targeting and product or brand positioning. Most marketing systems are designed as a inquiry or feedback forms that provide inputs to marketing, planning control and research. A typical marketing information system should incorporate the following basic formats:

(i) Performance analysis based on sales summaries

(ii) Management Report System derived from performance analysis.

(iii) Feedback forms from the market.

Marketing control systems with appropriate credit and discounting system.

Human Resource Development (HRD) management emphasizes an optimum utilization of human resources by formulating coherent politics aimed at promoting commitment to the organization. Traditionally, information systems for HRD had been restricted to personnel management systems whose purview includes recruitment, placement, training and development, compensation and maintenance. HRD systems tie functions of personnel management system with other functions of organization such as marketing, finance, production and inventory control. HRD information systems are classified as typical Personnel Management Information Systems (PMIS) and Human Resource Management Information Systems (HRMIS), PMIS undertake the data processing of routine personnel activities while HRMIS are primarily based on the requirements of human resource planning. The scope of HR management includes work design, recruiting, performance analysis, reward and motivation plan, work evaluation, salary structure design, employees' skill analysis and systematic training.

## 5.6 KEYWORDS

***Information System:*** A collection of elements that capture data and convert it in information and disseminate to the decision-makers in an organization.

***Information Technology:*** Hardware and software that perform data processing tasks, such as capturing, transmitting, storing, retrieving, manipulating or displaying data.

***Financial Accounting System:*** This system provides financial statements to investors, governmental authorities and other interested parties in accordance with their reporting formats.

***Management Accounting System:*** It provides reports to managers (i) for strategic and tactical decisions and (ii) on profitability of the firm.

***Cost Accounting System:*** It provides reports to managers for cost planning and cost control of operations.

***Inventory Control Systems:*** All organizations need an efficient system to maintain and control the optimum level of investment in all types of inventories.

## 5.7 QUESTIONS FOR DISCUSSION

1. How does an accounting information system satisfy the information needs of management and other people?
2. Differentiate among three types of accounts along with suitable examples.

3. Describe the inputs and outputs of a typical accounting information system. How does the system help managers?
4. Discuss the importance of computerized information systems for human resource development.
5. Differentiate among HRD, PMIS and HRMIS with suitable examples.
6. Describe the importance of various types of human resource information systems for an organization.
7. Discuss importance of office systems in a business organization.
8. What are the advantages of ERP systems? What are the bottlenecks in implementation of ERP systems?
9. What are the threats to privacy that the IT era has brought along with itself?

**Check Your Progress: Modal Answers**

1. This system provides financial statements to investors, governmental authorities and other interested parties in accordance with their reporting formats.
2. Most commonly, ERP (Enterprise Resource Planning) systems are practiced in manufacturing sector though lately service sector organizations are also planning to deploy ERP solutions to streamline their business processes.

## 5.8 SUGGESTED READINGS

Deepak Bharihoke. *Fundamentals of IT*. Excel Books.

Deepak Bharihoke, *Fundamentals of Information Technology*, Excel Books.

Turban, Rainer, Potter, *Introduction to Information Technology*, John Wiley & Sons, Inc.

# LESSON

# 6

# COMPUTER HARDWARE

CONTENTS

## 6.0 AIMS AND OBJECTIVES

After studying this lesson, you will be able to:

- Discuss computer hardware
- Discuss hardware components
- Discuss memory and its type
- Discuss input devices and output devices

## 6.1 INTRODUCTION

The importance of Information Technology (IT) infrastructure is recognized more and more within companies and corporations. In addition to the increasing interest shown for IT infrastructure by practitioners, the academic literature abounds with research and studies related to the topic. The sooner companies realize the importance of building and leveraging IT infrastructure, the better will be the value and higher the return they can capitalize on. But what is IT infrastructure, actually? Firm-wide centrally coordinated IT infrastructure consists of technology components (such as communication technology and data) which individuals with technical and managerial competence use to produce standard and shared services. These services are then provided for shared and standard, firm-wide and business-specific applications, at the service levels required, according to standards defined in the IT architecture. It is understood, of course, that the flexibility of IT infrastructure and the securing of compatibility within and between the IT infrastructures of business units, industry and the public must also be arranged. This study, however, is delimited to firm-wide IT infrastructure.

The hardware is a collection of physically existing parts of a computer. As we have studied previously about the various operations of computer, in this lesson we will see what operation is taking place in which part of the computer, how these parts are connected together and how they communicate and work together to accomplish the task given to the computer.

We know that computer is an electronic device which uses electronic pulses for communication. Here we see how these bit patterns can be transferred to various parts of the computer, which parts are used for input, output and processing and how they perform this work.

## 6.2 DEFINITION OF HARDWARE

Computer hardware represents all the physical components of a computer system that can be seen and located. Thus, it includes input devices, output devices, central processing unit and storage devices.

## 6.3 COMPUTER SYSTEMS – HARDWARE

Technological change is becoming a driving force in our society. Information technology is a generic term used for a group of technologies. James William (1982) has identified the following six major new technologies as most relevant in modern library and information system.

1. Processor, memory and input/output channels,
2. Micro. Mini and Large scale computers,
3. Mass storage technologies,

4. Data communication, networking and distributed processing,
5. Data entry and display respond, and
6. Software

These technologies can also be grouped into three major areas:

1. Computer Technology,
2. Communication Technology and
3. Reprographic, Micrographic and Printing Technologies

A computer is a data processor. It can accept input (data and instructions), remember the input by storing it in memory cells, process the stored input by performing calculations and by making logical comparisons, and it can communicate or output information.

In a simple way, a computer is a machine that carries out instructions. The set of instructions, which tell a computer to execute a series of specific tasks, is called a program. A computer is more accurately referred to as a computer system consisting of hardware, the physical components, and software, the programs that control it.

Computer hardware consists of input devices, output devices, circuitry, memory, and the Central Processing Unit (CPU) where processing and operations are performed. Input devices, such as a keyboard or mouse, are the means by which the computer takes in symbolic data and instructions. Output devices, such as the monitor or printer, are the means by which the computer sends out the symbolic results.

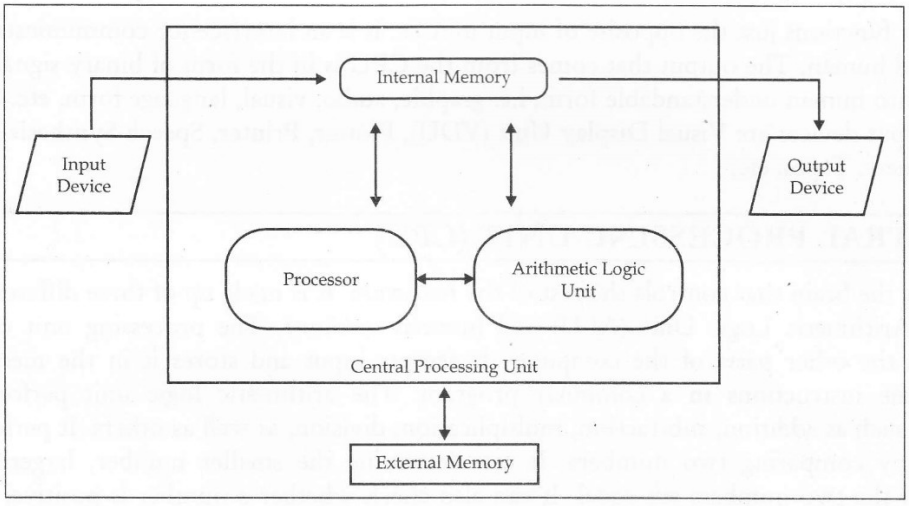


**Figure 6.1: Computer System**

Computer, as such, is not a single machine but a combination of several working units. To accomplish a task it requires input which is taken from Input Unit. The processing part is handled by the Central Processing Unit (CPU). The output that is generated is sent to Output Unit or saved on Secondary Storage Devices. The input unit converts the input in machine understandable form and transfers the input data in the form of digital signals for processing. These digital signals are interpreted by the CPU and processed. The output unit on the other hand, converts the output-digital-signals generated as a result of processing into understandable form.

