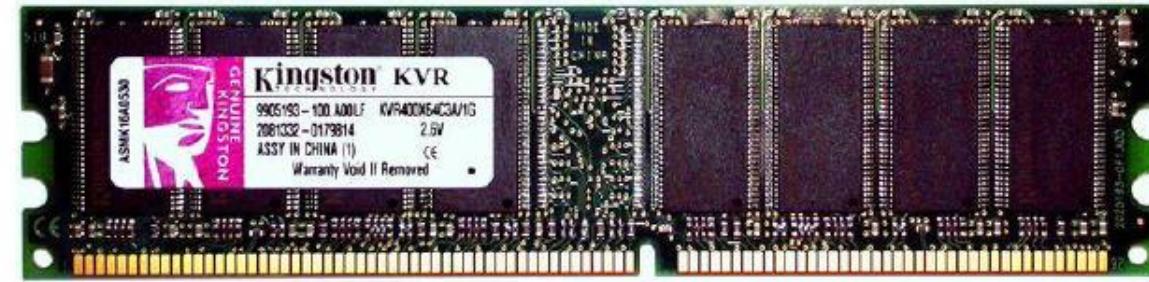


Figure 1.13 A Typical Memory Chip

- ▶ Data is temporarily stored here until you save your work to the hard disk.
- ▶ This short-term memory disappears when the computer is turned off, so always save your file before turning off the machine.
- ▶ The capacity of the RAM therefore determines how large the software that can be run on any computer and how fast it can run.

Random Access Memory

RAM is used to store data and instructions during the operation of computer. It is a volatile memory

The performance of RAM is affected by:

Access speed (how quickly information can be retrieved).

Data transfer unit size (how much information can be retrieved in one request).

There are two categories of RAM, depending on the technology used to construct a RAM

- ▶(1) Dynamic RAM (DRAM)
- ▶(2) Static RAM (SRAM).

DRAM

- Is the most common type of memory chip. It is mostly used as main memory since it is small and cheap.
- It uses transistors and capacitors.
- DRAM must be refreshed continually to store information.
- DRAM gets its name from the refresh operation that it requires to store the information; otherwise it will lose what it is holding. The refresh operation occurs automatically thousands of times per second.
- Access speed of DRAM ranges from 50 to 150 ns.

SRAM

- SRAM chip is usually used in cache memory due to its high speed.
- SRAM uses multiple transistors. It does not have a capacitor in each cell.
- A SRAM memory cell has more parts so it takes more space on a chip than DRAM cell.
- It does not need constant refreshing.
- SRAM is more expensive than DRAM.
- It stores information as long as it is supplied with power.
- SRAM are easier to use and very fast.

Flash Memory

It is a kind of semiconductor-based non-volatile, rewritable computer memory that can be electrically erased and reprogrammed.

- ✓ It combines the features of RAM and ROM.
- ✓ Flash memories are high-speed memories, durable, and have low-energy consumption.

Memory Capacity

- ▶ How much data -in other words, how many 0s and 1s -a computer memory or a storage device can hold is very important for its operation.
- ▶ As we already mentioned, a 0 or 1 occupies one bit of memory space.
- ▶ A character consists of eight bits thus occupies eight bits of memory space.
- ▶ As data are keyed into the computer in characters, bits are grouped into eight bits -1 byte.
- ▶ A Byte is used to hold a letter, number, or a special character (such as *, &, \$,

