

Chapter 3

Organization of a Computer System

3.1 Introduction to Computer Systems

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

3.2 Computer Hardware

Computer hardware is the physical part of the computer that you can see and the parts you can touch. The hardware part of a computer system is composed of a number of interacting physical parts based on the need of the information flow.

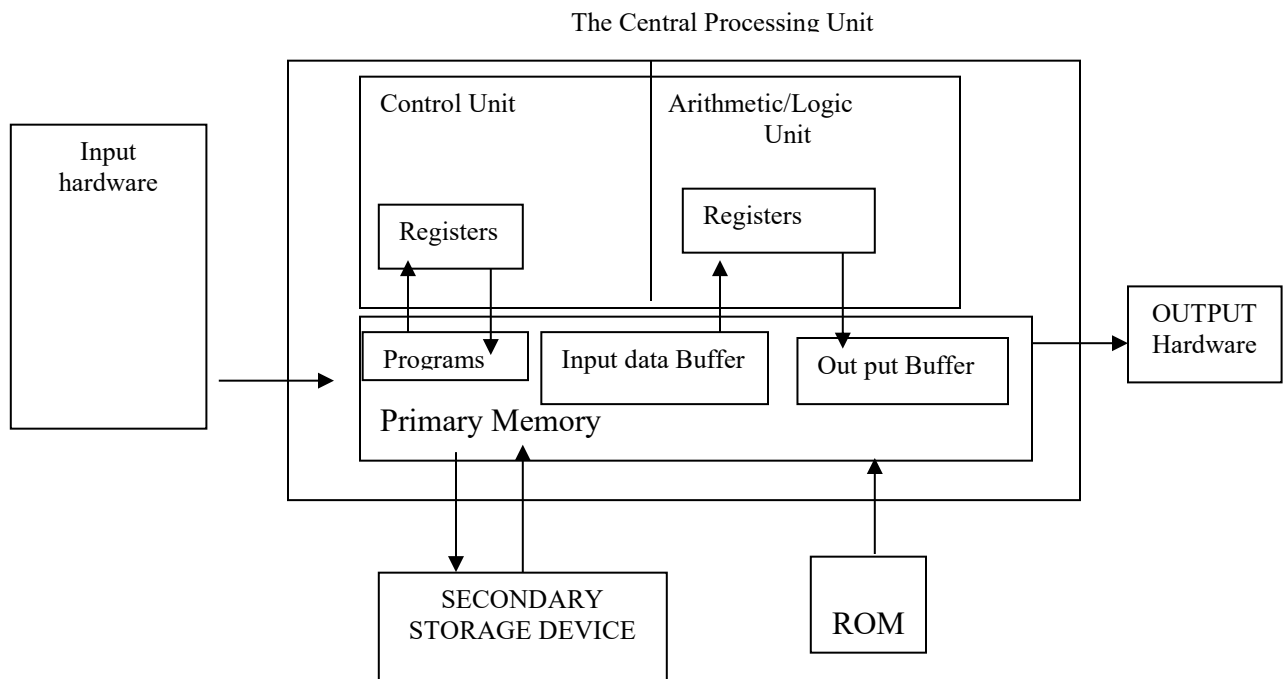


Fig 3.1 Information flow in the computer hardware

In general, the computer hardware is classified as:

- CPU- Central Processing unit
- I/O devices – Input/Output devices
- Storage devices

3.2.1 The Central Processing Unit (CPU)

- Is the most costly and main component of the computer system.
- As its name suggests is the unit that does the work of the computer system, i.e. it executes computer programs.
- It can do arithmetic, compare numbers, and perform input/output (read information and display or store it).
- Consists of the Control Unit & the Arithmetic Logic Unit and registers.
- The three parts work together to electronically control the function of the computer.
- The different parts are interconnected 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).

CPU cycle

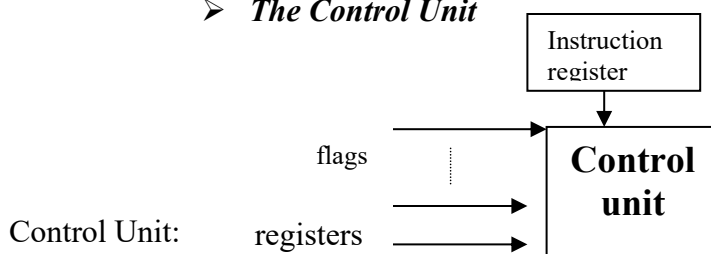
- fetch instruction: The CPU read instruction from the memory
- Interpret instruction: the instruction must be decoded to determine what action is required
- Fetch data: the execution of an instruction may require reading of data from memory or an I/O module
- Process data: the execution of an instruction may require performing some arithmetic or logical operation on data
- Write data: The result of an execution may require writing data to memory or an I/O module.

In order to able to do these the CPU needs:

- store instruction and data temporarily while execution.