For example, a computer user gives instructions to the computer through keyboard which is processed by the CPU and output is displayed back on the screen or printer.

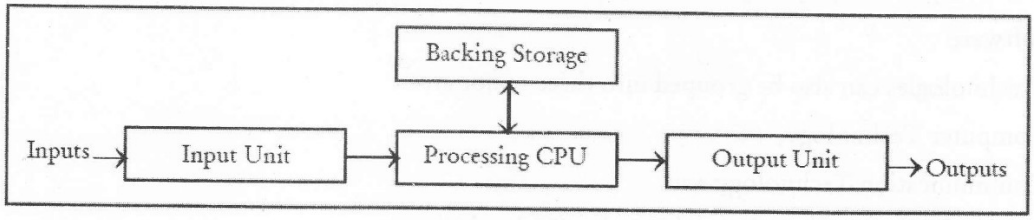


Figure 6.2

All the units communicate with each other through internal set of wires called ports. Let us, understand each of these units separately.

### 6.3.1 Input Unit

The input unit provides man to machine communication. Input of any form is converted into binary electronic signals which can be understood by the CPU. This process is called digitizing. Input data may be graphical, audio, visual, linguistic, mechanical, etc. Some of the input services used for this purpose are Keyboard, Mouse, Joystick, Light pen, Voice Data Entry (VDE), Punched Cards, Optical Mark Reader (OMR), Optical Character Reader (OCR), Magnetic Ink Character Reader (MICR), Bar Code Reader, Magnetic Tapes and Disks, etc.

### 6.3.2 Output Unit

Output unit functions just the opposite of input unit i.e. it is an interface for communication between machine and human. The output that comes from the CPU is in the form of binary signals which get converted into human understandable form, i.e. graphic, audio, visual, language form, etc. Some of the popular output devices are Visual Display Unit (VDU), Plotter, Printer, Speech Synthesizer, Magnetic Disks, Magnetic Tapes, etc.

## 6.4 CENTRAL PROCESSING UNIT (CPU)

The CPU is the brain that controls the rest of the hardware. It is made up of three different parts: the processor, Arithmetic Logic Unit (ALU) and internal memory. The processing unit or processor controls all the other parts of the computer. It accepts input and stores it in the memory and it interprets the instructions in a computer program. The arithmetic logic unit performs various operations, such as addition, subtraction, multiplication, division, as well as others. It performs logical operations by comparing two numbers. It can determine the smaller number, larger number or determine if the two numbers are equal. It can also check whether a number is positive, negative or zero. The processor and the ALU use a small amount of the internal memory; most data are stored in external memory devices using hard or floppy disk drives that are attached to the processor. All the actions performed by the computer system are initiated, performed and controlled by the CPU. The CPU works with binary signals only. Every instruction that is executed first gets stored in the memory unit, then it gets processed by the CPU. Basically CPU has three parts:

- Arithmetic Logic Unit
- Control Unit
- Memory

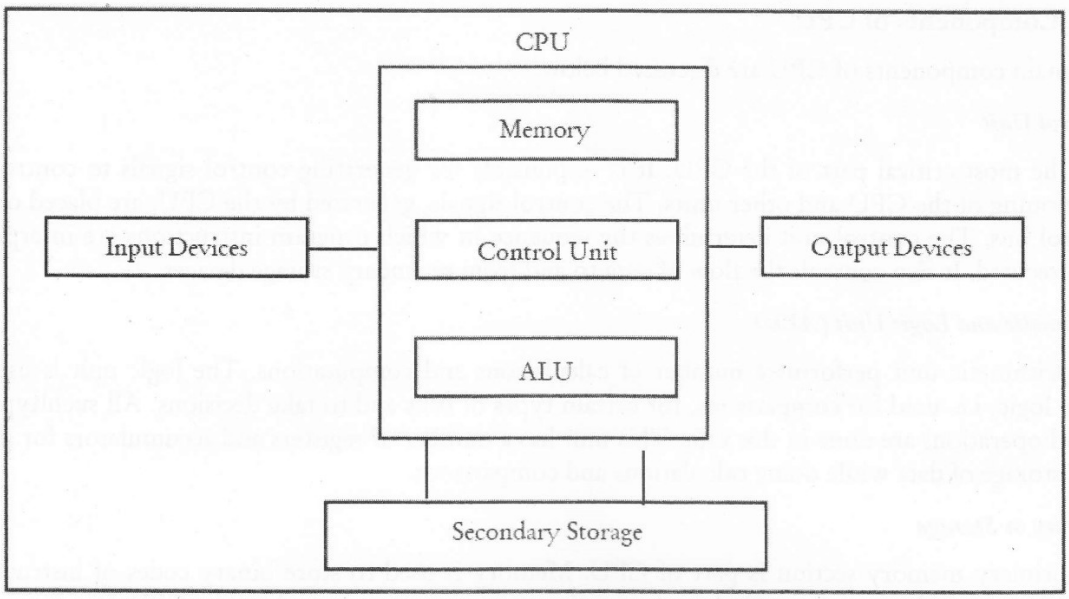


**Figure 6.3: Block Diagram of a Computer**

The components of CPU communicate among themselves with the help of a internal set of wires called 'Bus'. Just as buses carry people from one place to another, here these wires are used to carry data from one unit to another hence the name BUS. There are different kinds of buses for different purposes.

***Data Bus***

The data bus carries the data that is transferred from one unit to another. Generally a data bus is a bi-directional bus. This means that data can travel in both the directions. The size of a bus determines how much data can be transferred at one time. If the width of data bus is 16 then 2 bytes of data can be transferred at a time.

The need of data transfer may arise due to interaction between memory and CPU, input output unit and processor, etc.

***Address Bus***

Every information stored in the memory is identified by a unique number called an 'address'. This address needs to be supplied to this memory for accessing of data. The address bus carries the address of the data to be accessed. The number of memory locations that a CPU can address is determined by the number of address lines. If the CPU has no address lines then it can address 2n different addresses in the memory and other I/O equipment. The address bus is uni-directional - from CPU to memory or from CPU to I/O unit.

***Control Bus***

It is the most important bus of the system. It controls nearly all the operations in the CPU. The most common control bus signals are the read-write signals. To read from memory unit, the CPU places the address on the address bus, i.e. location from where data is to be read and initiates the read control signal.

The control bus is also unidirectional because control signals are initiated only by the CPU.

### 6.4.1 Components of CPU

The main components of CPU are discussed below.

***Control Unit***

It is the most critical part of the CPU. It is responsible for generating control signals to control the functioning of the CPU and other units. The control signals, generated by the CPU, are placed on the control bus. The control unit determines the sequence in which program instructions are interpreted and executed. It also controls the flow of data to and from secondary storage devices.

***Arithmetic and Logic Unit (ALU)***

The arithmetic unit performs a number of calculations and computations. The logic unit is used to apply logic, i.e. used for comparisons, for certain types of tests and to take decisions. All such types of logical operations are done in this unit. This unit has a number of registers and accumulators for short-term storage of data while doing calculations and comparisons.

