मङ्गलायतन विश्वविद्यालय

॥ विश्वं ज्ञाने प्रतिष्ठितम् ॥

MANGALAYATAN UNIVERSITY

Learn Today to Lead Tomorrow

Computer Applications in Business Management

MGO-1105

Edited By

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DIRECTORATE OF DISTANCE AND ONLINE EDUCATION

MANGALAYATAN UNIVERSITY

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Unit–1

Introduction to Computers

Notes

Structure

1.1. Introduction
1.2. Characteristics of a Computer
1.3. History of computers
1.4. Types of Computers
1.5. Popularity of Personal Computers
1.6. Computers of the Future
1.7. Key Point Summary
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1.1. Introduction

Computer Science is the study of computers that includes their evolution, architecture, operation and applications. It combines both theoretical and practical aspects of engineering, electronics and information technology. Information Technology (IT) is the most fascinating technology used by people to handle information. Information technology refers to modern technology based on electronics and computing. Now, computers have become essential tools of Information Technology. Information Technology incorporates the technologies of electronics, computing, networking and telecommunications.

Computers are the essential ingredients for the success of today's man. Computers are being used in almost every field now and everyday new areas of activities are being discovered. There is hardly any area in our society, where computers are not being used. For instance, computers are used in homes, offices, schools, colleges, universities, nursing homes, hospitals, export houses, shops and business establishments, industries, banks, railway stations, airports, research centers and many other organisations. As, computers are performing most of the routine activities in today's society, it has become essential for everybody to learn computer science. The computer science and information technology have witnessed a tremendous interest among people recently with the introduction of Internet, E-commerce, Mobile commerce, Artificial Intelligence and Virtual Reality.

In this chapter, we will study how the modern computers have evolved. We will categorise computers into various types based on different criteria. We will also study the features of different historic and modern computers.

Notes

In a layman's language, a computer is a fast calculating device that can perform arithmetic operations. Although the computer was originally invented mainly for doing high speed and accurate calculations, it is not just a calculating device. Computer can perform any kind of work involving arithmetic and logical operations on data. It gets the data through an input device, processes it as per the instructions given and gives the information as output.

A computer is defined as a fast electronic device that processes the input data according to the instructions given by the programmer/user and provides the desired information as output.

The terms used in the above definition are defined in table 1.1.

Table 1.1 Terms used while defining a computer

Term	Definition
Data	A set of basic facts and entities which itself has no meaning
Information	Data which has some meaning or value
Instruction	A statement given to computer to perform a task
Input	Data and instructions given to computer
Process	Manipulation of data
Output	Information obtained after processing of data

1.2. Characteristics of a Computer

A computer has the following characteristics, which makes it so important for all of us:

1. **Fast.** A computer is so fast that it can perform the given task (arithmetical or logical) in few seconds as compared to man who can spend many months for doing the same task. A computer can process millions of instructions per second.
2. **Accurate.** While doing calculations, a computer is more accurate than a man. Man can make mistakes in calculations but a computer does not, if it is provided with accurate instructions.
3. **High memory.** A computer has much more memory or storage capacity than human beings. It can store millions of data and instructions, which can be retrieved and recalled even after a number of years. This is not possible in case of human brain.
4. **Diligence.** A computer does not suffer from the human traits of tiredness and boredom. Man will be tired and bored while doing millions of calculations but computer, being a machine, does this job very efficiently and without any tiredness and boredom.

1.3. History of computers

History of computers begins with the invention of the abacus in 3000

BC, followed by the invention of mechanical calculators in 1617. The years beyond 1642 till 1980 are marked by inventions of zeroth, first, second and third generation computers. The years beyond 1980 till today, are marked by fourth generation computers. Fifth generation computers are still under research and development.

Earlier Computing Devices (3000 BC–1617 AD)

Abacus is a rudimentary first computing device developed in 3000 BC. It consists of a row of wires held in a wooden frame having beads stung on them as shown in figure 1.1. It is used for calculations by sliding the heads along the wires.

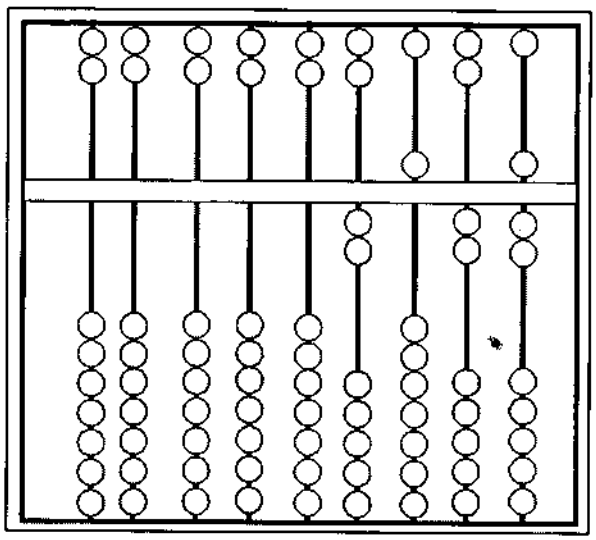

Fig. 1.1: The Abacus—First computing device

In 1617, John Napier, a Scottish mathematician invented a mechanical calculator called the 'Napier's bones'. He devised a set of eleven rods each having four faces. As these rods were carved from bones, therefore they were called *Napier's bones*. The rods were used to find products and quotients of large numbers. John Napier also introduced logarithms.

Zeroth Generation Computers (1642–1946)

The zeroth generation of computers (1642–1946) was marked by the invention of mainly mechanical computers. Pascaline was the first mechanical device, invented by Blaise Pascal, a French mathematician in 1642. In this machine, numbers were entered, by dialing a series of number wheels. A series of toothed wheels transferred the movements to a dial and hence showed the results. In 1800, punched card was invented by Jacquard. It is an obsolete computer input device, mode of stiff paper that stores data in columns containing patter of punched holes.

In 1822, Charles Babbage, an English mathematician, designed a machine called Difference Engine to compute tables of numbers for naval navigation. Later on, in the year 1834, Babbage attempted to build a digital computer,

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called Analytical Engine. The analytical engine had all the parts of a modern computer i.e. it had four components — the store (memory unit), the mill (computation unit), the punched card reader (input unit) and the punched/printed output (output unit). As all basic parts of modern computers were thought out by Charles Babbage, he is known as Father of Computers. The daughter of the poet Lord Byron, Augusta Ada became Charles Babbage's most enthusiatic supporter. She wrote programs for the Analytical Engine and made several innovations that are central to programming today.

In later years, Herman Hollerith invented a machine for doing counting for 1880 US census, which was called the Tabulating Machine. In 1944, Howard A. Eiken invented first American general purpose electro-mechanical computer, called Mark I and later on its successor, Mark II. The zeroth generation of computers or the era of mechanical computers ended in 1946, when vacuum tubes were invented. Various inventions during era of mechanical computers are described in table 1.2.

Table 1.2: History of computers during the year 1642–1946

Year	Invention
1642	The Arithmetic Machine, invented by Blasic Pascal.
1800	First punched cards for storing data, invented by Jacquard.
1822	The Difference Engine, invented by Charles Babbage.
1834	The Analytical Engine, Invented by Charles Babbage
1857	Sir Charles Wheatstone used paper tape to store data.
1936	Dvorak keyboard, developed by August Dvarak and William L. Dealyed.
1937	Konrad Zuse completed the first fully functioning electro-mechanical computer of the world.

First Generation Computers (1946–1954)

The first generation of computers (1946–1954) was marked by the use of vacuum tubes or valves as their basic electronic component. Although these computers were faster than earlier mechanical devices, they had many disadvantages. First of all, they were very large in size. They consumed too much power and generated too much heat, when used for even short duration of time. They were very unreliable and broke down frequently. They required regular maintenance and their components had also to be assembled manually.

Examples:

(*i*) **ENIAC (Electronic Numerical Integrator and Calculator).** It was the first electronic computer using vacuum tubes. It was the first stored-program computer, built by John Mauchly and J. Presper Eckert. It took up 1,000 square feet of floor space. Cards, lights, switches, and plugs were the input/output device of this computer

as shown in figure 1.2. The speed of this Computer was 5,000 oprations per second.