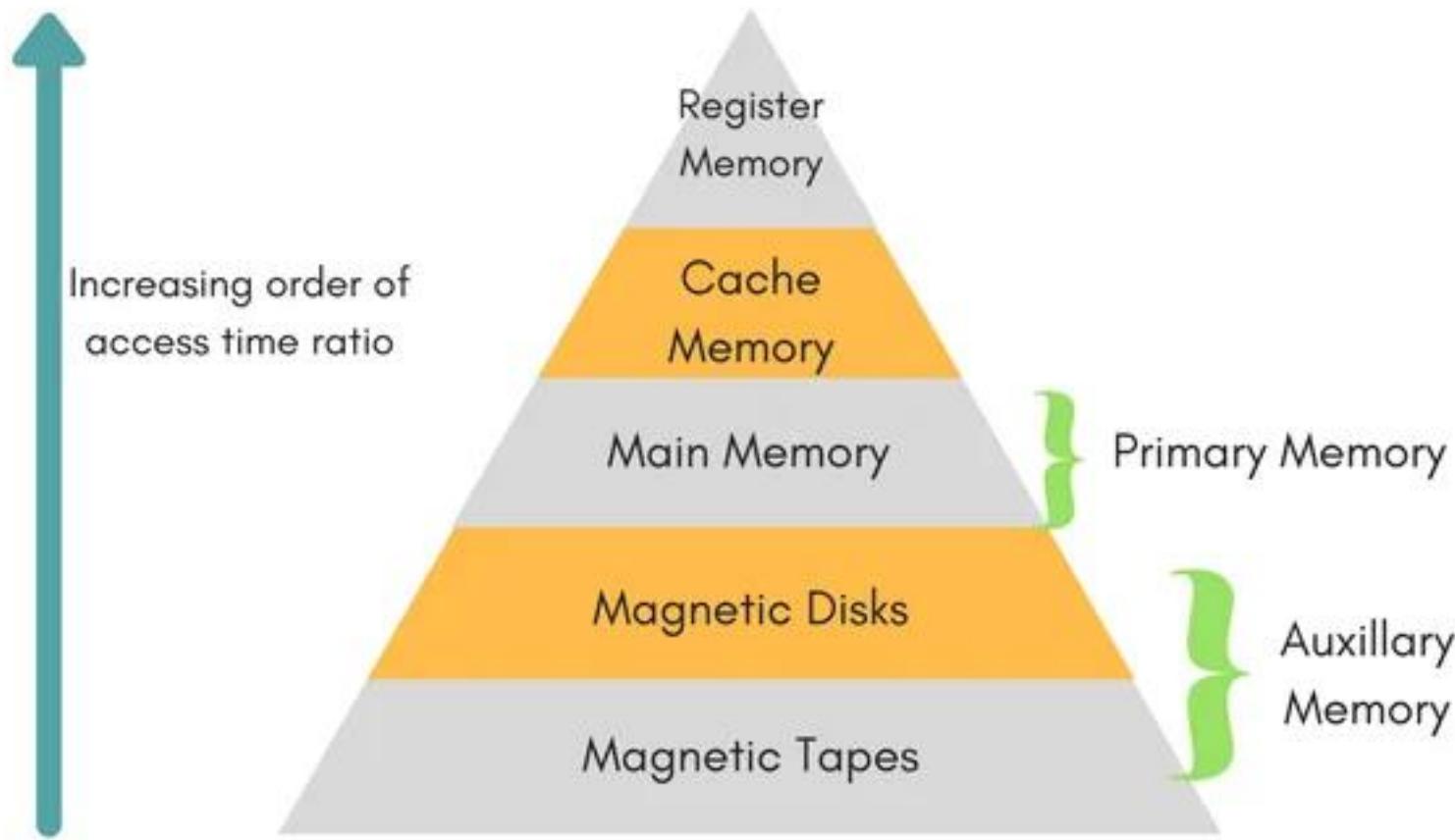
Memory Representation

- ▶ The Kilobyte (KB) is the common unit of measure for internal memory of microcomputers (1024 bytes, 2¹⁰ bytes)
- ▶ A Megabyte (MB) is about 1 million bytes, precisely (1,048,576 bytes). A floppy diskette for example has a capacity of 2 MB (2²⁰ bytes)
- ▶ A Gigabyte (GB) is about 1 billion bytes, precisely 1,073,741,824 bytes. This measure is often used to measure the capacity of hard disks of microcomputers or PCs, CD-ROMs and main memory capacity of mainframes and supercomputers.
- ▶ A Terabyte (TB) represents 1 trillion bytes, precisely 1,009,511,627,776 bytes.

Memory Hierarchy

- ▶ The memory is characterized on the basis of two key factors **Capacity** and **Access Time**.
- ▶ **Capacity** is the amount of information (in bits) that a memory can store.
- ▶ **Access Time** is the time interval between the read/ write request and the availability of data.
- ▶ The lesser the access time, the faster is the speed of memory

Memory Hierarchy Cont...