In other words, the CPU needs a small internal memory called **registers**, to remember the location of the last instruction, etc.

➤ *The Control Unit*



- Controls the flow of information.
- As the name implies, it performs all the control functions of the computer.
- It retrieves the instruction from memory.
- Translates those instructions into computer functions and sends signals to other computer hardware units to carry out those functions.
- It is also responsible for determining the next instruction to be executed by the computer.
- In general it serves as the computer traffic cop.

The Arithmetic Logical Unit (ALU)



ALU:

- It is referred as the computers "number crunchier ".
- It performs the arithmetic calculations: addition, subtraction, multiplication, division and comparisons (and, or, xor) and it is used to keep track of and execute instruction.
- All modern digital computers can do is addition;
 - multiplication is merely a continuous addition;
 - subtraction is the addition of the complements of the number to be subtracted;
 - division is the addition of complements.

In addition to the ALU and CU, the processor has a small number (usually less than 100) of storage locations to store information that is currently being processed. These locations are called **registers** and depending on the processor, a register may typically store 8, 16, 32 or 64 bits. The register size of a particular processor allows us to classify the processor. Processors with a register size of n-bits are called **n-bit** processors, so that processors with 8-bit registers are called **8-bit processors**, similarly there are **16-bit**, **32-bit** and **64-bit** processors. An n-bit processor is said to have an n-bit word size so a 32-bit processor has a 32-bit word size. The greater the number of bits the more powerful the processor is, since it will be able to process a larger unit of information in a single operation. For example, a 32-bit processor will be able to add two 32-bit numbers in a single operation

whereas an 8-bit processor will only be able to add two 8-bit numbers in a single operation. An n-bit processor will usually be capable of transferring n-bits to or from memory in a single operation. This number of bits is also referred to as the memory **word** size. So, while a byte refers to an 8-bit quantity, a word can mean 8, 16, 32, 64 or some other number of bits. On some machines a word is taken to mean a 16-bit quantity and the term **long word** is used to refer to a 32-bit quantity. Generally,

- Registers are paths or conduits that connect the Arithmetic Logical Unit to the main memory.
- When an instruction loaded from main memory, it is placed first in the register to wait instructions from the control unit.
- Data are also stored in registers prior to execution in the ALU.

An alternative method of classifying a processor is to use the **width of the data bus** (described later), in which case an n-bit processor describes one operating with a data bus of n-bits. This means that the CPU can transfer n-bits to another device in a single operation. Using this classification, the Intel 8088 microprocessor is an 8-bit processor since it uses an 8-bit data bus, although its CPU registers are in fact 16-bit registers. Similarly the Motorola 68000 is classified as a 16-bit processor, even though its CPU registers are 32-bit registers. Sometimes a combination of the two classifications is used where the 8088 might be described as 8/16-bit processor and the Motorola 68000 as a 16/32-bit processor.

Another important component is the CPU **clock**. The clock controls the rate at which activities are carried out by the CPU. It generates a stream of **cycles** or **ticks** and an action can only be carried out on the occurrence of a clock tick. Obviously, the more cycles per second the more actions that the CPU can carry out. The speed of the clock is measured in millions of cycles per second. One cycle per second is one Hertz (Hz), a kilohertz (KHz) is 1000Hz, a megahertz (MHz) is 1000 KHz, and a gigahertz is 1000 MHz. Currently, PCs are being marketed with clock rates range from 2 to 4 GHz and the rate continues to increase.

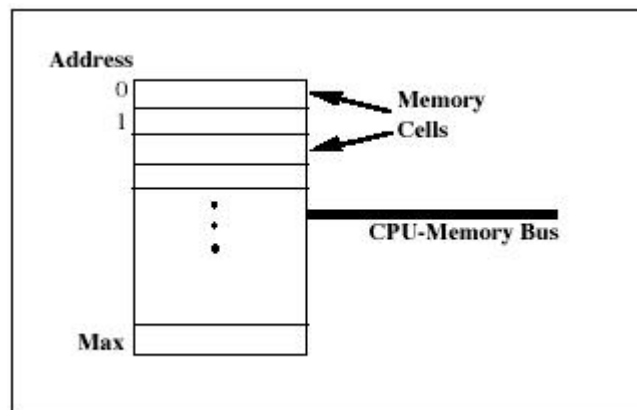
3.2.2 Storage Units

Storage units are classified as Primary and Secondary storage units.

Main Memory or Primary Memory or RAM

- ◆ Is that the memory which is directly accessible by the CPU;
- ◆ Usually referred as Random Access Memory (RAM), because each memory location can be accessed without having to work sequentially through hundreds or even thousands of memory locations called addresses;
- ◆ Each memory location can be referred by its memory location (address);
- ◆ Holds instructions and data elements which are currently being used by the computer;
- ◆ The data in the main memory will be lost when the power is off, i.e. it is volatile;

RAM consists of a large number of storage locations or cells, each one capable of storing a small amount of information typically a single byte. These cells are numbered or **addressed** starting at zero, up to some maximum number determined by the amount of RAM present, as illustrated in the figure below. Currently (2004), PCs typically have 256 Mb to 512Mb of RAM installed, but the figure is constantly being revised upwards.