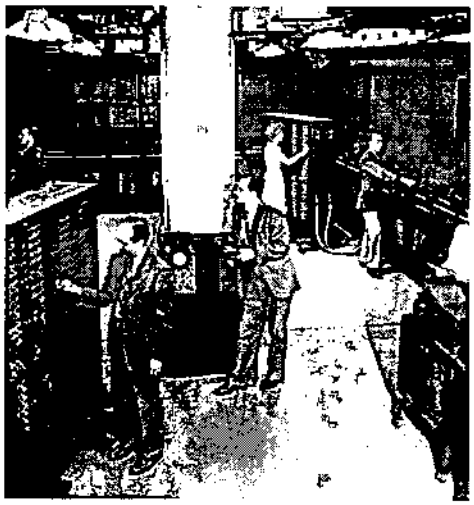

Fig. 1.2: ENIAC

(*ii*) **EDSAC (Electronic Delay Storage Automatic Calculator).** It was made by Maurice Wilkes, at Cambrige University. Its speed was 714 operations per second asshown in figure,1.3.

Fig. 1.3: EDSAC

(*iii*) **EDVAC (Electronic Discrete Variable Automatic Computer).** It was successor of EDSAC.

(*iv*) **IAS machine (Princeton's Institute of Advanced Studies).** It was a new version of the EDVAC, built by von Neumann. The basic design of IAS machine is now known as von Neumann machine, which had five basic parts - the memory, the arithmetic logic unit, the program control unit, the input and output unitas shown in figure 1.4.

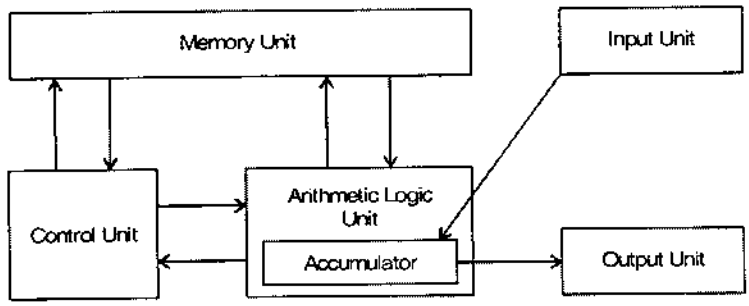

Fig. 1.4: The original von Neumann machine

(*v*) **UNIVAC I (Universal Automatic Calculator).** It was the first computer to handle both numeric and textual information as shown in figure 1.5.

Fig. 1.5: UNIVAC I

Various historical events happened during 1946 to 1954 are described in table 1.3.

Table 1.3: History of computers during the year 1946–1952

Year	Invention
1946	First electronic general purpose computer: ENIAC
1947	Invention of Williams Tube by modifying a cathode-ray tube to display dots and dashes which represented binary ones and zeros, by Sir Frederick Williams of Manchester University.
1947	Successfully testing of the point-contact transistor, by William Shockley, Walter Brattain, and John Bardeen.
1949	Manchester Mark I computer having 1300 vacuum tubes, invented by Frederick Williams and Tom Kilburn.
1950	SEAC (Standards Eastern Automatic Computer), built by the National Bureau of Standards in Washington to test component and systems.
1951	First stored program computer is EDVAC.
1952	First commercial computer UNIVAC.

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Second Generation Computers (1953–1964)

The first generation of computers became out-dated, when in 1954, the Philco Corporation developed transistors that can be used in place of vacuum tubes. The second generation of computers (1953–64) was marked by the use of transistors in place of vacuum tubes. Transistors had a number of advantages over the vacuum tubes. As transistors were made from pieces of silicon, so they were more compact than vacuum tubes. The second-generation computers, therefore, were smaller in size and less heat generated than first generation computers. Although they were slightly faster and more reliable than earlier computers, they also had many disadvantages. They had limited storage capacity, consumed more power and were also relatively slow in performance. Like first generation computers, they also required regular maintenance and their components had also to be assembled manually. Manual assembly of components was very expensive and later many attempts were made to reduce such manual assembly. It was in 1964, when it was discovered that a number of transistors could be sealed up into a tiny package, called an Integrated Circuit (IC) or a Chip.

Examples:

1. IBM 701, IBM's first electronic large computer.
2. PDP-1, developed by DEC was the first minicomuter as shown in figure 1.6.

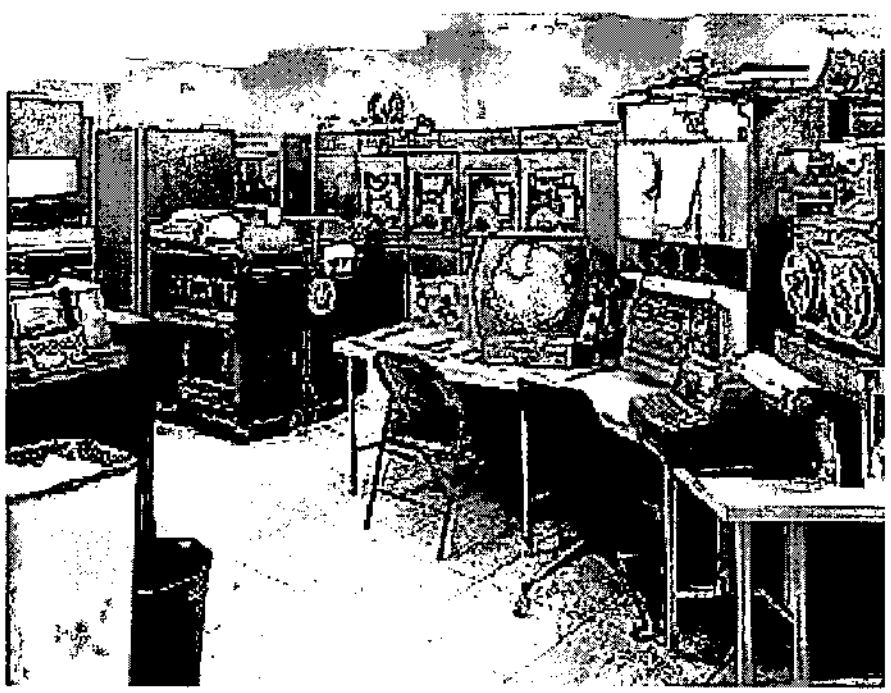

Fig. 1.6: PDP-1

3. IBM 650, The magnetic drum calculator was the first mass-produced computer. Various historical events occurred during 1954–1964 are described in table 1.4.

Notes

Table 1.4: History of computers during the year 1954–1964

Year	Invention
1953	IBM 701, IBM's first electronic large computer that could perform 17,000 instructions per second.
1954	Beginning of commercial production of silicon transistor by Texas instrument.
1956	The first transistorised computer. TX-O (Transistorized Experimental computer).
1958	First integrated circuit built by Jack Kilby at Texas Instruments.
1960	First automatic mass-production facility for transistors, developed by IBM.
1962	Patent on the mouse-pointing device for computers, received by Douglas Engelbart.
1964	The BASIC programming language developed by John Kemeny and Thomas Kurtz at Dartmouth College.

Third Generation Computers (1964–1980)

Second generation computers became out-dated after the invention of ICs. The third generation of computers (1964–978) was marked by use of Integrated Circuits (ICs) in place of transistors. As hundreds of transistors could be put on a single small circuit, so ICs were more compact than transistors. An integrated circuit is a microelectronic semiconductor device consisting of many interconnected transistors and other components. ICs are constructed on a small rectangle cut from a Silicon wafer.

Semiconductor is a material, typically crystalline, which allows current to flow under certain circumstances. Common semiconductors are silicon, germanium, and gallium arsenide. Semiconductors are used to make diodes, transistors and other basic "solid state" electronic components.

The third generation computers, removed many drawbacks of second generation computers. The third generation computers were even smaller in size, very less heat generated and required very less power as compared to earlier two generation of computers. These computers required less human labour at the assembly stage. Although, third generation computers were also still faster and even more reliable, they also had few disadvantages. They still had less storage capacity, relatively slower performance and thus could not fulfill the requirements of the users and programmers.