Memory Hierarchy Cont...

- ▶ The **internal memory** and **external memory** are the two broad categories of memory used in the computer.
- ▶ The **internal memory** consists of the **CPU Registers, Cache Memory** and primary memory to perform the computing tasks.
- ▶ The **external memory** is also called the **secondary memory**. It is used to store the large amount of data and the software.

The Internal Memory

Internal Memory the key features are:

- ▶ (1) Limited Storage Capacity
- ▶ (2) Temporary Storage
- ▶ (3) Fast Access
- ▶ (4) High Cost

Registers, cache memory, and primary memory constitute the internal memory. Primary Memory is further of two kinds RAM and ROM. Registers are the fastest and the most expensive among all the memory types.

Secondary Memory

The key features of secondary memory storage devices are

- ▶ (1) Very High Storage Capacity
- ▶ (2) Permanent Storage (Non-volatile), Unless Erased By User
- ▶ (3) Relatively Slower Access
- ▶ (4) Stores Data And Instructions That Are Not Currently Being Used By CPU But May Be Required Later For Processing
- ▶ (5) Cheapest Among All Memory.

For example, Magnetic Tape Drive and Magnetic Tape, Magnetic Disk Drive and Disk, and, Optical Disk Drive and Disk.

Secondary Memory Cont...

- ▶ With respect to CPU, the memory is organized as follows:
- ▶ Registers are placed inside the CPU (small capacity, high cost, very high speed)
- ▶ Cache memory is placed next in the hierarchy (inside and outside the CPU)
- ▶ Primary memory is placed next in the hierarchy
- ▶ Secondary memory is the farthest from CPU (large capacity, low cost, low speed)

Secondary Memory

- ▶ Secondary memory is also called the storage device of computer.
- ▶ It stores much larger amounts of data and information for extended periods of time. Magnetic tape drives, magnetic disk drives, optical disk drives and magneto-optical disk drives are the different types of storage devices.
- ▶ Information stored on the storage devices can be assessed by two ways:
 - Sequential access
 - Direct access

Storage Devices

- ▶ Storage devices are media for storing data. Often referred to as secondary storage, storage devices can range from
- ▶ Computer software or programs in addition to data must be stored in a computer-usable form.
- ▶ Software instructions must be retrieved from a permanent storage device and placed into RAM for any processing to take place.

➤ Generally, a secondary storage can be likened to a file cabinet in which files (data) are stored until they are needed.

- Then you open the drawer, take out the appropriate folder or file, and place it on top of your desk (in primary storage, or RAM), where you work on it -either to write some few things on it or to remove and throw some few pages away.
- However, in the case of electronic documents, you are actually taking out a copy of the desired file and putting it on the desktop.

Storage Devices

- ▶ The original file remains in the file cabinet (secondary storage) while the copy of the original is being edited or updated on the desktop (in the RAM).
- ▶ After working on the file, you take it off the desktop (out of primary storage) and return it to the cabinet (secondary storage). Thus the updated file replaces the original file.
- ▶ Storage devices can be categorized in two ways. One is by their method of storage the other is by method of access.

Storage Devices

- Method of storage implies the technology used for storing or writing information onto the storage medium.
- Most popular types of technology include magnetic, optical and magneto-optical.
- Method of access implies the order in which information is written to and read from the storage medium.

Storage Devices: Method of Access

Basically, we have two main types of access methods -sequential and direct.

- ▶ To understand access methods, think about the difference between cassette tapes and CDs.
- ▶ Cassette use sequential method; music tracks are stored sequentially on them.
- ▶ On the other hand, CDs use direct access as such you can play any track by going directly to it without having to fast forward or rewind to the track as with tapes.

Storage Devices: Method of Access

Storage devices fall into families of cassettes or CDs -tape or disk. Tape storage devices use sequential access method and magnetic storage method while disk devices use direct access method and magnetic, optical or magneto-optical storage methods.

Tape Storage Devices

- ▶ Magnetic tapes simply called tape drives used to be a common secondary storage medium for large computer systems.
- ▶ However, these days magnetic tape is used mainly on large systems for backup and archiving, maintaining historical records and on some microcomputers for backup.
- ▶ Tape storage devices use a magnetic method of storage and a sequential method of access to read and write information to and from a magnetic tape. These are similar to cassette tapes.