Memory Organization

The address of a memory cell is used when we wish to access that particular memory location. This means that we must know the address of a cell in memory before we can access its contents.

There are two major forms of RAM called **static** RAM (**SRAM**) and dynamic RAM (**DRAM**). SRAM is the more expensive of the two as it is more complex to manufacture but it is considerably faster to access than DRAM. DRAM has an access time in the range of 20-60 nanoseconds upwards, while SRAM access times range from 4 or 5 nanoseconds to 20 nanoseconds. It is not uncommon for a computer system to have a small amount of SRAM and a larger volume of DRAM making up its total RAM capacity.

The SRAM is used to construct a **cache** memory which stores frequently accessed information and so speed up memory access for the system.

There are other forms of primary memory such as **ROM, PROM, EPROM EEPROM** and **flash memory**. ROM (**Read Only Memory**) is the same as RAM in so far as any location can be **read** from at random, but it cannot be written to. ROM is **pre-programmed** by the manufacturer and its contents cannot be changed, hence its name read only. This means that ROM is a form of permanent storage. However, since the user cannot store information in ROM, its usefulness is restricted. ROM is typically used to store programs and data that are required to **start up** (boot) a computer system. When a computer is powered on, its RAM will contain no useful information, but the processor is designed to run programs that it finds in memory. One major use of ROM is to store the initial program used by the processor when the machine is started. Another use of ROM in personal computers, is to store operating systems subprograms for carrying out I/O and other activities. The term **firmware** is used for the combination of ROM and the software stored on it. **PROM** stands for **programmable** ROM which means that the memory chip manufacturer provides a form of ROM that can be programmed via the use of a special hardware device. This allows computer system designers place their own programs on the PROM chip. If their programs do not operate correctly, the designer can program another PROM chip, as opposed to getting the memory manufacturer to do it, as is the case when a designer uses ROM. EPROM is a form of ROM that is **erasable** which means that the contents of the EPROM chip can be erased in their entirety and the chip can be reprogrammed (a limited number of times). As in the case of PROM, EPROM can only be programmed and erased (via exposure to ultra violet light) by a special hardware device, outside the computer system. EEPROM is **electrically erasable** PROM. EEPROM can be erased inside a computer system using an electrical current. Its major advantage is that it does not have to be removed from the computer system. In recent years work has advanced on such **non-volatile** RAM (**NVRAM**) devices. **Flash memory** is one such device. This memory can be accessed like RAM (read and written), but is non-volatile i.e. it is a form of permanent storage. At the time of writing flash, memory is available in the 512Mb to 4 Gb range. One disadvantage of current NVRAMs is that they cannot be written to, as quickly as ordinary RAM. However, they are much faster to

access than disk storage systems and they consume less power, so that in small portable computer systems they offer an alternative low-powered option to disk storage. However, NVRAMs are more expensive than disk storage devices. In general ROM:

- ◆ is integrated into the circuitry of the computer and can not be altered without altering the computer circuitry.
- ◆ is used to store programs and data that are used frequently and permanently.

Due to high price of a primary storage memory of a computer system, the need to have other type of storage to hold large amount of data in a less expensive and yet accessible manner is evident. Hence secondary storage device were created with this need in mind.

Secondary Storage: - secondary storage or auxiliary storage, can take many forms, which have traditionally included punched cards, papers tape, magnetic tape, magnetic disk and magnetic drum. This category of storage devices store large amount of data permanently. The two commonest forms of secondary storage are disk and tape storage. We can classify secondary storage devices as:

- Sequential access devices: where accessing the n^{th} element or data requires passing through from 1^{st} element to the $n-1^{\text{th}}$ element.
- Direct access devices : where we can access every element or data directly.

Sequential Access Medias

Magnetic Tapes

Magnetic tapes are a particularly popular form of secondary storage because of their high data density (the number of bytes per inch of tape) and their convenience in handling. Magnetic tapes are approximately one - half inch wide and are made of Mylar – based plastic film which can be magnetized. Data are stored on a magnetic tape by running the tape over the electromagnetic called read/write head which magnetizes small spots on the tape. Seven-track tapes store information as bytes of information, where each byte consists of a six-bit code and a one-bit parity bit. Nine-track tape uses an eight-bit and a parity bit.

An 800 bytes per inch density of magnetic tape with a length of 100 inch can store 80,000 bytes of information.

Random Processing Medias

Magnetic disks

Magnetic disks are metals or plastic platters coated with ferrous oxide, an easily magnetizable material. Magnetic disks allow for random access of information and overcome the slow access time commonly found in tape files.