Examples:

1. IBM 360, developed by IBM in 1964 was the first product line designed as a family.
2. PDP-8, developed by DEC in 1965 was the first mass-market min computer as shown in figure 1.7.

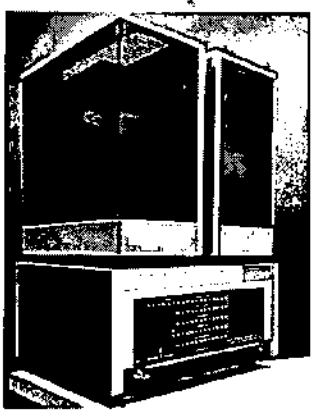

Fig. 1.7: PDP-8

3. PDP-11, developed by DEC in 1970 was the first highly successful minicomputer.
4. CRAY-1, developed by Cray in 1976 was the first suercomputer as shown in figure 1.8.

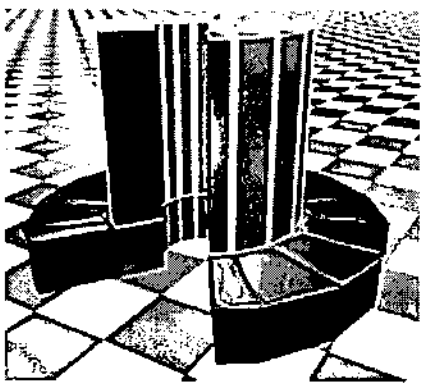

Fig. 1.8: CRAY-1

5. VAX, developed by DEC in 1978 was the first super minicomputer.

Various historical events during 1964–1980 are described in table 1.5.

Table 1.5: History of computers during the year 1964–1978

Year	Invention
1964	IBM 360 computer, built by IBM.
1967	First floppy disk, built by IBM. Unix, developed at AT&T's Bell Laboratories.
1970	First 4004 microprocessor, created by Intel.
1971	Intel introduced its 4-bit bus, 108-KHz 4004 chip - the first microprocessor. Niklaus Writhe invented the Pascal programming language.
1972	Traf-O-Data Company formed by Bill Gates and Paul Allen. 5.25 inch diskettes first appeared.

1973	Gary Kildall wrote a simple operating system in his PL/M language, called CP/M. IBM introduced the IBM 3340 hard disk unit, known as the Winchester.
1974	2-MHz 8080 chip, an 8-bit microprocessor, released by Intel. The C programming language, developed by Brian Kernighan and Dennis Ritchie.
1975	Gates and Allen's Traf-O-Data Company was renamed Microsoft.
1976	Intel introduced the 5-MHz 8085 microprocessor.

Fourth Generation Computers (1978–Till Date)

The third generation computers became out-dated, when it was found in around 1978 that thousands of ICs could be integrated onto a single chip, called *Large Scale Integration* (LSI). The fourth generation of computers (1978–till date) was marked by use of large-scale Integrated (LSI) circuits in place of ICs. As thousands of ICs could be put onto a single circuit, so LSI circuits are still more compact than ICs. In 1978, it was found that millions of components could be packed onto a single circuit, known as Very *Large Scale Integration* (VLSI). VLSI is the latest technology of computer that led to the development of the popular Personal Computers (PCs), also called as *Microcomputers*. All present day computers are fourth generation of computers. These computers are very powerful having a high memory and a fast processing speed. Today's PCs are even more powerful than mainframe computers.

Examples:

1. IBM PC, developed in 1981 was the first industry standard personal computer, having Intel 8088 memory chip.
2. IBM PC/AT, developed in 1982 was the first advanced technology PC, having Intel 80286 memory chip.
3. 386, developed in 1985, had Intel 80386 memory chip.
4. CRAY-2, developed in 1985, was the fourth generation supercomputer.
5. 486, developed in 1989, had Intel 80486 memory chip.
6. Pentium, developed in 1995, has Pentium (80586) memory chip.

Various events occurred during 1975—till date are described in table 1.6.

Table 1.6: History of computers during the year 1978–till date

Year	Invention
1978	The 4.77-MHz 8086 microprocessor, introduced by Intel.
1979	The 4.77-MHz 8088 microprocessor, introduced by Intel.
1980	The first Winchester 5.25-inch hard disk drive, introduced by Seagate Technologies. The XENIX OS, a portable and commercial version of Unix, developed by Microsoft. The 8087 math coprocessor, introduced by Intel.

1982	The 6-MHz 80286 microprocessor, introduced by Intel. MS-DOS 1.1, released by Microsoft. Lotus 1-2-3, released by Lotus Development. Microsoft released Microsoft COBOL for MS-DOS. Mouse Systems introduced the first commercial mouse for the IBM PC.
1983	AT&T Bell Labs designed C++. IBM announced the IBM PC-XT Model 370. Microsoft formally announced Microsoft Windows. Novell introduced the NetWare network operating system for the IBM PC.
1984	The PC-AT model of microcomputer, introduced by IBM. Microsoft released MS-DOS 3.0 for PCs. Hewlett-Packard introduced the LaserJet laser printer Philips announced CD ROM players for personal computers
1985	Intel introduced the 16-MHz 80386DX microprocessor. Microsoft introduced Windows 1.0.
1986	Microsoft released MS-DOS 3.2. IBM boosted the speed of the IBM PC AT by replacing the CPU with a 8-MHz Intel 80286.
1987	Intel introduced the 20-MHz 80386DX microprocessor. IBM and Microsoft announced Operating System/2 (OS/2) Windows 2.0, introduced by Microsoft. The 80387 math coprocessor, introduced by Intel.
1988	Intel introduced the 25-MHz 80386DX microprocessor. Microsoft released MS-DOS 4.0. Intel introduced the 16-MHz 80386SX microprocessor. Hewlett-Packard introduced the HP DeskJet inkjet printer
1989	The 80486 microprocessor, introduced by Intel. Microsoft released Word 5.0 for DOS.
1990	Intel introduced the 33-MHz 486 microprocessor. Windows 3.0, introduced by Microsoft.
1991	Microsoft released MS-DOS 5.0.
1992	Windows 3.1, introduced by Microsoft.
1993	Microsoft release MS-DOS 6.0. Pentium, a family of 32-bit microprocessors introduced by Intel.
1994	Pentium pro, successes to the Pentium, introduced by Intel. Windows 95, an operating system with a graphical user interface for 8386 and higher processors, released by Microsoft.
1997	Pentium II, a Pentium pro with MMX instructions introduced by Intel.
1998	Celeron, a low-priced version of the Pentium II for desktop PCS Introduced by Intell. Windows 98, released by Microsoft.
1999	Pentium III with 450/500 MHz clock speed introduced by Intel.
2000	Windows 2000 introduced by Microsoft.
2001	Pentium 4, the latest in Pentium series, introduced by Intel.

Fifth Generation Computers

Although fourth generation computers offer too many advantages to users, still they have one main disadvantage. The major drawback of these

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computers is that they have no intelligence on their own. Scientists are now trying to remove this drawback by making computers, which would have artificial intelligence. The fifth generation computers (Tomorrow's computers) are still under research and development stage. These computers would have artificial intelligence. They will use Ultra Large-Scale Integration (ULSI) chips in place of VLSI chips. One USLI chip contains millions of components on a single IC. The most important feature of fifth generation computers is that they will use an intelligent software. This software will enable the user to tell computer 'What to do' and not 'How to do' by using intelligent programming and knowledge-based problem solving techniques. So, the programmers or users would not require to give each and every instruction to the computer for solving a problem. These computers will also have user interface in form of speech in natural languages.

Example:

Yet to develop, but Robots have some features of fifth generation computers.

The comparative features of various generation of computers are shown in table 1.7.