***Memory or Storage***

The primary memory section is part of CPU. Memory is used to store binary codes of instructions you want the CPU to execute. Each and every instruction to be executed by the CPU is first brought in the main memory. It cannot be executed while it is stored on secondary storage devices like disk, tape, etc. The memory stores all the data currently being processed as well as the program that controls the processing.

Large amount of data is stored on a computer using various types of storage media. The storage media are distinguished by their relative speed and capacity.

- ***Volatile Storage:*** Information residing in such storage needs continuous power supply. The contents are lost if power supply is switched off. Some of the example are main memory and cache memory. Access to volatile storage is very fast, both because of the technology used and because of the access method.
- ***Non-volatile Storage:*** Such storage do not require power supply to retain their contents. For example, storage media, disks and magnetic tapes. Disk is used for online storage, while tapes are used for archival storage. Disks and magnetic tapes are reliable storage media.

Memory or storage refers to physical memory that is internal to the computer. The word main is used to distinguish it from external mass storage devices such as disk drives. Another term for main memory is RAM.

The computer can manipulate only data that is in main memory. Therefore, every program you execute and every file you access must be copied from a storage device into main memory. The amount of main memory on a computer is crucial because it determines how many programs can be executed at one time and how much data can be readily available to a program.

Because computers often have too little main memory to hold all the data they need, computer engineers invented a technique called swapping, in which portions of data are copied into main memory as they are needed. Swapping occurs when there is no room in memory for needed data. When one portion of data is copied into memory, an equal-sized portion is copied (swapped) out to make room.

**Table 6.1 Commonly Used Names and Abbreviations for Storage Capacity**

| Name | Abbreviation | Number of Bytes |
|---|---|---|
| Byte | B | 1 |
| kilobyte | KB | 1024 |
| Megabyte | MB | 1024*1024 |
| Gigabyte | GB | 1024*1024*1024 |
| Terabyte | TB | 1024*1024*1024*1024 |

*Memory Types*

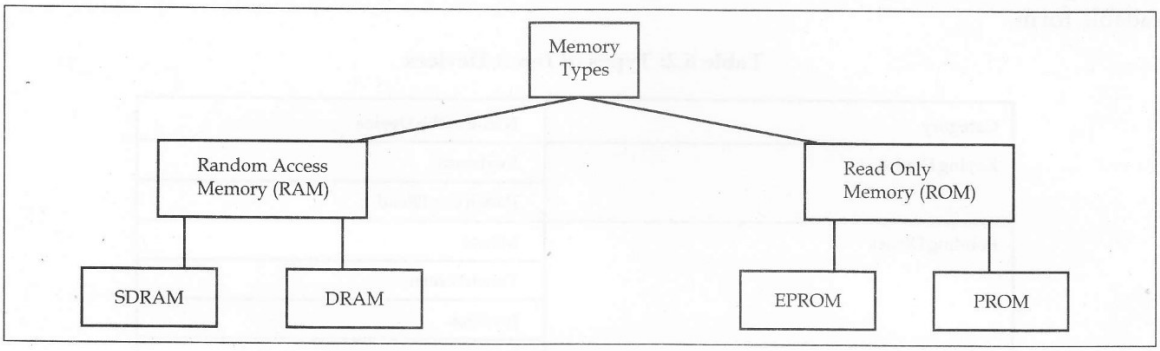


**Figure 6.4: Memory System**

Memory can be of various types like Random Access Memory (RAM) and Read Only Memory (ROM).

RAM has become the synonym for main memory. As the name suggests, any location of the memory can be accessed randomly and the access time too is independent of the location, It is very fast and the access time is in nano seconds. RAM is volatile which means that its contents are lost in absence of power.

DRAM is most common kind of RAM. The data is stored in the cell of transistors and capacitors and the data has to be refreshed every few milliseconds. Static Random Access Memory (SRAM) is a type of semi-conductor memory where the word static indicates that it, unlike Dynamic RAM (DRAM), does not need to be periodically refreshed, but is still volatile in the conventional sense that data is eventually lost when the memory is not powered. The term SDRAM, which stands for synchronous DRAM, should not be confused with SRAM.

A part of computer storage is ROM that cannot be erased or changed. ROM is non volatile i.e. its contents are not lost when power is switched off. ROM is required for storing the boot program that should not be lost or changed due to any failure. ROM also comes in many flavors such as PROM and EPROM. PROM (Programmable Read Only Memory) is used for storing some specialized application. PROM can be written only once. EPROM (Erasable Programmable Read Only Memory) can be erased and reprogrammed many times.

*Secondary Storage*

It acts as an extension/archive for primary memory and refers to peripherals with both input and output functions. This form of storage is semi-permanent.

***Examples:*** Magnetic tapes, magnetic disks (hard disks floppy diskettes, etc.), optical disks (CD-ROMs, DVD), Flash Drive, Memory Cards and Pen Drive etc.

## 6.5 INPUT DEVICES

Input devices are necessary to convert inputs into a form understandable by the computers. There are different categories of input devices. Key Entry Input Devices are used for data entry, i.e. key punching method to input the data, while other devices can directly accept the data in machine readable form.

**Table 6.2: Types of Input Devices**

| Category | Name of the Device |
|---|---|
| Keying Device | Keyboard |
| | Punch Card Reader |
| Pointing Device | Mouse |
| | Touch Screen |
| | Joy Stick |
| | Light Pen |
| Optical Character Recognizer | Bar Code Reader |
| | Optical Character Reader |
| Other Devices | Cameras |
| | Digitizers ( for maps a, graphs etc ) |
| | Smart Cards |
| | Telephone |
| Output Devices | Printer, Plotter, Fax, Monitor |

### 6.5.1 Need for Input

The quality and usefulness of output depends primarily on input data. Input phase of data processing is very important because input is the right place to detect and correct errors. Effective and error free data preparation and data entry reduces the cost of the overall system operation. There are three important characteristics of input data of good quality.

- ***Timeliness:*** Timely input of data is important because it is the first step in data processing. Delay in either the collection or preparation of data results in bottlenecks that delay the completion of all subsequent processing operations.
- ***Accuracy:*** Input is usually the best place to detect and correct errors, if poor data is entered (i.e. untimely, inaccurate or incomplete data), the outputs are bound to be less useful.

- ***Potential Usefulness:*** In computerized data processing application, much of the data that is entered into a computer system is used later to update files stored on tapes and disks in a batch mode. Accurate input is, therefore, essential to protect these files from accidental or intentional damage.

***Source Documents***

Source documents record transaction data and are the starting point for capturing input data. For example time cards, survey results, job application forms, patient registration forms, etc.

***Advantages of Source Documents***

- Source documents can be prepared by individuals with no computer background.
- Serves as back-up for computer files.
- Provides evidence of authenticity.

The only disadvantage of source documents is that they are rarely machine readable.

### 6.5.2 Key Entry Input Device

Input devices can be broadly categorized into two types on the basis of method applied by computer system to accept inputs.

- Off-line input devices
- On-line input devices

***Off-line Data Input Devices***

Off-line data input devices do not consume valuable time of the central processor. Data can be keyed in directly to storage media for subsequent input to a computer in off-line devices.

Key to diskette entry system operation is simple. First the format in which data is to be entered is decided. Then data is entered at a key station and is directly recorded on a floppy disk. Verification is done by another operator by repeating the operations. Finally, disks can be read as input to the computer by a floppy disk unit. Similarly key to tape/cartridge is followed.