Disk Storage

- ▶ Disk storage devices are the most common storage device in use today.
- ▶ These types of devices are so named because of the shape of their storage medium. The storage medium is called a disk; round platter on which information is written on tracks in the form of concentric circles.
- ▶ The storage capacity of disk storage devices is measured in the same way as the internal memory; kilobytes (KB), megabytes (MB), and gigabytes (GB).
- ▶ The storage capacity of magnetic disks ranges from few megabytes to several gigabytes; billions of characters.
- ▶ Variations of magnetic disks include the floppy disks, internal hard disks and compact disks.

Optical Disks

Optical disks are removable disks on which data is written and read using laser technology. These disks store much more data than floppies. A single optical disk of type called CD-ROM can hold up to 700 MB of data.

The main types of optical technology used with computers are:

- ▶ CD-ROM disks
- ▶ CD-R disks
- ▶ CD-RW disks
- ▶ DVD/DVD-ROM

CD-ROM

- ▶ One of the most popular of optical disks is the CD-ROM -compact disk-read-only memory.
- ▶ This type is used only to hold software programs and data.
- ▶ CD-ROM is much like the music CD; it is a read-only storage medium.
- ▶ Read-only means once data or information -which may include visuals and sound is written on the disk from the factory, it cannot be overwritten or erased by the user.
- ▶ Most microcomputers have built-in CD-ROM drives.
- ▶ The faster the drive spins, the more quickly it can deliver data to the processor.

CD-R

- ▶ CD-R, which stands for compact disk-recordable, is a CD format that allows users with CD-R drives to write data, only once, onto a specially manufactured disk that can then be read by a standard CD-ROM drive.
- ▶ CD-R are now becoming the industry standard for backing up files on the hard disk and for coping large volume of software programs and data including audio visuals.
- ▶ A typical CD-R has a capacity 700 megabytes

CD-RW

- ▶ CD-RW stands for **compact disk rewritable**. It is sometime referred to as **erasable CD**.
- ▶ CD-RW allows users to erase data so that the disk can be used over and over again just like the pen drive.

DVD-ROM

- ▶ The letters used to be interpreted as “digital video disk” and later, when its diverse possibilities became obvious, for “digital versatile disk”.
- ▶ DVD is a silvery, 5-inch optically readable digital disk that looks like an audio compact disk but can store up to 40 gigabytes.
- ▶ The computer version of DVD is called the DVD-ROM disk.
- ▶ It represents a new generation of high-density CD-ROM disks.

Hard Disks

- ▶ A hard disk cartridge is a disk storage device in which the disk drive is separate from the hard disk storage medium.
- ▶ This type provides increased storage capacity of hard disks and ability to change disk media, as with floppy disks.
- ▶ Hard card, often referred to as memory cards, this is a type of hard disk that can be added to your system by inserting it into an expansion slot.

- Hard disks have the advantage of capacity and speed.
- Seek time -the time it takes for read-write heads to move to the correct track -measured in milliseconds (1000th of a second).
- Seek time for microcomputers hard disks ranges from 1 to 3ms.
- After the head reaches the desired data, it must wait for the disk to rotate so the head is positioned over the correct sector; this rotation time is called latency, which may be about 1 to 2ms for a hard drive.

Hard Disks

- ▶ Access time is the sum of seek time and latency.
- ▶ Main disadvantage of hard disk remains the possibility of head crash.
- ▶ A head crash happens when the surface of the read-write head or particles on its surface come into contact with the disk surface, causing the loss of some or all of the data on the disk.

- A head crash can also be caused by jarring or even power outage when the hard disk is in use.
- Hard disk crash can be disastrous particularly if the data on it has not been back up, so care has to be taken to backup your data at all times.
- It is also strongly recommended that your system be always connected to an uninterrupted power supply (UPS).