Table 1.7: Comparison of generation of computers

Criteria	Basic Electronic Component	Speed	Size	Availability
First Gen. Computers	Vacuum Tubes/ Valves	Slowest	Largest	Out-dated
Second Gen. Computers	Transistors	Slower	Large	Out-dated
Third Gen. Computers	ICs (Integrated Circuits)	Medium	Medium	Out-dated
Fourth Gen. Computers	VLSIs (Very Large Scale Integration)	Faster	Smallest	Current
Fifth Gen. Computers	ULSI (Ultra Large Scale Integration)	Fastest	Medium	Under R & D

1.4. Types of Computers

Computers are classified into various types based on purpose, technology used, size and storage capacity and historical development as illustrated in figure 1.9. We have already discussed the six types of computers based on historical development. Let us categorise computers based on other criteria.

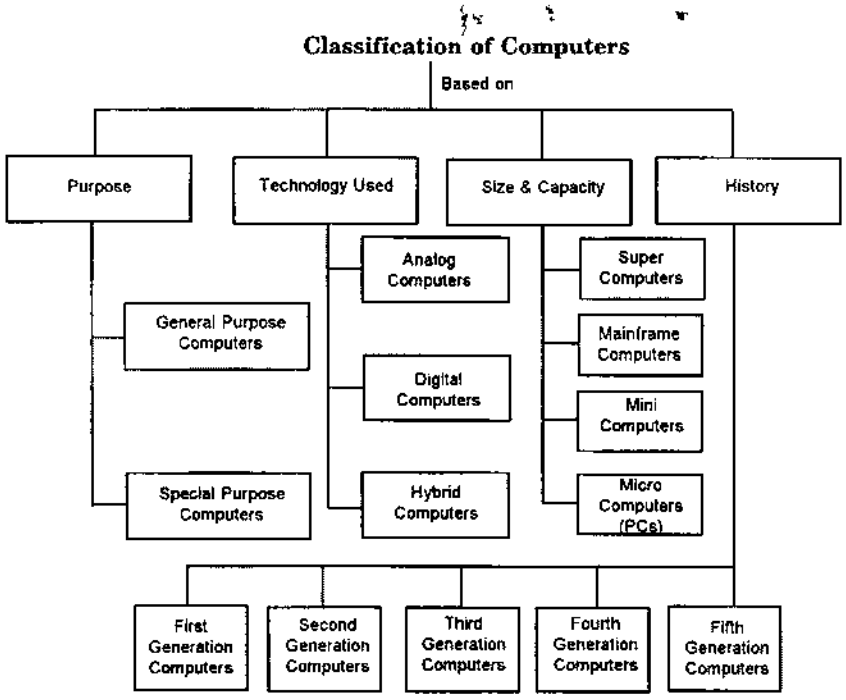

Fig. 1.9: Classification of computers based on different criteria

Based on Purpose

According to the utilisation of computer for different uses, computers are of the following two types :

(*i*) **General Purpose Computers.** Computers that follow instructions for general requirements such as sales analysis, financial accounting, invoicing, inventory, management information etc. are called General Purpose Computers. Almost all computers used in offices for commercial, educational and other applications are general purpose computers.

(*ii*) **Special Purpose Computers.** Computers that are designed from scratch to perform special tasks like scientific applications and research, weather forecasting, space applications, medical diagnostics, etc. are called Special Purpose Computers.

Based on Technology Used

According to the technology used, computers are of the following three types:

(*i*) **Analog Computers.** Analog computers are special purpose computers that represent and store data in continuously varying physical quantities such as current, voltage or frequency. These computers are programmed for measuring physical quantities like pressure, temperature, speed etc. and to perform computations on these measurements. Analog computers are mainly used for scientific and engineering applications. Some of the examples of analog computers are given below:

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(*a*) *Thermometer.* It is a simple analog computer used to measure temperature. In thermometer, the mercury moves up or down as the temperature varies.

(*b*) *Speedometer.* Car's speedometer is another example of analog computer where the position of the needle on dial represents the speed of the car.

(*ii*) **Digital Computers.** Digital computers are mainly general-purpose computers that represent and store data in discrete quantities or numbers. In these computers, all processing is done in terms of numeric representation (Binary Digits) of data and information. Although the user enters data in decimal or character form, it is converted into binary digits (0's and 1's). Almost all the computers used now a days are digital computers and we will discuss the detailed working and components of these computers in subsequent chapters.

(*iii*) **Hybrid Computers.** Hybrid computers incorporate the technology of both analog and digital computers. These computers store and process analog signals which have been converted into discrete numbers using analog-to-digital converters. They can also convert the digital numbers into analog signals or physical properties using digital-to-analog converters. Hybrid computers are mainly used in artificial intelligence (robotics) and computer aided manufacturing (e.g. process control).

Based on Size and Storage Capacity

According to the size and memory/storage capacity, computers are of the following four types:

(*i*) **Supercomputer.** Supercomputer is the biggest and fastest computer, which is mainly designed for complex scientific applications. It has many CPUs (Central Processing Units–main part of a computer) which operate in parallel to make it as a fastest computer. It is the most expensive and sophisticated computer that executor complex calculations at the fastest speed. It can process huge amounts of scientific data. For instance, an IBM super computer limit for U.S. Department of energy is equipped with 2.5 terabytes of memory and memory and can execute 3 trillion program instructions per second.

Applications of Supercomputer: A supercomputer is typically used for the following applications:

- Weather information
- Petroleum exploration and production
- Energy management
- Defense
- Nuclear energy research
- Structural analysis
- Electronic design
- Real-time animation

- Medicine

Features of Supercomputer. A supercomputer has the following capabilities :

- It contains many CPUs operating parallel with processing speed in the range of 400–10.000 MIPS (Million of Instructions per second)
- It maximises the number of floating point instruction per second (FLOPS) which is usually above 1 gigaflop per second.
- It has a very high memory and hard disk capacity. Entire memory of a supercomputer consists of high speed
- Its cycle time is as low as 4 nano second (ns). Thus, it can add two 64-bit data in a single machine cycle

Examples: Some of the examples of supercomputers are :

(1) Param 8000, 9000 & 10000 developed by C-DAC, India

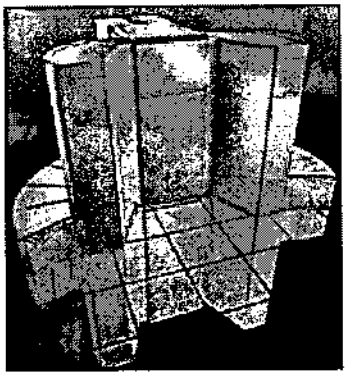
(2) CRAY X-MP/14,24, 48, Y-MP8D, 1, 2 & 3 developed by Control Data Corporation

(3) SX-2 & SX-3R developed by Nippon Electric corporation

(4) HITAC S-300 developed by Hitachi, Japan

(5) VPP 300 developed by Fujitsu

The pictures of sme popular supercomputers are shown in Figure 1.10.



CRAY Y-MP8D

Param 10000

Fig. 1.10: Two popular supercomputers

***(ii)* Mainframe Computer.** Mainframe computers are very large and fast computers but smaller and slower than supercomputers. They are used in a centralised location where many terminals (input/output devices) are connected with one CPU and thus, allow different users to share the single CPU. They have a very high memory (several hundred Megabytes) and can support thousands of users.

Applications of Mainframe Computers. They are mainly used for following applications:

- Railway and airline reservations
- Banking applications
- Commercial applications of large industries/companies

Notes

Features of Mainframe Computer. A mainframe computer has the following features:

- It has very large disks that can store several gigabytes of data.
- It has a very high memory for storing several hundred megabytes.
- It needs a control climate to use. Therefore, a mainframe computer is stored in special secure room.
- It can have thousands of terminals (monitor and keyboard).
- It costs several million rupees.

Examples: Some of the examples of mainframe computers are

(1) IBM 3090, 4381 & 4300

(2) IBM ES 2000 & 9000

(3) DEC 10,000.

***(iii)* Minicomputers.** Minicomputers are medium-scale, smaller and generally slower than mainframe computers. Like mainframes, they have many terminals, which are connected with one CPU and can support many users. The cost of a minicomputer is less as compared to mainframe. Therefore, it is mainly used in applications where processing can be distributed among several minicomputers rather than using a mainframe computer.