Disk storage is the most popular form of secondary storage. It is more versatile than tape storage. It is faster to access, as information on any part of the disk can be accessed (**direct access**) quickly, independently of its position on the disk. Its disadvantage is that it is more expensive than tape storage. The surface of a disk is divided into **tracks** and each track is divided into **sectors (blocks)**.

There may be from 40 to hundreds of tracks on a disk surface. Each sector of a track will typically have a capacity from 32 to 1024 (1Kb) bytes. Information is stored on or read from a disk magnetically, using a read/write head. To access information on a disk, the head must be moved to the correct track (the time taken to do this is called the **seek time**); the correct **sector** must **rotate** around to the head (the time taken to do this is called the **rotational delay** or **latency**) and finally the information may be transferred (transfer time). On a typical hard disk, the average seek time is less than 20 ms (milliseconds). Based on a disk rotation speed of 3600, the average rotational delay is the time for half of one rotation, about 8 ms. The transfer time is so small, compared to the seek time and latency, that it can be ignored. Rotation speeds now range from 3000 to 9000 revolutions per sec.

Note: It is approximately 100,000 times slower to access information on disk than to access information in RAM.

This is because of the electromechanical nature of the disk drive, involving disk rotation and read/write head movement. While the speeds used in disk drives are quite fast in human terms, in CPU terms, they are extremely slow. For example, the CPU can access information stored in RAM in of the order of 20 to 100 nanoseconds. The CPU can access information in its registers in a few nanoseconds. So from the CPU's perspective, if information has to be fetched from disk which takes of the order of 28 milliseconds, then a long wait ensues. As a result of the mismatch in speed between the CPU and disks, much work is concerned with making disk I/O as efficient as possible. For example, you can arrange to do disk I/O, so that when you read something from disk, you read a big

chunk (at least one sector). Then when you need another piece of information, it may have been read into memory already, as part of the large chunk. You can also arrange information on disk, so that it is stored on the same track or neighboring tracks which means that the seek time can be significantly reduced. The physical size of disk drives has decreased dramatically over the years. Only a few years ago, a disk drive of 100MB capacity would have been larger than a domestic washing machine. Nowadays such a multi-gigabyte disk drive fits easily inside a laptop or notebook computer. The cost of disk storage has fallen in a similar manner. The shrinking size and low cost of disk drives has led to the use of systems with several disk drives or arrays of disk drives. In addition, to increase availability of data, **Redundant Arrays of Independent Disks (RAID)** systems have been developed. Current disk sizes for PCs range from 6 to 120GB, and the amount is constantly increasing. In summary hard disk:

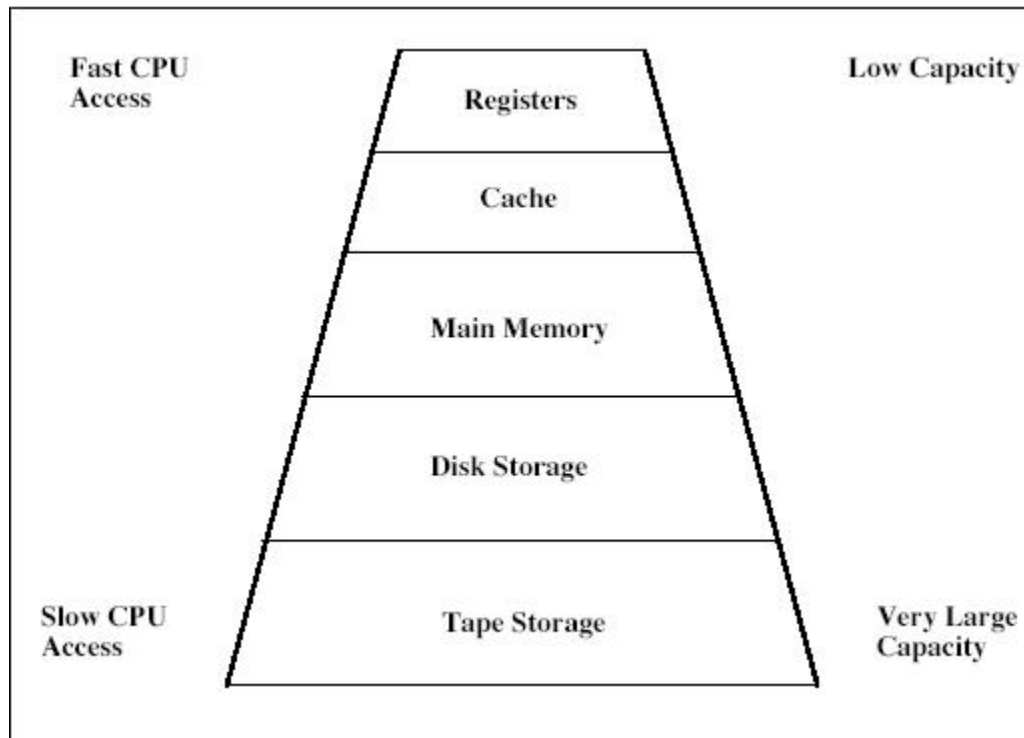
- Is a high capacity magnetic disk made up of metal which can be fixed in the system unit of the computer.
- Serves as a secondary storage.
- Enables very fast accessibility of data.
- Accessing data from hard disk is faster than from floppy disks.
- The disks, which are usually grouped together into a *disk pack*, are separated by small air spaces to allow access for read/write head.
- Each disk has approximately 200 tracks on which information is stored. Tracks of the same number on all adjacent disks are referred to as a *cylinder* of that disk.
- The disk pack is mounted on a magnetic disk drive which rotates the disk at speed up to 1,000 revolutions per second.
- Cross section of a disk pack
- The total collection of tracks available on one movement of the access mechanism is known as *cylinder*.
- The amount of time it takes to retrieve (or store) data from (or to) disk is called the disk access time.