Pen drives

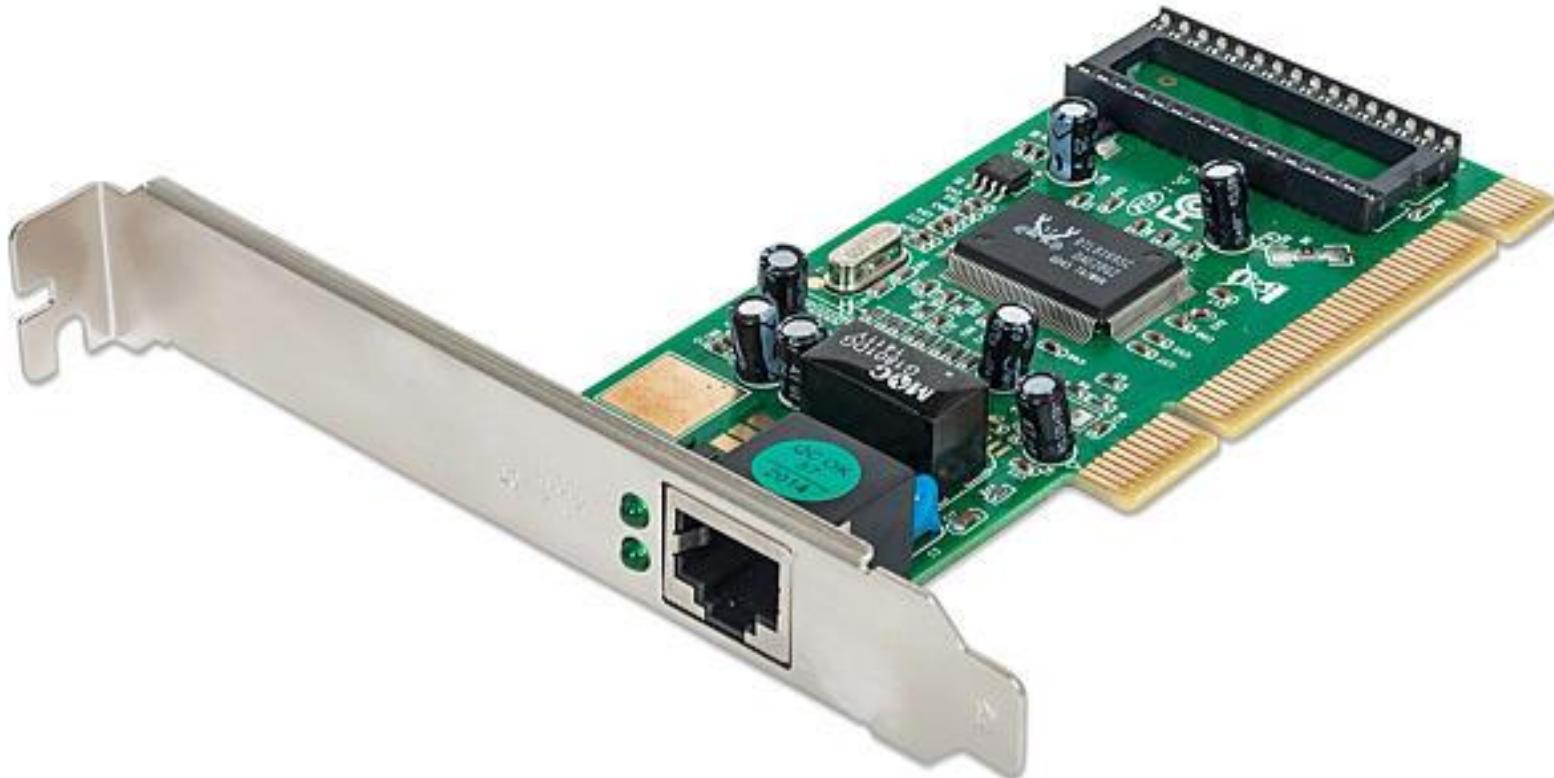
- ▶ Pen drive is a portable USB flash memory device that can be used to quickly transfer audio, video and data files from the hard drive of one computer to another. It is physically small in size
- ▶ USB flash drives are typically removable and rewritable, much smaller than a floppy disk, and most USB flash drives weigh less than an ounce (30 g)
- ▶ Most flash drives use a standard type -USB interface -connection allowing plugging into a port on a personal computer, but drives for other interfaces also exist.