Features of Minicomputer. A minicomputer provides the following features :

- It has smaller disks and lesser memory than a mainframe computer.
- Its processing speed is generally slower than a mainframe computer.
- Like mainframes, it can support thousand of users with separate terminals.
- It costs several lacs rupees.

Examples: Some of the examples of minicomputers are

(1) PDP-1

(2) DEC Micro VAX

(3) IBM AS/400 (It is actually a midicomputer – a computer with performance between a mainframe and minicomputer)

***(iv)* Microcomputers.** A microcomputer is the smallest digital computer, which uses a microprocessor as its CPU. Microprocessor is a single chip (integrated circuit) CPU. Microcomputer is popularly called as Personal Computer (PC). It can be used both as a stand-alone machine and a terminal in a multi-user environment. Microcomputers are becoming very popular now-a-days due to very high processing power and memory. Today, a powerful microcomputer may be used as a substitute for mini or mainframe computer.

Model of PCs. Microcomputers are either of desktop or portable model. Portable computers can be carried from one place to another. Some of the models are called as laptops while others as notebook computers. Notebook computers are smaller, lighter and costlier than laptops. Desktop computers fit on a desktop and are used widely in offices and homes. The picture of some of the desktop and portable computers are shown in figure 1.11.

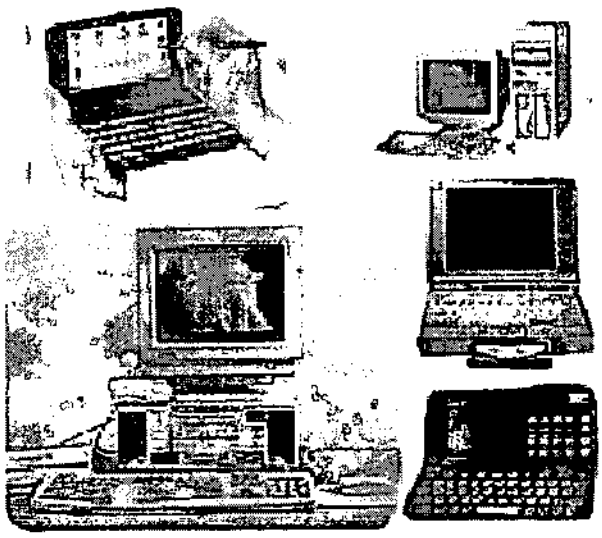


Fig. 1.11: Some desktop and portable computers

There are many types and models of personal computers, which are described in table 1.8.

Table 1.8: Models of microcomputers

CPU Model	Clock (MHz)	Data Bus	Register (BIT)	Max. Memory (RAM)	Comments
8088	8	8	16	1 MB	First 8 bit microprocessor (Original PC)
8086	8	16	16	1 MB	First 16 bit CPU on a chip (PC/XT)*
80286	20	16	16	16 MB	5 times faster than PC/XT (PC/AT)*
80386 SX	33	16	32	16 MB	80386 with an 80286 bus
80386 DX	40	32	32	4 GB	True 32 bit CPU on a chip
80486 SX	40	32	32	4 GB	Math co-processor disabled
80486 DX2	66	32	32	4 GB	More speed with Math
80486 DX4	100	32	32	4 GB	More speed than 486 DX2
Pentium Pro	200	64	32	4 GB	Superscope architecture Able to execute 2 instructions Simultaneously
Pentium II (P6)	266	64	32	64 GB	Faster than Pentium Pro
Pentium III	750				Faster than P II
Pentium IV	1000				Faster than P III

** XT stands for Extended Technology and AT for Advanced Technology*

Notes

Original PC. The original PC (1983 model) had 8 bit microprocessor, 640 K RAM, and 5¼ 360 K floppy drives as shown in figure 1.12. The green screen monitor has no on/off switch, since it drew its power from the P supply. The keyboard was click with tiny little shift and return keys.

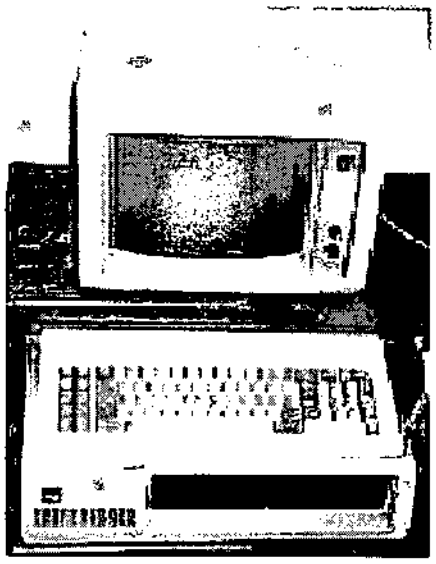


Fig. 1.12: A picture of the original IBM PC

IBM PCjr. IBM PCjr, a smaller version of the IBM PC, jr featured a tiny battery operated "Freeboard" keyboard which operated with no wires, through sensors two cartridge ports on the front. It had an 8088 processor, CGA monitor and one 5¼" 360 K floppy drive as shown in figure 1.13. It was produced during 1983–1985. Themain features of IBM PCjr that its ROM contained IBM BASIC interpreter.

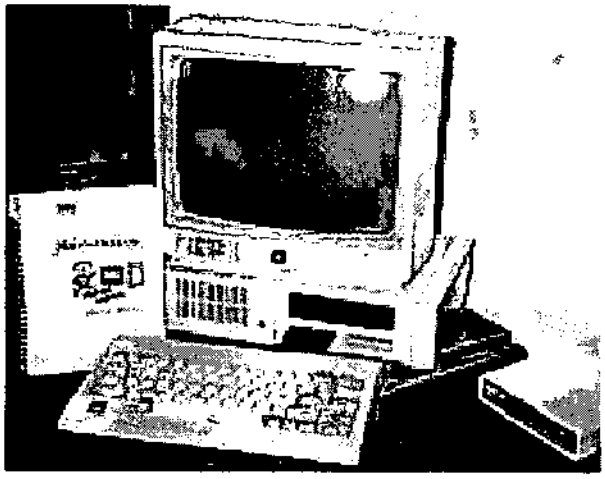


Fig. 1.13: A picture of IBM PCjr

IBM PC/XT. IBM PC/XT had 16 bit microprocessor, 512 K RAM, one ¼" 360 K floppy drive and 20 MB hard disk drive as shown in figure 1.14.

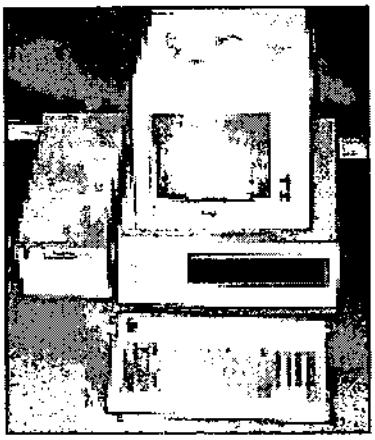


Fig. 1.14: A picture of IBM PC/XT

1.5. Popularity of Personal Computers

IBM PC is the first personal computer, introduced in 1981 by the world's largest computer company—IBM (International Business Machines Corp., New York). This computer was based on Intel's 8088 microprocessor or chip. It became a success almost overnight. In later years, IBM manufactured 80286, 80386, 80486 and recently the Pentium PCs. Although IBM is still the largest supplier of PCs, the majority of PCs are manufactured by other companies as per the standards set by IBM. This whole family of PCs is known as IBM-compatible PCs. So, whenever we talk about a PC, it usually means one of the IBM-compatible PCs. PS/2 and PS/1 (PS stands for Personal System) are IBM computer series introduced in 1987 and 1990, respectively.

Apple Macintosh PC (popularly called as Mac) is another series of 32-bit personal computers, introduced in 1984 by one of the first microcomputer manufacturing company—Apple (Apple Computer, Inc.). Apple is the largest independent manufacturer of non-IBM-compatible PCs. Apple Mac PC uses the Motorola (a leading manufacturer of semiconductor devices) 68000 processor family and a proprietary operating system. As this PC come with its own operating system, there is no need of DOS (Disk Operating System) or other operating system for operating it. The method of operating a Mac PC is known as Macintosh user interface. All Mac PCs have graphic displays, as their operating systems provide Graphical User Interface (GUI). The Mac PC always displays a row of menu titles at the top of the screen, from which options are selected.