CD-ROM (Compact Disk Read-Only Memory) is another form of secondary storage that is increasing in popularity. It is a low-cost storage medium with a very large capacity. Unlike disk storage, CD-ROM is a WORM (Write Once Read Many times) device i.e. it

is a **read only** storage device. This means that like ROM, the disk comes with information already stored on it. Thus, one of the main uses of CD-ROM is to disseminate information such as library catalogues, reports, manuals, journals, directories and software. It has also become a very popular medium for computer games. Many software vendors and computer manufacturers such as Sun and Apple distribute their software and manuals on CD-ROM. Many publishers now use CD-ROM especially for educational material and it is possible to buy encyclopedia and history texts in CD-ROM form. The CD-ROM has sufficient capacity not only to store the written text, but also video and audio material which require large amounts of storage, for example, a digital version of a passport size photograph requires up to a megabyte of storage.

CD-ROM uses the same technology as the compact audio disk or CD and such disks can also be used in a CD-ROM drive. Optical scanning techniques, using lasers, are employed with CD-ROMs, which allow massive amounts of data to be stored in a compact area. A CD-ROM drive is about the same size as a floppy disk drive. In terms of capacity, a single CD-ROM may store up to 600 megabytes. In terms of text this is equivalent to about 200 books of 1000 pages each. A disadvantage of CD-ROM is that it takes longer to access information compared to a hard disk. However, clever software tailored for particular applications often means that this is not a serious problem. **Video Disks** are similar to CD-ROM (but have a larger capacity) and are used for similar applications. Rewritable CD storage (CD-R) is now becoming more widely used. This storage combines the reliability and storage capacity of CD-ROM with the flexibility of magnetic disks in that users can store their own information on them. They are still slower to access than conventional hard disks. CD-ROMs are now being replaced by **DVD-ROMs** (Digital Versatile Disks). DVD-ROM capacity ranges from 4.7 Gb upwards (4.7 x 2 or 4.7 x 4 Gb). These are also used for distributing films as a rival to video tapes. A current PC will typically have a DVD drive which is also capable of reading

conventional CDs. DVD-RAMs are also available which allow users to store files.



Storage hierarchy of a computer system

3.2.3 Input/Output Units

Input/Output (I/O) units allow people and other technologies to put data into a computer and get information out of a computer. I/O units are the means to communicate with the computer.

Input Units

- Are units used to enter data into the computer so that it can be processed.
- Convert information from a form suitable to human beings to one understandable by the computer and vice versa.

Examples of input devices;

- Keyboard (which is the most widely used input devices)
- Disk drives (floppy and CD-ROM drives)
- Mouse, trackball, joystick
- Scanner
- Light pen (a photo cell to choose a displayed response to request)

further information).

- Voice synthesizer, etc

Special Input Units

1. Magnetic Ink Character Recognition Systems

- It is intensively used by U.S. banking industry to input information on checking account transactions. It has been in use since the 1950s, allows checks and deposit slips to be read both by people and by machines. The machines, called magnetic ink character readers, read and convert the characters into machine code by detecting the presence of magnetized particles in the ink on the checks or deposit slips. As many as 1500 checks per minute can be read and stored.

2. Optical Recognition Systems

Optical Recognition Systems fall into two categories. The first and most advanced are the Optical Character Recognition (**OCR**) systems, which are **able to recognize hand-printed and typewritten characters**. The second type of optical character recognition is referred to as Optical Mark recognition (OMR). **OMR** doesn't utilize **letters of the alphabet**. Instead, with the use of **electronic scanners, marks and symbols are converted into appropriate electronic signals**. A typical example of an OMR application would be computerized test forms. OMR systems are also used to read bar codes such as the Universal Product Code (UPC).

Output Unit

- 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.