Communication Devices

- ▶ Communication devices make it possible for computers to communicate with each other and share information and other resources in a **network environment**.
- ▶ When the radius of the network is within a short range, the network is called a **Local Area Network (LAN)** and if the radius spans over **long distances like cities and even countries, it is called a Wide Area Network (WAN)**.

- ▶ Communication devices make it possible for computers to communicate with each other and share information and other resources in a network environment.
- ▶ When the radius of the network is within a short range, the network is called a Local Area Network (LAN) and if the radius spans over long distances like cities and even countries, it is called a Wide Area Network (WAN).

Network Card for Communication



A network card

Computer Communication

- ▶ Computer communication is accomplished in two ways.

We have **wired connection and wireless connection.**

- ▶ Wired connection is implemented with the use of

telephone lines and cables

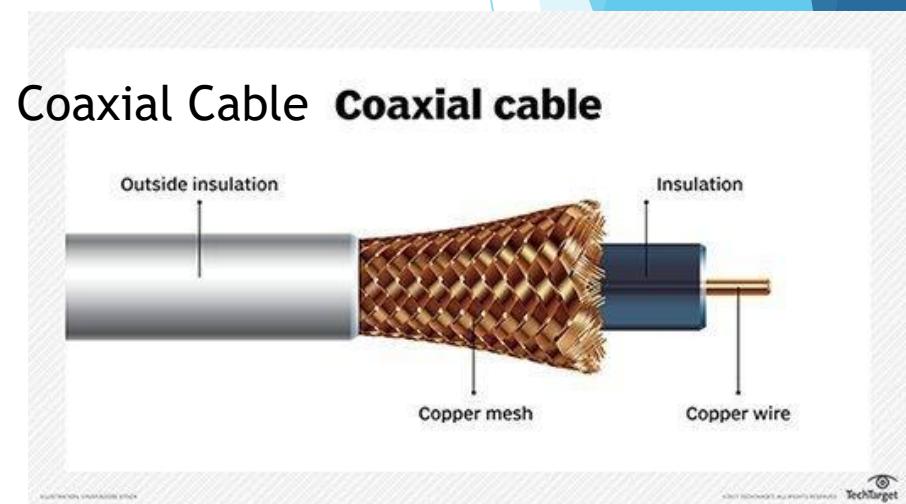
Computer Communication

- ▶ Wireless connection with the use of microwaves and radio waves
- ▶ In the transmission of information from one computer to another, particularly wired connection which is most predominant, a piece of hardware known as **MODEM (modulator-demodulator modem)** is needed for conversion of signals from digital form into analog form and vice-versa as transmission over telephone lines is in analog form while computer data to be transferred are usually in digital form.

Communication devices

Other forms of channels are the cables. In this category, we have the **coaxial cable** and the **fiber-optic cable**.

- ▶ Coaxial cable commonly called “co-ax”, consists of insulated copper wire wrapped in a solid or braided metal shield, then in an external cover.
- ▶ Co-ax is mostly used for **cable television** and to connect **parts of a LAN over a long range**.



Communication devices

- ▶ The world of telecommunications is rapidly moving from **copper wire networks to fiber optics**. Optical fiber is a very thin strand of pure glass which acts as a waveguide for light over long distances.



Fiber Optic Cable

Internal Data Representation

The two common binary coding schemes normally used in data representation are the ASCII -and EBCDIC -codes.

- ▶ ASCII, which is an acronym for *American Standard Code for Information Interchange* was later extended to accommodate more special characters and the latter version was referred to as extended ASCII or ASCII-8.
- ▶ The latest of the versions is the ASCII-16 coding scheme which uses 16 bits. ASCII is the most widely coding scheme used in microcomputers.