Although the first Mac PC was praised by many users due to its ease of use and low-cost system, it was not exciting for most corporate buyers due to its slow speed, small screen and closed architecture (a system whose technical specifications are not made public). In 1987, Apple manufactured Mac II, which offers full-size screens, high-speed and open architecture (a system whose technical specifications are made public). In 1991, IBM formed an alliance with Apple to fully integrate Macs into IBM enterprise networks for developing PowerPC with Motorola.

Notes

IBM-compatible PCs are used as stand-alone machines or as workstations/ file servers in a local area network (we will discuss about local area network in subsequent chapters). These PCs are very popular as stand-alone systems, which run under DOS. IBM-compatible PCs (80486 & above) are also popular for using as client/server systems (we will also discuss about client/server systems in subsequent chapters). On the other hand, Apple Macintosh PCs are rarely used as the primary client computers in client/server systems. Macintosh PCs are useful mainly for desktop publishing systems, due to graphical user inteface. IBM-compatible PCs, on the other hand, are useful for any kind of business applications. They have become very popular among all users in India and abroad.

Workstations

Workstations are desktop personal computers that can be connected to a Local Area network (LAN). A LAN connects several PCs within a confined geographical area with permanently installed cables and dial-up-lines. A typical LAN consists of a server, workstations, a network operating system (such as Windows NT or UNIX) and a communication link (such as a modem). Server is any LAN computer that holds data/programs and makes access to files, printing and other services available to users of the network. Workstation is a user's machine (other than server) that can also function as a stand-alone computer. Typically, a workstation has a less advanced CPU with less memory and lesser storage capacity than a server. Workstation is also the user's PC, called client in client/server computing.

1.6. Computers of the Future

Information technology is changing very fast. Can you imagine, the computers of the future? The future computer would have artificial intelligence, would be mobile and as small as atoms or molecules. We have already discussed the fifth generation computers having artificial intelligence. Let us discuss about mobile and nanotech computers in brief.

Mobile Computers

In the future, mobile computing will become ubiquitous. A specification for a Handheld Device Markup Language (HDML) for mobile computers with screens similar to those in cellular telephones has been proposed to the W3 Consortium, the organization that develops new versions of the Hypertext Markup Language (HTML). HDML will make cellular phones smarter, allowing people to use wireless communications

The currently available mobile Global Positioning System (GPS) devices enable people to use satellite data to determine their location within a few yards anywhere on earth. Mobile computers with GPS capability will be a boon to anyone who is lost or in unfamiliar territory, travelers, sailors, lost children, police, and troops behind enemy lines.

The low-orbit satellite systems planned by Teledesic and Motorola will be an enormous boon to mobile computing, They will help people to use portable computers and wireless connections to the global network from just about any place on earth.

Notes

Nanotech Computers

Researchers in laboratories around the world are working toward the construction of computers consisting of individual atoms or molecules. The science of such atomic-level construction is known as nanotechnology. Scientists expect to be able to build microscopic computers that would be more powerful than the desktop computers of today and supercomputers that can be worn like a wristwatch. Such computers with size and molecular would be called nanotech computer. The possible applications of such nanotech computer would be un-believable. For instance, such computer can be programmed such that they could be injected into the human blood to destroy viruses. The nanotech computer could be complex enough to build other nanotech computer.

1.7. Key Point Summary

- A computer is a fast electronic device that processes the input data and provides the desired information as output.
- A computer is more accurate, faster, diligent and has much more memory than human beings.
- Based on the historical developments, computers are classified into Zeroth, First, Second, Third, Fourth and Fifth generation computers.
- The zeroth generation of computers (1642–1946) was marked by the invention of mainly mechanical computers such as Pascaline, Difference engine, Analytical engine, etc.
- The first generation of computers (1946–1954) was marked the use of vacuum tubes as their basic electronic component. Some examples of first generation computers are ENIAC, EDSAC, EDVAC, IAS machine and UNIVAC I.
- The second generation of computers (1953–64) was marked by the use of transistors in place of vacuum tubes. IBM 701, PDP-1 and IBM 650 are some examples of second generation computers.
- The third generation of computers (1964–1978) was marked by the use of Integrated Circuits (ICs) in place of transistors. IBM 360, PDP-8, PDP-II, CRAY-1 and VAX are some examples of third generation computers.
- The fourth generation of computers (1978–till date) was marked by use of very large scale Integration (VLSI) chips in place of ICs. The present day PCs (Personal Computers) are examples of fourth generation computers.
- The fifth generation computers will use ULSI (Ultra Large Scale Integration) chips and are still under research and development stage.

Notes

- According to the utilisation of computer for different uses, computers are of two types—General Purpose and Special Purpose computers.
- According to the technology used, computers are of three types—Analog, Digital and Hybrid computers.
- According to the size and memory capacity, computers are of four types—Supercomputer, Mainframe Computer, Minicomputer and Microcomputer (or PC).
- Microcomputers are either of desktop or portable model. Portable computers can be either laptops or notebook computers.
- IBM compatible PCs and Apple Macintosh PCs are two popular series of personal computers.
- Workstations are desktop PCs that can be connected to a local area Network (LAN).
- Mobile and nanotech computers are the computers of the future.

1.8. Review Questions

1. Define Computer. Discuss the various characteristics of a computer.
2. Write short notes on the following computing devices :
   (*a*) Abacus (*b*) Napier's bones.
3. What are the mechanical computers ? Explain with examples.
4. Why did the first generation computers fail ? Did the second generation computers become successful ? Discuss with examples.
5. Write the differences between Third and Fourth generation of computer.
6. What are the Fifth generation computers ? Do you think these computers would replace fourth generation computers ? Discuss.
7. Write the full form of the following abbreviations :
   (*a*) ENIAC (*b*) EDVAC
   (*c*) IAS (*d*) EDSAC
   (*e*) UNIVAC (*f*) IBM.
8. Name the following computers :
   (*a*) First Supermini Computer
   (*b*) First Supercomputer
   (*c*) First highly successful Minicomputer
   (*d*) First industry standard Personal Computer
   (*e*) First mass-market Minicomputer.
9. Which major category of computers is used in almost all offices and homes ? Discuss why ?
10. Explain the salient features of Analog, digital and Hybrid computers.
11. What is supercomputer ? List the various uses of supercomputers.

12. Write the differences between mainframe computer and minicomputer.
13. What is a microcomputer ? Explain the differences among various models of microcomputers.
14. Classify the following computers in different categories :
    (*a*) IBM AS/400
    (*b*) PDP-1
    (*c*) CRAY 3
    (*d*) IBM 3090
    (*e*) IBM ES-9000
    (*f*) DEC Micro VAX
    (*g*) NCR 304
    (*h*) IBM 360
    (*i*) Pentium IV
    (*j*) Param 10,000.
15. Why are IBM-compatible PCs more popular than Apple Mac PCs ? Discuss.
16. Write short notes on the following :
    (a) Mobile computers
    (b) Nanotech computers.

Notes

Unit–2

Notes

Applications of Computers

Structure

2.1. Introduction
2.2. Role of Computers in Business
2.3. Role of Computers in science
2.4. Role of Computers in Education
2.5. Role of Computers in Entertainment
2.6. Role of Computers in Data Communications
2.7. Emerging Information Technologies
2.8. Limitations and Disadvantages of Computers
2.9. Key Point Summary
2.10. Review Questions

2.1. Introduction

During the last four decades, computers have revolutionised almost all disciplines of our life. Computers have made possible many scientific, industrial and commercial advances that would have been impossible otherwise. Computers are being used in many areas of applications viz. business, industry, scientific research, defense, space, communications, medicine, education etc. In this chapter, we are discussing the utilisation of computers in different fields.