***On-line Data Input/Terminal Input Devices***

A computer terminal generally combines input and output functions. Terminals are either dumb, smart or intelligent terminals.

*Dumb Terminals*

- These are simple devices that immediately transmit each keyed data character to the processor.
- They have no storage or logic capability.
- They cannot be programmed by the user.
- On-screen formatting is not feasible with dumb terminals.

*Smart Terminals*

- They are equipped with a micro processor chip as well as internal storage capability.
- They can store and consolidate input data prior to sending it to the processor.
- On-screen formatting is possible with smart terminals.

*Intelligent Terminals*

- They are equipped with built-in microprocessor chips that are user-programmable.
- Data can be collected and edited before it is transmitted to the main computer.
- Intelligent terminals, besides data collection and editing, can also check the validity of input data.

*Advantages of Terminal Input*

Terminal input is relatively inexpensive. It is highly visual; therefore one can make use of colours to aid the data entry process. They are commonly online to a computer. This enables users to enter data directly into a processing system, thereby increasing the timeliness of data input and eliminating the need for intermediary storage media such as floppy disks. They have the ability to enter data into computer systems from remote sites.

*Disadvantages of Terminal Input*

They are dependent on a working computer for operation. If the computer goes down, the connected terminals are useless. Many terminals cannot create back-up copies of data input thereby requiring the user to re-enter the original input data if it is lost. Finally, there is a growing concern that extended work at VDTs is a health hazard due to ultraviolet and soft x-rays coming from the CRT.

### 6.5.3 Popular Input Devices

Some popular input devices are as follows:

***Keying Device***

***Keyboard:*** In computing, a keyboard is an input device, partially modeled after the typewriter keyboard, which uses an arrangement of buttons or keys, which act as mechanical levers or electronic switches. A keyboard typically has characters engraved or printed on the keys and each press of a key typically corresponds to a single written symbol. However, to produce some symbols requires pressing and holding several keys simultaneously or in sequence. While most keyboard keys produce letters, numbers or signs (characters), other keys or simultaneous key presses can produce actions or computer commands.

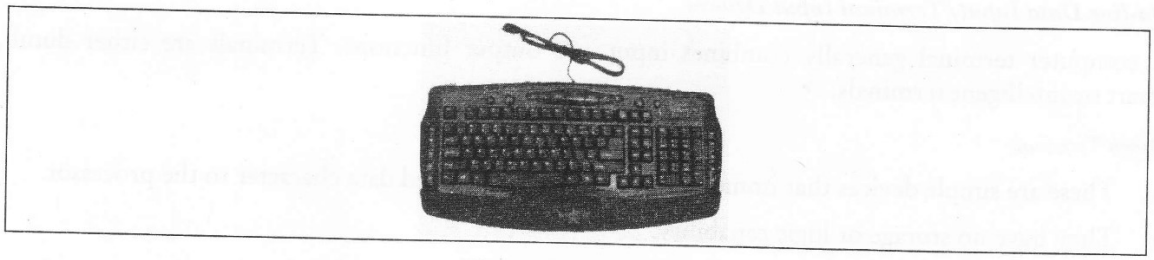

**Figure 6.5: Keyboard**

***Punch Card Reader:*** A punch card reader reads a punch card or punched card, is a piece of stiff paper that contains digital information represented by the presence or absence of holes in predefined positions. Now almost an obsolete recording medium, punched cards were widely used throughout the 19th century.

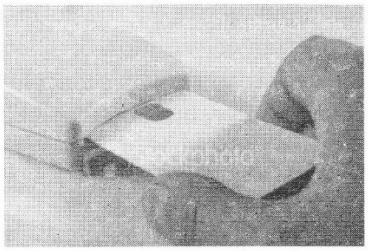

Figure 6.6: Punch Card Reader

*Pointing Device*

***Mouse:*** In computing, a mouse is a pointing device that functions by detecting two-dimensional motion relative to its supporting surface. Physically, a mouse consists of an object held under one of the user's hands, with one or more buttons. It sometimes features other elements, such as "wheels", which allow the user to perform various system-dependent operations, or extra buttons or features can add more control or dimensional input. The mouse's motion typically translates into the motion of a pointer on a display, which allows for fine control of a Graphical User Interface.

***Touch Screen:*** A touch screen is a display which can detect the presence and location of a touch within the display area. The term generally refers to touch or contact to the display of the device by a finger or hand. Touch screens can also sense other passive objects, such as a stylus. However, if the object sensed is active, as with a light pen, the term touch screen is generally not applicable. The ability to interact directly with a display typically indicates the presence of a touch screen.

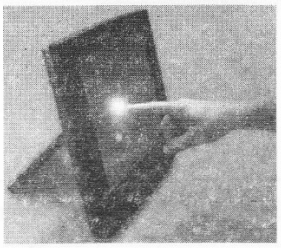

Figure 6.7: Touch Screen

***Joystick:*** A joystick is an input device consisting of a stick that pivots on a base and reports its angle or direction to the device it is controlling. Joysticks are often used to control video games, and usually have one or more push-buttons whose state can also be read by the computer. A popular variation of the joystick used on modern video game consoles is the analog stick.

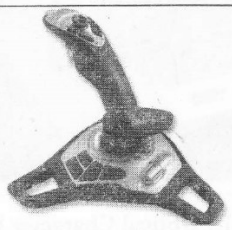

Figure 6.8: Joystick

***Light Pen:*** A light pen is a computer input device in the form of a light-sensitive wand used in conjunction with a computer's CRT TV set or monitor. It allows the user to point to displayed objects, or draw on the screen, in a similar way to a touch screen but with greater positional accuracy. A light pen can work with any CRT-based display, but not with LCD screens.

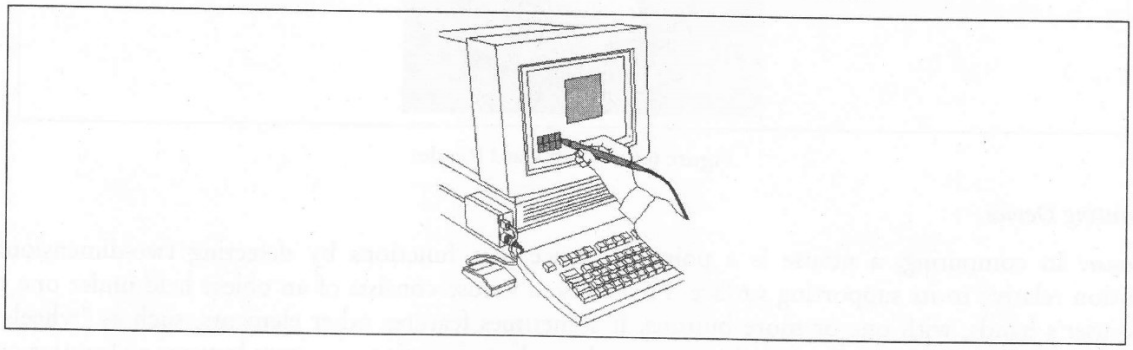

**Figure 6.9: Light Pen**

***Optical Character Recognizer***

***Bar code Reader:*** A barcode reader (or barcode scanner) is an electronic device for reading printed barcodes. Like a flatbed scanner, it consists of a light source, a lens and a light sensor translating optical impulses into electrical ones. Additionally, nearly all barcode readers contain decoder circuitry analyzing the barcode's image data provided by the sensor and sending the barcode's content to the scanner's output port.