Internal Data Representation

- ▶ Unicode or ASCII-16 which is a version of ASCII uses 2 bytes (16 bits) to represent a character, instead of 1 byte (8 bits) and therefore can handle 65,536 characters rather than just 256
- ▶ EBCDIC stands for *Extended Binary Coded Decimal Interchange Code* is the most widely used scheme in mainframe computers. Table 1.1 shows the codes for the uppercase alphabetic letters and numerical digits, 0 to 9. (See Table 1.1)

Internal Data Representation

Table 1.1

<i>Character</i>	<i>ASCII</i>	<i>EBCDIC</i>	<i>Character</i>	<i>ASCII</i>	<i>EBCDIC</i>
A	0100 0001	1100 0001	N	0100 1110	1101 0101
B	0100 0010	1100 0010	O	0100 1111	1101 0110
C	0100 0011	1100 0011	P	0101 0000	1101 0111
D	0100 0100	1100 0100	Q	0101 0001	1101 1000
E	0100 0101	1100 0101	R	0101 0010	1101 1001
F	0100 0110	1100 0110	S	0101 0011	1110 0010
G	0100 0111	1100 0111	T	0101 0100	1110 0011
H	0100 1000	1100 1000	U	0101 0101	1110 0100
I	0100 1001	1100 1001	V	0101 0110	1110 0101
J	0100 1010	1101 0001	W	0101 0111	1110 0110
K	0100 1011	1101 0010	X	0101 1000	1110 0111
L	0100 1100	1101 0011	Y	0101 1001	1110 1000
M	0100 1101	1101 0100	Z	0101 1010	1110 1001
0	0011 0000	1111 0000	5	0011 0101	1111 0101
1	0011 0001	1111 0001	6	0011 0110	1111 0110
2	0011 0010	1111 0010	7	0011 0111	1111 0111
3	0011 0011	1111 0011	8	0011 1000	1111 1000
4	0011 0100	1111 0100	9	0011 1001	1111 1001

Machine Language

- ▶ Machine language -the language that the computer “speaks and understands” -is the binary programming codes which can be processed directly.
- ▶ Instructions in machine language consist of series of 0s and 1s which could be quite tedious to read and write to humans.
- ▶ Machine language is machine dependent due to differences in instruction sets.

Machine Language

- Thus each model or family of processors has a unique machine language.
- To circumvent this problem, programmers write in special programming languages -high level languages -that more closely resemble human languages.
- Codes in these high level languages such as BASIC or C++ are then translated by system software programs called language translators (Assemblers, Interpreters and compilers) into the machine language that the particular type of processor can “understand”.

Types of Files

A file is a collection of related data or information that is identified by a unique name and treated as a unit by the computer.

- ▶ Not all files however, can be used by all software.
- ▶ The format in which a file is saved must be compatible with the particular software for the software to be able to use or process the file.
- ▶ Each file is given a unique named and a – "tag" (PC-based) or extension names added after a period such as .DOC added onto the name of a Microsoft word-processed document file (MYFILE.DOC).
- ▶ Normally, the applications software automatically adds an extension to file names.

Types of Files

The following are some common types of files:

Program files:

- ▶ These are files containing software instructions. Source program files contain high-level computer instructions in their original form, written in a programming language by computer programmers.
- ▶ Files that contain the machine language instructions are called executable files (or binary files).
- ▶ These files can be identified as having the extension as .COM or .EXE

Data Files

- ▶ Data files contain data, not programs -that is, they contain user-created text documents.
- ▶ Such documents are often created using application software programs.
- ▶ These files are given extension names by the software that was used to create them.
- ▶ Example is spreadsheet files created with Excel having .xls extensions or documents created using word-processing software, such as Microsoft Word having .doc extensions.

ASCII Files

- ▶ Also referred to as text files, these are plain text-only files. They contain no formatting such as boldface or italics, and no graphics. The characters are in ASCII code.
- ▶ This file format is used to transfer documents between incompatible platforms, such as IBM and Macintosh. ASCII or Text file usually have .txt extensions.

Image Files

- ▶ These file types hold digitized graphics. They often have many different extensions, depending on the software used to create them.
- ▶ Some examples are .JPG (still images compressed according to standards of the Joint Photographic Experts Group), .GIF (graphics interchange format), and .BMP (bitmap) files that use standard Windows graphics format.

Audio and Video Files

► **Audio Files:**

Audio files contain digitized sound. Common extensions are .WAV
and .MID

► **Video Files:**

Video files contain digitized video images. Common extensions are
.MPG (Moving Pictures Expert Groups) and also .AVI.