2.2. Role of Computers in Business

Computers are widely used in business for processing volumes of data of an organisation. They are used in various areas of business functions such as Accounting, Inventory, Sales and Marketing, Manufacturing and Human Resource Development. They are widely used for automation of general office tasks. Let us discuss the role of computers in these areas.

Accounting

Accounting is the most important service activity in business. An organisation uses computers to maintain its accounting records in order to generate various financials statements and reports. A computerised accounting information system satisfies the information needs of management and other people. Managers use computers to access information about the

organisation's assets, liabilities, revenues and expenses. Today, all financial accounting functions in most large organisations are computerised. Various financial statements viz. Trial balance, Trading account, Profit and loss account, Balance sheet, etc. and MIS reports viz. Cost analysis, Forecasting etc. are generated through computers. Computers are also used to calculate salaries/wages of employees and to generate payslips and payroll.

Inventory

Inventory is concerned with the stock of raw materials and finished goods available in the firm. The improper stock levels (low or high) cause many problems to the company. Therefore, maintaining of optimum level of inventories becomes critical for an organisation. Computers are used to maintain optimum level inventories in the firm. A computerised inventory control system generates purchase order, purchase book, inventory status reports, materials return report, materials transfer report and purchase analysis reports.

Sales and Marketing

Sales and Marketing departments use databases to store the names, addresses, telephone numbers, buying habits and other details of potential customers. Marketing Managers and executives use computers for the following purposes:

- Generating invoices and cash-memos
- Checking and executing customer orders
- Designing advertisements and promotional materials
- Mailing promotional materials, bills, reminders etc. to customers
- Maintaining customers credit histories
- Devising pricing and discount strategies of the products
- Planning and analysing the results of market surveys.

Manufacturing

Computers are widely used in the manufacturing industries for:

- Designing products ranging from leather shoes to airplanes by using CAD (Computer Aided Designing) and CAM (Computer Aided Manufacturing) software.
- Generating production, planning and control reports
- Creating simulated versions of finished products such as cars, planes, medical equipment etc. using Virtual reality.
- Assembling and testing of products using Robots.

Human Resource Development (HRD)

In the area of human resources, computers are used for:

- Selection and recruitment of candidates for jobs
- Training of the employees
- Salary and wages structures design

- Performance analysis of employees
- Data processing of routine personnel activities.

Office Automation

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Office automation is the application of computer and related technologies like communication and networking to integrate the general office tasks so that the efficiency of office work is improved. Although all the work of a small or big office can be performed manually, but it is very difficult or even impossible today for an organisation to compete in the market without office automation. There are many essential requirements of today's office environment, which are listed below:

- To reduce cost of administrative overheads.
- To increase the efficiency of office tasks.
- To provide better service to the customers.
- To provide accurate information to the management.
- To provide the best and fastest way of communication.

The above requirements cannot be achieved without using latest technologies and therefore, office automation is needed for an organisation.

Office Automation Systems. Many types of functions are performed in an office. The basic functions, which are needed to be automated in any office are –

(*a*) *Document Generation.* In all offices, many documents are needed to be prepared, typed and printed. Typewriters, computers and printers are widely used in automating this routine task of offices.

(*b*) *Document Processing.* Documents are also needed to be processed in order to extract useful information required for MIS and other official purposes. Many office automation tools like word processing, desktop publishing, etc. are used to perform this task.

(*c*) *Document Distribution.* All offices require an electronic distribution system for transferring documents and data within and outside the organisation. The main office automation tools for distribution of documents are Photocopiers, Teletax and Fax machines.

(*d*) *Archival Storage.* The office documents are also needed to be stored for a long period, so that they can be retrieved when required. This task is achieved by the use of different storage devices like tapes, disks, etc.

For achieving the basic functions of an office, different types of office automation systems are used. These systems can be broadly classified into following four types:

(*a*) *Document Management Systems.* These systems include computerised tools for generation, storage, processing and distribution of documents. Document management is the first important office task, which is needed to be automated. The commonly used office automation tools for document generation are typewriters, computers, printers and scanners. Photocopiers are widely used

for preparing multiples copies of documents.

Computers have revolutionised the system of generation, processing and storage of documents in offices by a technology, called word processing. Desktop Publishing (DTP) is the another popular office technology, used widely for generation of documents using computers and laser printers. This office automation technology is used to produce a high-quality document for commercial printing. Using DTP technology, text and graphics can be combined into a single document that is printed generally on a laser printer.

Besides printers, there are some computer systems which are used to electronicaly capture, store, process and retrieve images of documents. These systems are called as image-processing systems. Optical scanners are often used as image-processing systems.

Archival Storage is generally very expensive and inefficient to store large volume of archival data on paper or on line computers. Therefore, offices need efficient storage devices to store such data. The commonly used archival storage devices are magnetic tapes, optical disks, floppy disks, hard disks and computer output microfilms.

(*b*) *Support Systems.* Certain support systems for managing the activities of work groups are also used in some offices. An automated office also needs certain systems that can help to manage the activities of work groups. These systems, which are actually software packages, are known as office support systems or office automation tools. Word processors, Spreadsheets and Database Management packages are also available as integrated packages generally called Office Automation Packages/Software Tools or Office Suites. MS Office and Lotus Smartsuite are two most popular examples of office automation packages (For details on Office Automation Packages refer Chapter 8–Software)

(*c*) *Communication Systems.* These systems are used for sending messages, documents and data within and outside the organisation. We will discuss about these systems in the later part of the chapter.

(*d*) *Teleconferencing Systems.* An electronic means of communication for conducting seminars and training programmes in an organisation is achieved through various teleconferencing systems. We will discuss about these systems in later part of the chapter.

2.3. Role of Computers in science

Computer are extensively used in various scientific research programmes and medicine for:

- Storing and analyzing scientific data collected from experiments and field work.
- Doing complex scientific calculations
- Representing data graphically

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- Creating models and simulations
- Controlling various scientific devices
- Predicting earthquakes
- Forecasting weather
- Designing compounds for treatment of various diseases
- Analysing human DNA (a genetic molecule) for treatment of genetic diseases
- Maintaining database of patients' history
- Scanning body organs by CAT (Computerized Axial Tomography) scan and MRI (Magnetic Resonance Imaging) machines
- Doing various clinical tests of blood, urine, stool, etc. in a laboratory
- Providing help to physically disabled persons
- Controlling devices (e.g. pacemakers) implanted in human body
- Conducting nuclear tests without physical explosions
- To simulate potential military scenarios and determine defensive strategies
- To guide equipment from satellites to nuclear submarines
- To analyse satellite photographs for searching locations of missile sites

... and so on, There is no end of this list as the use of computers in scientific research, medicine and defense is enormous.

2.4. Role of Computers in Education

Computers have brought dramatic changes in the field of education. Today, almost all universities, colleges, institutes and school systems use computers for the following purposes:

- To perform accounting functions like salary and fee calculations
- To prepare time-tables, date-sheets for examinations and question papers
- To prepare syllabus and course materials
- To generate documents like letters, circulars, memos and mailing lists
- To provide Computer Assisted Instruction (CAI) or Computer Based Teaching (CBT)
- To provide facilities to students for submitting applications for courses and examinations on-line through Internet
- To provide distance learning programmes through CDs and Internet
- To provide E-mail and Internet facilities to students
- To computerise Library information services
- To provide training through educational software and electronic textbooks.

2.5. Role of Computers in Entertainment

Besides commercial, scientific, industrial or any other professional purpose, computers also provide entertainment to the user. Now a day,

many special application software are available which can entertain you. The popular entertainment software available for PCs are:

- Computer games programs
- Graphics software
- Multimedia and animation software
- Internet web pages and chatting

Using graphics, multimedia and animation software, you can draw pictures, make movies and games along with the audio. Computer games are not only popular among children but also among professionals. Some of the popular games are Prince, Chess, Cat, Kingkong and Bricks. Actually, there is a long list of computer games available in Windows and Internet. You can entertain yourself by browsing interesting web pages on Internet. You can also watch movies and some TV channels on Internet. People spend hours on Internet Cafe for chatting and making friends.