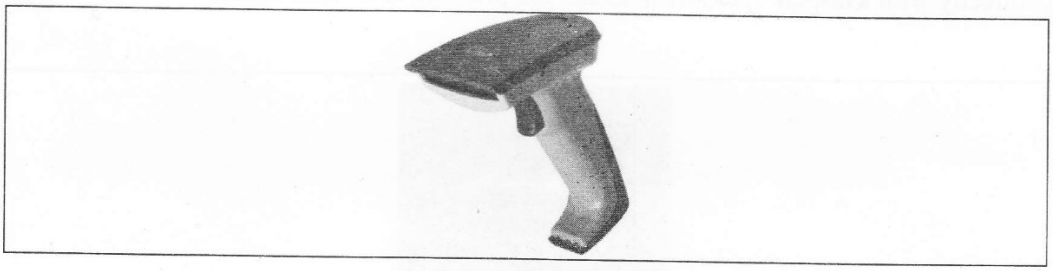

**Figure 6.10: Bar code Reader**

***Optical Character Reader:*** Optical character recognition, usually abbreviated to OCR, is the mechanical or electronic translation of images of handwritten, typewritten or printed text (usually captured by a scanner) into machine-editable text.

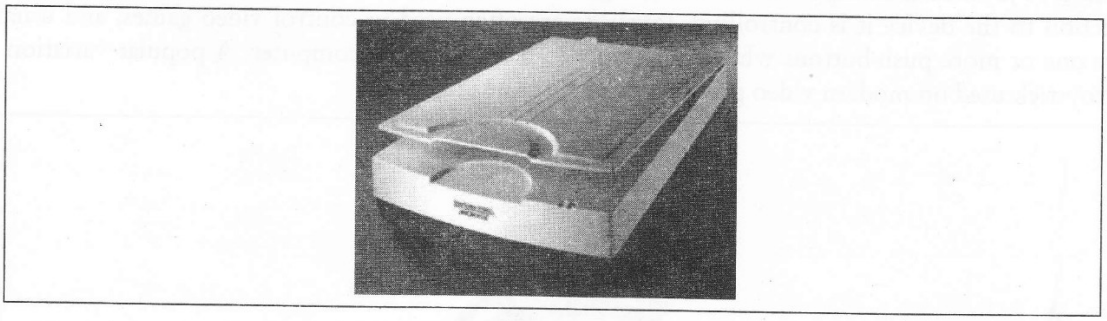

**Figure 6.11: Optical Character Reader**

***Other Devices***

***Digitizer:*** Digitizing or digitization is representing an object, image, document or a signal (usually an analog signal) by a discrete set of its points or samples. The result is called "digital representation" or, more specifically, a "digital image", for the object, and "digital form", for the signal.

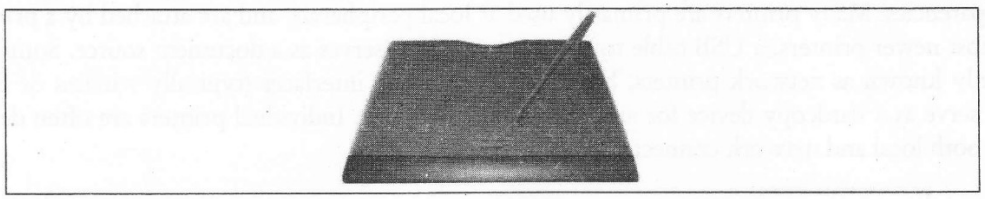

**Figure 6.12: Digitizer**

***Smart Card:*** A smart card, chip card, or Integrated Circuit Card (ICC), is in any pocket-sized card with embedded integrated circuits which can process data. This implies that it can receive input which is processed by way of the ICC applications and delivered as an output.

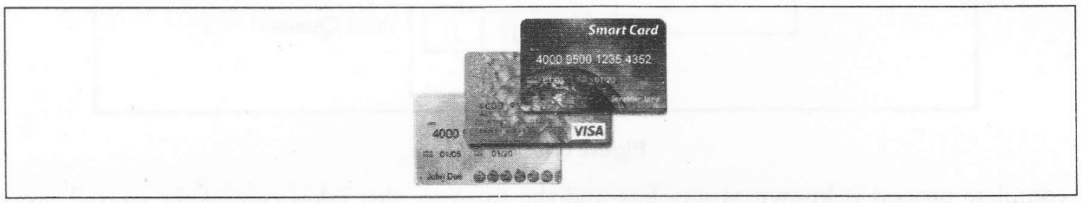


**Figure 6.13: Smart Card**

## 6.6 OUTPUT DEVICES

Output may be typed, printed or graphical, or may be of video or audio type. Output devices can be classified as soft copy devices and hard copy devices. All the output devices communicate with the CPU through an output unit.

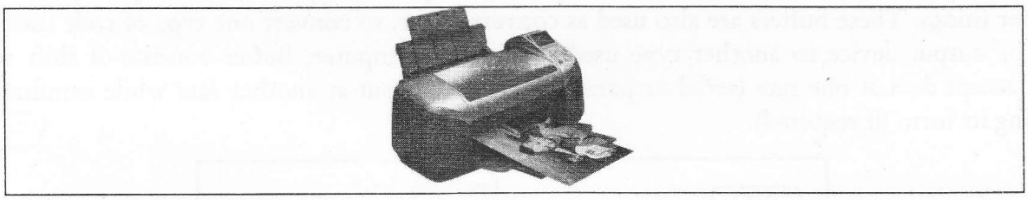

**Figure 6.14: Printer**

### 6.6.1 Output Unit

The processing speed of CPU is very fast as compared to output devices. The output unit functions as an interface between the devices and the processor to match their working speed. It uses various techniques like, 'spooling' and 'buffering' to match the computing performance of the processor.

***Spooling***

Spool stands for Simultaneous Peripheral Operation On Line. It is a technique used by computers to allow users to continue using CPU for other stations while printing is in progress. Under this approach the output is redirected to an intermediate disk-file instead of to a printer, because disk-writing speed is much

faster than the printing speed. This frees the CPU to do another job. Later on, the output is retrieved from the disk and printed on the printer. This process continues till all the printing is completed.

***Printer:*** In computing, a printer is a peripheral which produces a hard copy (permanent human-readable text and/or graphics) of documents stored in electronic form, usually on physical print media such as paper or transparencies. Many printers are primarily used as local peripherals, and are attached by a printer cable or, in most newer printers, a USB cable to a computer which serves as a document source. Some printers, commonly known as network printers, have built-in network interfaces (typically wireless or Ethernet), and can serve as a hardcopy device for any user on the network. Individual printers are often designed to support both local and network connected users at the same time.

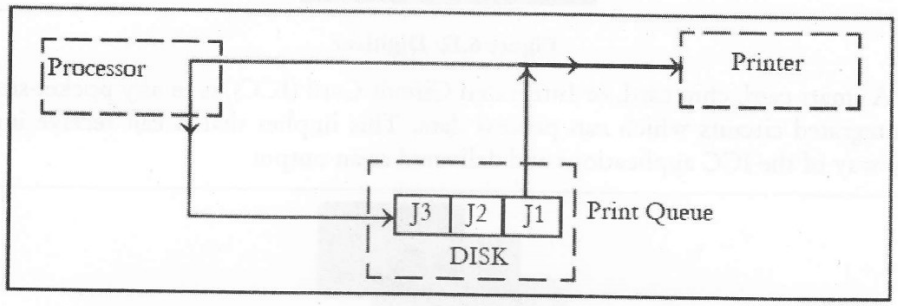


**Figure 6.15: Spooling**

The complete process is known as spooling and the software that takes care of the overall process is known as spooler. New printing requests are queued in one after another on an FCFS (First Come First Serve) basis.