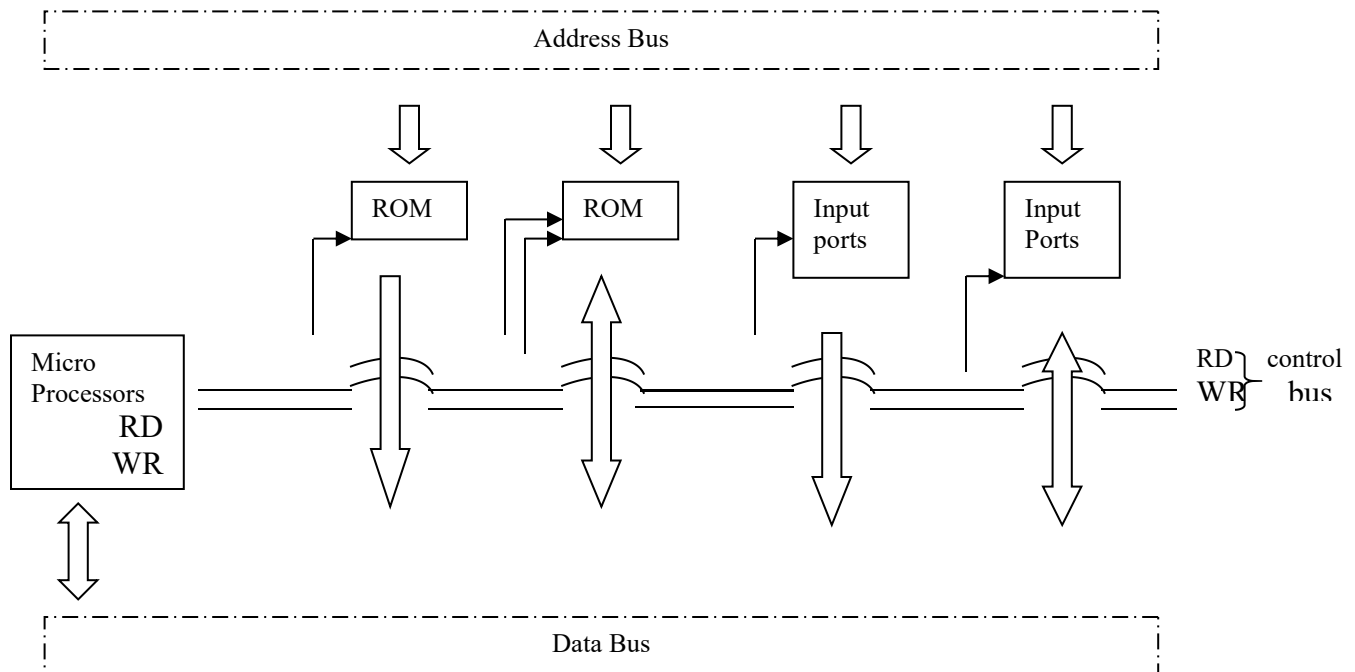
Examples

- The Visual Display Unit (VDU) or monitor or screen
- Printers (dot matrix, desk wheel, laser printers)
- Plotters
- speakers
- Disk drives

Interconnecting Components in a Computer and Information Movement in a Computer System.

We have seen that there are different components of a computer and each performs a specific function. But to perform a given task in synchronized form there should be some mechanism of communication. For this **reason there is an electronic circuit which produces communication path between the different components of a computer system along which data are transferred, that is Bus.**

The bus, which communicates the different parts of the CPU is called Internal Bus. And the bus, which communicates the CPU with memory and peripheral devices is called External Bus. The size of the bus determines the speed of efficiency of the computer.

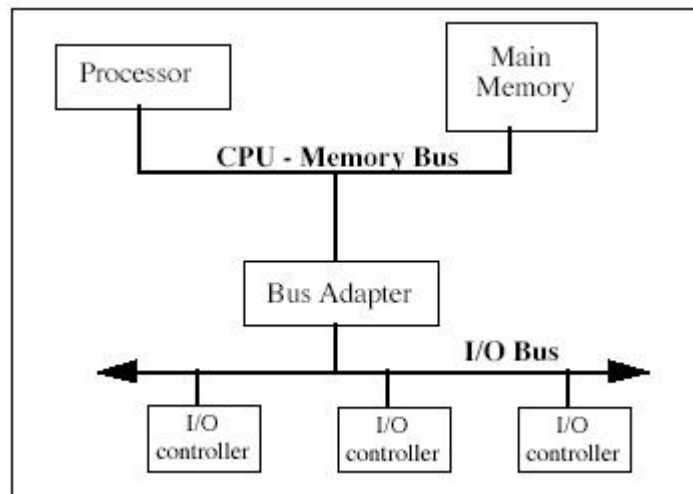


Address Bus: - is a unidirectional bus over which digital information is transferred to identify either a particular memory location or particular I/O address.

Data Bus: - a bus system which interconnects the CPU, memory and all the peripheral Input / Output devices of a computer system for the purpose of exchanging data.