***Buffering***

It is an additional temporary storage device which accepts text to be printed at faster speed than the printer. When using buffer memory, the cpu transfers print output to a temporary memory called 'buffer'. Buffers slowly release the text data to match the printer's speed while the processor is free to do other things. These buffers are also used as converters, i.e. to convert one type of code used by the input or output device to another type used within the computer. Buffer consists of shift registers which accept data at one rate (serial or parallel) and shift it out at another rate while simultaneously changing its form (if required).

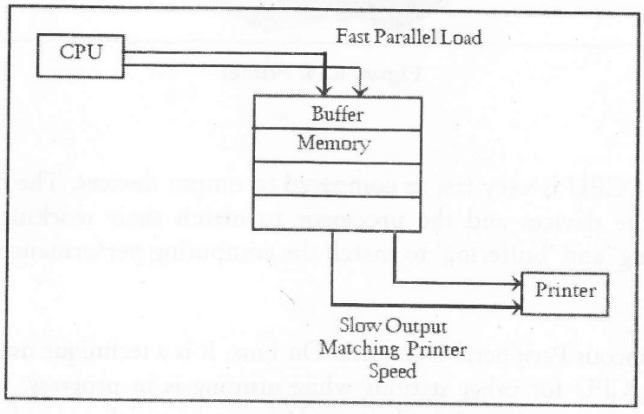


**Figure 6.16**

### 6.6.2 Types of Output Devices

***Hard Copy Devices***

Hard copy means that the output is in directly usable form, that is, in printed or plotted form. Hard copy devices produce a permanent record on media such as paper or microfilm. They are very slow in operation as compared to soft copy devices because these often involve mechanical movement. Following hard copy devices are very popular:

- Printers
- Plotters
- Photographic output
- Punched card (now outdated)

***Soft Copy Devices***

Soft copy is in magnetic/audible form that cannot be used directly. These devices do not produce a permanent record. Following soft copy devices are very popular:

- VDU
- Liquid Crystal Display (LCD) used in laptop computers
- Audio Response Unit (ARU)

### 6.6.3 Hard Copy Output Devices

***Printers***

Hard copy devices, i.e. printers, can be divided into two distinct categories on the basis of producing impression over the paper:

- Impact Printers
- Non-impact Printers

***Impact Printers***

In impact printer, a character is printed on the paper through physical contact between the print head and paper. Either the needle or a character is stuck on the paper through the ribbon. This creates a lot of noise when these printers work. Impact printers may also be categorized into two types on the basis of produced (impression) pattern.

- Solid Font In a solid font printer, a complete character strikes a carbon ribbon or other inked surface against paper to produce an image of the character.
- Dot Matrix Dot matrix printer has a set of printing needles or pins. Selected print needles strike the inked ribbon against paper to produce an image of the character.

*Character Printer*

Character printer prints character by character. It may work on both technologies: Dot Matrix as well as Solid Font.

1. ***Line Printer:*** Line printer prints one complete line at a time. It works on both the technologies : Dot Matrix and Solid Font. Dot matrix type line printers are relatively slower than solid font impact line printers. Speed may be 300 lines per minute or more.

2. ***Dot Matrix Printer:*** In a dot matrix printer, the character is formed with closely packed dots. The printing head contains a vertical array of pins. Formation of character is done by the movement of head across the paper. Selected print needles strike the inked ribbon against paper to produce an image of the character. Dot matrix printer supports printing of graphics. It is faster than daisy wheel printer and the printing speed lies between 30 to 600 cps. It comes in two print head specifications, 9 pin and 24 pin.

   Examples are EPSON EX, 1000, EPSON LQ 1050, CITIZEN MSP 55, GODREJ, etc.

3. ***Daisy Wheel Printer:*** It is a solid font type character printer. Daisy wheel printer is named as such because the print head resembles a daisy flower, with the printing arms appearing like the petals of the flower. Speed lies between 30 cps to 90 cps. Print quality is better than dot matrix. It is a bi-directional printer, i.e. the head of the printer prints while moving in forward direction as well as in backward direction. It also supports graphics such as curves which can also be produced.

   Daisy wheel printer is a letter quality printer because it produces solid characters unlike broken characters formed by a dot matrix printer. The font (i.e. style of character) is of fixed type for a Daisy Wheel printer.

***Non-impact Printers***

In Non-impact printers, the head does not come directly in contact with the paper. There is no impact or hitting of needles so non-impact printers don't make any noise while printing. They come in many of varieties:

- Thermal printer
- Laser printer
- Ink Jet printer
- Electrostatic printer
- Electro graphic printer

1. ***Thermal Printer:*** In a thermal printer the characters are formed by pressing an array of electrically heated needles against heat sensitive paper. Such papers have a special heat sensitive coating which becomes dark when a spot is heated. Character is printed with a matrix of dots which are heated by the needles.

   It is not possible to produce multiple copies simultaneously with this type of printer. A special type of paper is used with this printer which is costly. This has reduced the popularity of thermal printers.

2. ***Laser Printer:*** Laser printer works on the concept of using laser beams to create an image on a photosensitive surface. Initially the desired output image is written on a copier drum with a laser beam that operates under the control of the computer. The laser exposed drum areas attract a toner that attaches itself to the laser-generated charges on the drum. The toner is permanently fused on paper with heat and/or pressure by rolling the drum over the blank paper. Laser printers are quiet and produce very high quality of output. They are capable of printing 4-30 pages per minute.

3. ***Ink Jet Printers:*** Ink Jet printers uses dot matrix approach to print text and graphics. Nozzles in the print head produce tiny ink droplets. These droplets are charged which are deflected and then directed to the desired spots on the paper to form the impression of a character. It has a speed of 40-300 cps (character per second) with software controls on size and style of characters. These printers support colour printing and are very quiet and noiseless in operation. The print quality of such printers is very near letter-quality.

4. ***Electrostatic Printers:*** An electrostatic printer moves a continuous sheet of paper over the printing pins which put small electric charges on the paper. The paper is then passed through a bath of oppositely charged toner particles. As the opposite charges attract, the paper picks up the toner on the spots charged by the print pins. The paper is then passed through the fusing process and the toner is melted onto the paper to form the character impression. Some electrostatic printers print up to 5000 lines per minute. Such printers use dot-matrix approach for printing. The print head contains a vertical array (i.e. a vertical column) of pins. Such printers can also produce graphics.

5. ***Plotters:*** Plotters are output devices that are used to produce precise and good quality graphics and drawings under computer control. They use ink pen or ink jet to draw graphics or Now we will discuss memory in detail. drawings. Either single colour or multicolour pens can be employed. The pens are driven by a motor. The graphics and drawings produced by plotters are uniform and precise and of very high quality. Plotters are used for complex engineering drawings and for drawing of maps that require high degree of accuracy. Flatbed plotters use horizontal flat surface on which paper can be fixed. The pen moves in X and Y directions which is controlled by the computer.

## 6.7 MEMORY: STORING DATA

Memory is an essential component of a digital computer. It is a storing device. It stores programs, data, results, etc. At present the following two kinds of memory are commonly used in modern computers.

- Semiconductor memory
- Magnetic memory

The semiconductor memory is faster, compact and lighter. It consumes less power and is a static device, i.e. there is no rotating part in it. The magnetic memory is cheaper than static memory. It is in the form of magnetic disk or magnetic tapes. The semiconductor memory is employed as the main memory or primary memory of the computer. It stores programs and data which are currently needed by the CPU. The magnetic memory is used as secondary memory or auxiliary memory.

### 6.7.1 Primary Memory and Secondary Memory

The size of the main memory is comparatively much smaller than that of the secondary memory. CPU communicates directly with the main memory. The speed of main memory must match the fast speed of the CPU so semiconductor (chip) technology is used in the main memory. Random Access Memory (RAM) and Read Only Memory (ROM) ICs are used for main memory. RAMs are volatile in nature, i.e. their contents get erased when power goes off.

The secondary memory is employed for bulk storage of programs, data and other information. The secondary storage is of a permanent nature, i.e. it stores the information permanently. Magnetic

memories like hard disks and floppy disks are commonly used as secondary memories. The classification of memory can now be done on the basis of primary and secondary memories.

***Capacity of Memory***

In computers the capacity of memory is measured in Mega bytes. Byte is the smaller unit and means a set of 8 bits. Higher units are Kilo bytes, Mega bytes and Giga bytes.

| | | |
|---|---|---|
| 1 character = 1byte | = | 8 bits |
| 1 Kilo bytes (KB) | = | 1024 bytes or 210 bytes |
| 1 Mega byte (MB) | = | 1024 KB |
| | = | 1024 × 1024 bytes or 220 bytes |
| 1 Giga byte (GB) | = | 1024 MB |
| | = | 1024 × 1024 × 1024 bytes or 230 bytes |

Thus if we say that the capacity of a primary memory is 16 MB it means it contains 16 × 220 bytes or 224 bytes. Also a 1.44 MB floppy can store 1.44 × 220 bytes of information.

### 6.7.2 Cache Memory

The cache memory is placed between the CPU and the main memory. It is a fast speed memory and is expensive and faster than the main memory.

Cache memory is used to store the frequently accessed data of main memory. The instructions that are frequently used by the CPU are stored in cache memory. It is used to reduce the average access time for address, instructions or data which are normally stored in the main memory. Thus the cache memory increases the operating speed of the system. But it is much costlier than main memory. From economic considerations, the capacity of the cache memory is much less as compared to main memory.

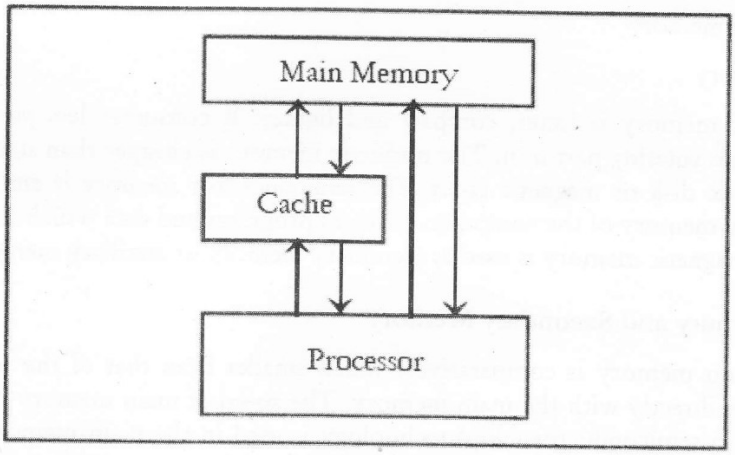


Figure 6.17

Most of the 32-bit microprocessors, new-a-days, have cache memory on the chip. Besides this modern computers also provide external cache on the mother board. The technique to access the cache memory is different from that of accessing the main memory. When CPU accesses the main memory, it outputs the data contained at that specified address. The cache memory first compares the incoming

address to the address stored with data in cache – if it matches it is said that a 'hit' has occurred and corresponding data is read from cache memory. In case the address does not match then it is said that a 'miss' has occurred and the data is read from the main memory by the CPU which also gets stored in cache memory simultaneously, so that when the same address is accessed next time, a hit may occur.

### 6.7.3 RAM (Random Access Memory)

RAM stands for Random Access Memory and is a read-write memory of the computer. In a RAM, any location can be accessed in a random manner and the access time is the same for each memory location.

A chip actually contains lot of memory cells within it. Each cell contains group of bits that are accessed together. The size of memory data register is equal to the number of bits stored in each of the cells. The data bus contains a number of lines equal to the size of MDR. Each memory cell is identified by a unique address. This address is placed in the memory address register to access the memory cell. The size of the address bus is equal to the number of bits in memory address register. Two control signals are used to distinguish between memory read and memory write. It is volatile in nature. Although both RAM and ROM possess random access, the R/W memory is called RAM. There are two important types of RAM – Static RAM and Dynamic RAM.

*Static Ram (SRAM)*

Static RAM consists of internal flip-flops that store the binary information. The stored information in this SRAM remains valid as long as power is applied to the unit. SRAM is easier to use and has shorter read and write cycles, i.e. high speed. Static RAMs are costlier and consume more power.

*Dynamic RAM (DRAM)*

It stores binary information in the form of electric charges that are applied to capacitors. The stored charges on the capacitors tend to discharge with time. The capacitors must be periodically recharged by refreshing the dynamic memory. This refreshing is done by cycling through the words every few milliseconds to restore the decaying charge. DRAM has reduced power consumption and larger storage capacity in a single memory chip.

### 6.7.4 ROM (Read Only Memory)

ROM stands for Read Only Memory, i.e. nothing can be written on it. ROM is a non-volatile memory, i.e. the information stored on it is not lost when power goes off. It is used for storing the bulk of the programs that are permanent residents in the computer. The contents of ROM are decided by the hardware manufacturer. The necessary programs are hardwired during the manufacture of computer. It also possesses random access property and store information which is not subject to change.

*Need for ROM*

ROM is used for storing an initial program called a 'Bootstrap loader'. This is a program whose function is to start the computer software operating when power is turned on. Since RAM is volatile, its contents are destroyed when power is turned off. The contents of ROM remain unchanged after power is turned off and on again. When power is turned on, the hardware of the computer sets the program counter to the first address of the bootstrap loader. The bootstrap program loads a portion of

the operating system from disk to main memory and control is then transferred to the operating system.

***Memory Unit***

A memory unit is a collection of storage cells together with associated circuits needed to transfer information in and out of storage. The memory stores binary information in groups of bits called words. The identification code of each cell corresponding to a word in memory is known as its address. If a memory has 8 words, 8 different combinations will uniquely address these lines. In general, with n bits, 2n words of a memory can be addressed.

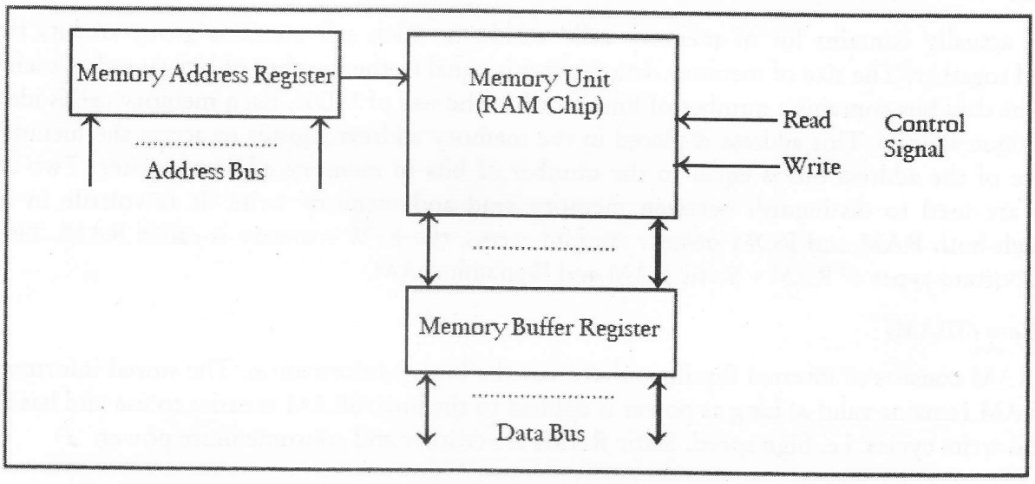


**Figure 6.18: Memory Unit**

***MAR***

For reading or writing, it is needed to specify the address of the word. Address is specified as a binary number and is placed in a register called Memory Address Register (MAR).