Control Bus: - a bus used to select and enable an area of main storage and transmit signals required to regulate the computer operation. It carries control signals that allow the CPU to control the transfer of information along the bus. For example, the CPU must be able to indicate whether information is to be transferred from memory or to memory; it must be able to signal when to start the transfer and so on.

It is important to realize that a computer system may have a number of separate bus systems so that information can be transferred between more than one pair of components at the same time. For example, it is common to have one bus for communicating between memory and the CPU at high speeds. This bus is called a CPU-Memory bus. In addition, this bus would be connected to a second I/O bus via a bus adapter, as illustrated in the figure shown below. This second bus would be used for the slower I/O devices.



This arrangement allows the processor more efficient access to memory, as the CPU-memory bus can operate at very high speeds. These high speeds are only possible, if the physical bus length is quite short. Thus, by providing a second I/O bus to accommodate the various I/O devices that may be connected to the computer, the length of the CPU-memory bus can be kept shorter than it would be if the I/O devices were to be directly attached to a single system bus. On the other hand, to keep the cost of a computer system low, a single bus running at a slower speed, may be used to connect all devices to the CPU.

In order to attach any device to a computer, it must be connected to the computer's bus system. This means that we need a unit that connects the device to the bus. The terms device **controller** and device **interface** are used to refer to such a unit. So, for example, a

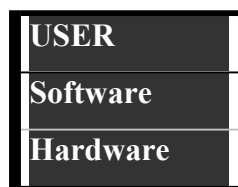
disk controller would be used to connect a disk drive to the system bus and the term I/O controller refers to the controller for any I/O device to be connected to the bus system. A computer system will have some standard interfaces such as a **serial interface**, which can be used with a number of different I/O devices. The serial interface, for example, can be used to attach a printer, a mouse or a modem (device for communications over a telephone line) to the computer. So, if you wish to construct a new type of I/O device, you could use the standard laid down for the serial interface (the RS-232 standard) and you could then attach your device to the computer, using the serial interface.

3.3 Computer Software

The computer hardware is an electronic device which has the potential of performing the task of solving a problem. However one has to give precise instructions to the hardware in order to solve problem. The hardware can perform nothing without a software.

The finite set of instructions (steps) that the computer follow to perform a given job is called a **program**. Any program to be executed, first it should reside / loaded/ in the memory.

Software:- is a collection of programs and routines that support the operations of performing a task using a computer. Software also includes documentations, rules and operational procedures. Software makes the interface between the user and the electronic components of the computer.



Computer software is classified into two

1. System software
2. Application software

3.3.1 System software

- Constitutes those programs which facilitate the work of the computer hardware.
- It organizes and manages the machine's resources, handles the input/output devices.

- 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.

The important categories of system software are:

- a). Operating system
- b). Language software

a). *Operating system*

Operating system coordinates the activity between the user and the computer. An operating system has three major functions.

i. *Controlling operations (control program)*

- 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.

ii. *Input/output Management*

- The I/O manager coordinates the computers communication with outside world, flow of data to the display screen and other output devices (printers/ plotters) and from the key board or other input devices.
- Handles the flow of data to and from the disk drives (file management).
- Handles the process of preparing a disk for use, the copying, renaming, erasing task of a file.

iii. *Command Processing (command Interpreter)*

- It interprets the commands or what you enter using the keyboard or other input devices.
- If you write an internal command it carries out the function of that command if

it is external command or other executable file it searches for the corresponding file in the default (current disk) or the user specified disk, loads the file into memory and transfers control to that program. Once this program is terminated, control returns to command and the program for that command or file is discarded from memory.

Types of Operating Systems

Operating systems can be classified by:

- The number of programs they can handle at a time and
- The number of users they serve at once at one or different stations (i.e. terminals or micro-computers connected to a central computer).

i. Single tasking operating systems

- With single tasking operating systems: only one program can be run on a computer at a time.
- In order to run another program, one must remove the first program loaded in the computers main memory and load the other one(i.e. it can't handle two or more programs at a time)
- These types of operating systems are single user or can serve only one user at a time.

ii. Multi user operating system

- It supports a number of work stations connected to a central system.
- A number of users can use the resources of one high capacity computer by the help of terminals.

iii. Real Time Operating System

- A real time is a system that is capable of processing data so quickly that the results are available to influence the activity currently taking place. Their primary characteristic is that, they respond to an event within a well defined time.

Example: - Air plane seat reservations and computer controlled plant.

B). Language Software.

- Are software which are used by programmers to develop application software's and translate programs to machine code.
- Language software is a generic name consisting of various programs that

serve as editors & translators to develop programs in a number of programming languages includes:- Translators, general purpose routines and utilities & high level languages

- ◆ Translator:- is a program that converts one or more languages to another language. Three types of translators are assemblers, Compilers & interpreters.
 - Assemblers:- is a program that translates assembly languages into machine code.
 - Compiler:- is a program that translates a high level language into machine code. (Pascal, Fortran Cobol)
 - Interpreter:- is a program that translates each instruction of high level language & executes the instruction before translating the next instruction.
- ◆ The general-purpose routine and utilities include programs which are used to handle file processing, editing and debugging.
- ◆ High level language software are software which have their own compilers to detect syntax errors of the users program code.