***MDR***

The data read from memory or that to be written in the memory is placed in a register called Memory Data Register (MDR).

*Example:*

i. A memory which is capable of storing 64K (K = 1024) bytes contains 16 bits in MAR and 8 bits in MDR.

   We know $64K = 2^{16}$ hence 16 address bits are there.

ii. Memory unit 2K × 16 (number of words * number of bits/word).

   $2K = 2 \times 1024 = 2048 = 2^{11}$ ® 11 address lines, 16 data lines.

   A RAM chip of capacity 512 × 16 means 512 memory cells each containing 16 bits of data. This requires 9 address lines and 16 data lines because 9 address lines can address $2^9$, i.e. 512 different addresses and 16 data lines are used to carry of data. Similarly 4 RAM chips of capacity 512 × 16 means it would require total of 11 address lines and 16 data lines.

### 6.7.5 Other Types of Memory

***PROM***

It is a programmable ROM. Its contents are decided by the user. The user can store permanent programs, data, etc., in a PROM. A special equipment called PROM-programmer is available for the programming of PROMs.

***EPROM***

An EPROM is erasable PROM. The stored data in EPROMs can be erased by exposing it to high intensity short wave ultraviolet light for about 20 minutes. EPROMs are used to store programs which are permanent but need updating. It needs to be removed from the computer to erase the EPROM.

***EEPROM or $E^2$ PROM***

EEPROM is an electrically erasable PROM. It is also known as EAPROM (Electrically Alterable PROM). The chip can be erased and reprogrammed on the board easily on a byte by byte basis. Either a single byte or the full chip can be erased without removing it from the mother board. There is a limit on the number of times EPPOMs can be reprogrammed.

***Non-volatile Flash Memory***

Flash memories are also electrically erasable and reprogrammable non-volatile memories. It can be used in place of EPROM. It is suitable for firmware (i.e. code) storage. The whole device is erased in one operation. For the updating of firmware codes flash memories are quick and economical than EPROMs. Its reliability is higher than E2PROMs.

**Check Your Progress**

1. Choose the appropriate answer:

   (a) The most frequently used output device on a computer is the ..... .

   (i) Monitor (ii) Printer

   (iii) Speakers (iv) Modem

   (b) The hardware component used to control the operation of a computer system is:

   (i) RAM (ii) Keyboard

   (iii) Processor (iv) Hard-disk

   (v) Monitor

   (c) The hardware component used for temporary storage of data and applications for processing is:

   (i) Hard-disk (ii) Processor

   (iii) Monitor (iv) RAM

   (v) Keyboard

*Contd...*

(d) The hardware component known as an input device is:

(i) RAM (ii) Hard-disk

(iii) Monitor (iv) Processor

(v) Keyboard

(e) The hardware component known as an output device is:

(i) Keyboard (ii) Monitor

(iii) RAM (iv) Hard-disk

(v) Processor

2. State whether the following statements are true or false:

(a) A client computer is used to centrally store information and applications and in an organization for shared access.

(b) When transmitting data over standard telephone lines, a modem is required because the telephone lines transmit only analog signals.

(c) In most GUIs, you can click a button to start an action or a task.

## 6.8 LET US SUM UP

IT infrastructure is described in a number of ways, but the elements for describing it remain largely the same.

The foundation is formed by the technology components, which human IT infrastructure uses to provide the required IT services for business needs.

There are many kinds of standards with defined related processes, which channel the development and maintenance of IT infrastructure for business purposes.

IT infrastructure must be built and maintained so that it is sufficient for the internal requirements of the firm, but also to fulfill the external requirements for connection to public or industry based infrastructure.

Some studies emphasize certain elements more than others.

However, it can be stated that current literature holds a common understanding of what IT infrastructure actually is, even though this understanding can be presented in a variety of ways.

The CPU has three main parts - ALU, control unit and memory. The CPU works in coordination with other devices under the supervision of control unit. The logical and conditional operations make the CPU different from a simple calculator. All the instructions with the CPU are in binary form, i.e. in the form of electric pulses. The capability of computer system to memorize comes from semiconductor devices like RAM, ROM chips which form the computers main memory and magnetic memory devices like tapes, disks, etc., which constitute the computer's secondary or auxiliary memory. The operation of computer system is only a series of input, processing and output instructions along with some storage capability. No hardware part functions on its own but they all are controlled by the operating system which is categorized as a system software. Thus for the

functioning of the computer system hardware is not sufficient by itself, rather software must also co-exist to run and control the hardware.

Input/Output devices and secondary storage of a computer attached to its surroundings are called 'peripherals'. Data and instructions are entered into a computer through input devices. The results and response of the computer system are communicated back to the user through output devices. Some of the devices serve both as input and output devices. Inputs to the computer can be given through various media - it may be on-line or off-line, directly computer readable form like MICR, OMR, etc., or simply through keyboards. The input may be visual or audio. Many advanced input devices are available to accept these different forms of input.

All the responses and outputs of different forms are presented through different output devices. The most common output devices are VDU and printer. On a VDU, soft copy is generated while printer gives a hard copy output. Besides a variety of printers, lot of other output devices like audio response unit, video outputs are available nowadays. For communicating with these devices, the computer system uses input output ports and I/O interface units. All the storage devices also come under I/O devices. The usage of these devices is not limited only to give inputs or store output but they have an important role to play during processing too. These devices like magnetic tapes, magnetic disks, CD ROMs are classified separately as storage devices and dealt with in the next chapter.

## 6.9 KEYWORDS

***Computer System:*** System consisting of computers and peripherals required to control the computer devices and process data by executing programs.

***Hardware:*** Physical device in a computer system.

***CPU:*** Component of a computer that execute machine language instructions.

***Data Bus:*** The bi-directional bus which carries the data from one unit to another.

***Control Bus:*** The uni-directional bus which controls nearly all the operations in the CPU.

***Control Unit:*** Portion of the CPU that controls the flow of information.

***Input/Output Interface Hardware:*** Devices such as I/O ports, I/O busses, buffers, channels, and input/output control units, which assist the CPU in its input/output assignments. These devices make it possible for modern computer systems to perform input, output, and processing functions simultaneously.

***Magnetic Tape:*** A plastic tape with a magnetic surface on which data can be stored by selective magnetization of portions of the surface.

***Optical Disks:*** A secondary storage medium using laser technology to read tiny spots on a plastic disk. The disks are currently capable of storing billions of characters of information.

***Pointing Devices:*** Devices that allow end users to issue commands or make choices by moving a cursor on the display screen.

***Pointing Stick:*** A small button like device on a keyboard that moves the cursor on the screen in the direction of the pressure placed upon it.

***Arithmetic-logic Unit (ALU):*** Portion of the CPU that performs the arithmetic calculations.