Example Cobol, Fortran, Pascal. Etc.

3.3.2 Application Software

- Is software that is designed to perform tasks for the specific area or areas. But for use in more than one installation.
- Are usually called application packages as they may include a number of programs along with operating instruction, documentation and so forth.
- Depending on their function or task they are categorized in to the following.

1. Word Processors/ Word processing

- is a computerized typewriter which permits the electronic creation, editing, formatting, filing and printing text.
- Is the most common application of microcomputers.
- Until recently, word processing could be done only dedicated word

processors. A dedicated word processor is a computer that denies its users the opportunity to execute any other program.

Example: WordStar, WordPerfect, Microsoft word

2.Spreadsheet

- is an electronic worksheet display on the VDU.
- Until recently, financial analysis and other mathematical calculation were done by entering numbers on pages of an accountants ruled ledger pad.
- You can quickly create a model of a situation on a spreadsheet by entering labels, numbers & formulas.
- Using the programs built-in function you can perform complicated calculations such as net percent value, internal rates of return, and monthly payments on a loan.

Example: Lotus 1-2-3, Microsoft Excel, Quatropro

3.Database management system.

- Allow you to store information on a computer, retrieve it when you need it and update it when necessary.
- You can do this with index cards, but database management programs do them more quickly and easily.
- Example: You can store large mailing list, inventory record or billing and collect information in lists stored in files and manipulate this information, one file at a time with database management program.
- You can record or create a database about employee information as ***Name, sex, Marital status, salary, Date of Birth, Date of employment, Post, Department, Level of education, Field of study, etc.***

Then you can ask the computer the following question

- How many female workers are there?
- List employees with a salary of birr 500 and above
- List those employees who are department head and have Bachelor degree or higher and so on.

Example: Dbase IV, FoxPro, Microsoft Access.

Processing Power of Computers

The potential and capacity of a computer is measured by different parameters. Some of these parameters are:

- a. Capacity of the computer
 - Processing speed of the processors:- Processing speed is measured in Hertz, a unit used in the definition of frequency.
20 Hz = 20 cycles per second
1 KHz = 1000 cycles per second
1 MHz = 1 million cycles per second
1 GHz = 1 billion cycles per second
- b. Primary memory storage capacity and its speed or access time (the time it took to read a data or write a data)
- c. Secondary storage devices capacity and their access time
- d. The efficiency and capability of the programs used.

The processors

- In large computers like mainframe and mini computers, the processor is often called a Central Processing Unit (CPU).
- In mini computer or personal computer the processor is sometimes called Microprocessor or just processor
- A microprocessor is a semiconductor device consisting mostly one software controlled LSI chip which performs the functions of automatic data processing.
- Processors are not optimized to perform complex numerical calculations and other special tasks (graphics manipulations). For this purpose specialized **coprocessors** which are also called **math-coprocessors** have been developed to increase the processing capability of a computer and speed up complex mathematical floating-point calculations
- The coprocessors operate in parallel with CPUs.
Examples are: 8087, 80287, 80387 and 80487

Family of processors

- The first processor, **Intel 4004**, a 4-bit microprocessor, was introduced in 1971 by Intel Company.
- An 8-bit microprocessors were introduced by a number of companies:
 - The Motorola's Mc 6809 Microprocessors

- The Zilog's Z80 and Z800 Microprocessors
- The Mos Technology's 6500 series Microprocessors
- The National Semiconductor's NSC 800 Microprocessors etc.

Processors of the Intel 86 family

- The ancestors of the 86 family are: the 4000, 8008, 8080A and 8085 A microprocessors.
- Computers store and manipulate information as bits.
- We can characterize a processor by saying how many bits it can work with at a time and how many bits it can send or receive at a time.

Intel Microprocessors

<u>Microprocessor</u>	<u>Word length</u>	<u>Clock frequency</u>
8086	16-bit	5-10 MHz
8088	8/16-bit	5-8 MHz
80186/186	16-bit	6-8 MHz
80188	8/16-bit	6-8 MHz
80286/286	16-bit	6-12.5 MHz
80386dx/386dx	32-bit	20-33 MHz
80386sx/386sx	16/32-bit	20 MHz
80486/486	32-bit	25-66 MHz
(80486Dx, 80486SX)		
Pentium	64-bit	-180 MHz

Motorola Microprocessors

<u>Microprocessor</u>	<u>Word length</u>	<u>Clock frequency</u>
6800	8-bit	1 MHz
6809	8-bit	4-8 MHz
68000	16/32 bit	10-25 MHz
68020	32-bit	12.5-33 MHz
68030	32-bit	20-33 MHz