2.6. Role of Computers in Data Communications

Computers provide data communication facilities to geographically separated offices through networking. They are used to transmit all forms of data and information, including digital data, voice, sound and video from one location to another over some form of transmission media. The major application areas of computers in the field of data communications and telecommunications are:

- Networking and client/server computing
- Internet
- Communication systems
- Teleconferencing systems

We shall discuss the role of computers in data communications in Chapter 12–Data Communications and Networking and Chapter 13–Overview of Internet in detail. However, we are providing below a brief overview of Communication and Teleconferencing systems.

Communication Systems

Modern offices need computer-based message or communication systems to transfer messages and data rapidly from one location to another. Telex, Teletex, Videotext, FAX, EPABX, Workstations, E-mail, Internet/Intranet are commonly used communication devices/technologies. Though Telex is the oldest means, E-mail and Internet/Intranet are the most modern means of telecommunications. We will now discuss mainly computer-based communication systems.

Videotext. Videotext is the modern means of computer-based telecommunication. In videotext, the data is superimposed upon TV signals and the message is displayed on television sets. Teletext and Viewdata are two common types of Videotext, which differ from each other in their way of communication. In teletext, the message or information is sent out as pages

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to the receivers' teletext in single way and cannot be received back, while in viewdata, the users can send as well as receive messages.

Workstations. Any Personal Computer (PC) or minicomputer in a single or multi-user environment with a wide range of features is known as workstation. Workstations or computers are the essential part of an automated office.

Electronic Mail. Electronic mail (E-mail) is most widely used technology for sending messages or documents from one location to another by using electronic workstations or computers. E-mail services are either available within intra-office network (e.g., local area network) or through an outside vendor. Within an organisation, the employees use a workstation for sending their messages from one electronic mailbox to another. By using E-mail services from a vendor, the E-mail subscriber enters the message into the computer and addresses to the recipient's computer by quoting the E-mail code. The message is then transmitted through the modem to the recipient's mailbox where the recipient can download it. (For more details refer Chapter 12–Data Communications and Networking and Chapter 13–Overview of Internet).

Internet and Intranet. Internet and Intranet are the most recent telecommu-nication technologies, which have brought a technological revolution not only in all offices but also in homes. Internet is the world's largest network of millions of computers all over the world connected through telephone lines. Intranet, on the other hand, is a network of computers within the closed perimeters of the office. (For more details refer Chapter 13–Overview of Internet).

Teleconferencing Systems

Teleconferencing systems are the latest office automation technologies for conducting meetings of widely separated people through a communication channel. These systems enable people to communicate audio, video or image information in a conversation taking place between two or more locations. The teleconferencing systems are of three types—Audio Teleconferencing, Video Conferencing and Computer Conferencing.

Audio Teleconferencing. Audio teleconferencing is simply a conference phone calls system. With such type of conferencing, participants can only hear the voice and cannot see the participants. Audio teleconferencing is used in most of the companies, as it is the least expensive medium for conducting meetings among the participants sitting at far away places.

Video Teleconferencing. Video teleconferencing has completely changed the atmosphere of a modern office. With videoconferencing systems, the participants not only hear the voice but also see each other. The communication takes place either in one-way or multi-way modes. In one-way mode, which is also known as point-to-point videoconferencing, one of the locations sends the information and others receive it. In multi-way mode, which is also known as multi-point videoconferencing, two or more locations can send or receive the information simultaneously.

Computer Conferencing. Some types of teleconferencing systems use computers for conducting meetings, which are known as Computer Conferencing Systems. In these systems, the participants use either E-mail or Electronic Bulletin Boards for sending and receiving information. The messages are entered into the computers using E-mail facility and an electronic conversation takes place among participants. The messages can also be posted on a computer system, called Electronic Bulletin Board, that maintains the list of messages.

2.7. Emerging Information Technologies

The IT industry is growing very rapidly and many new technologies are coming day by day. There are certain technologies which are still under research and development process. Artificial Intelligence and Virtual Reality are major emerging technologies.

Artificial Intelligence

A computer has no intelligence in itself. It performs tasks by getting instructions from human beings. Scientists are trying to impart certain abilities to the computer, which can enable them to perform tasks intelligently, just like human being. Artificial Intelligence (AI) is a capability in computer to carry out the tasks that require intelligence if carried out by human beings. The term 'Artificial Intelligence', which was coined in 1956 by John McCarthy at Dartmouth College, connotes a futuristic world. Artificial Intelligence is still under research & development program all over the world. Though we are not discussing this vast field of emerging technology in details, we are presenting below a brief outline of main areas of AI.

Applications of Artificial Intelligence. There are five main application areas of AI research, which are :

(*a*) Expert Systems

(*b*) Robotics

(*c*) Natural Language Processing

(*d*) Computer Vision

(*e*) Neural Networks.

(*a*) *Expert Systems.* Expert systems are programs that are like human experts which possess extensive background knowledge in their specialised field. They are needed because human expert manpower is scan and expensive. Today, expert systems are available for most of the business applications like finance, marketing, manufacturing etc. besides technical & medical fields. For example, PlanMan, Financial Advisor and Plan Power are some of the expert systems for financial planning areas. MYCIN was the first expert system project for medical applications. After MYCIN project, new systems like EMYCIN (empty MYCIN) were developed, which were without knowledge base. The expert systems without knowledge base are

Notes

called expert system shell. Guru and VP Expert are other examples of expert system shell.

(*b*) *Robotics.* Robotics is the major field of artificial intelligence. It is concerned with design, manufacturing and implementation of computer controlled devices, called Robots. Robots are widely used in many industries like car manufacturing, coal mining, chemical industries etc..

Examples:

(1) The Hexapod Walker Kit. The hexapod walker kit as shown in figure 2.3 is a robot that walks and uses the alternating tripod gate. This kit includes all the hardware, structural components, three standard servos, a Counterfeit Basic Stamp microcontroller kit with PC adapter board, Basic software and an illustrated assembly manual. This robot can walk forward, backwards and turn on a dime left or right.

Fig. 2.1: Hexapod walker kit

(2) Trilobot Mobile Robot. The Trilobot mobile robot as shown in figure 2.4 combines the latest in microcontroller and sensor technology. It has a strong and lightweight frame to create an affordable platform. You can place a laptop computer on the upper deck of the robot or communicate via wireless data links. You can then control the Trilobot using any terminal program or by using high level languages such as C, BASIC or Pascal. You can give commands to the Trilobo's on-board controller from a PC using a serial interface.

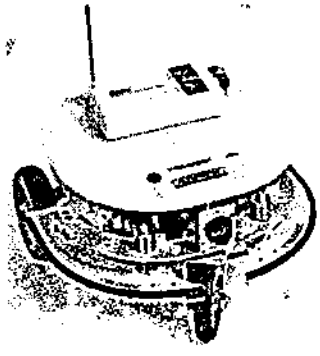

Fig. 2.2: Trilobot mobile robot

(c) *Natural Language Processing (NLP).* NLP is that field of artificial intelligence that allows computers to communicate with users in natural languages like English, French etc.. HAL is the popular natural language interface for Lotus 1-2-3. Guru is another example of NLP software with capabilities of database management, word processing, spreadsheets and graphics.

(d) *Computer Vision.* This field of artificial intelligence enables computers to recognise shapes and patterns through a technique called Pattern Recognition.

(e) *Neural Networks.* Neural networks are knowledge base computer systems that are designed to learn by observations and repetition just like human beings.

Virtual Reality

Virtual reality is a simulated environment that projects users into a three dimensional space generated by computer. Users wear a helmet-like device that completely covers both eyes and ears to create an artifical computer-simulated reality. In addition, many systems make use of glove containing sensors that feed information about the movements of the user's hand into the computer. This information is used to incorporate hand movements into the scene that the user is watching. Using virtual reality systems, users can move and manipulate illusory objects in their view. They can select and organise information with hand and body movements.

Applications of Virtual Reality. Several companies are developing business applications for this emerging technology. For instance, a major electronics firm in Japan is developing an application for a 'Virtual Showroom'. Virtual reality systems can be used for the following applications:

- Flight simulation in indoor games
- Exploration of the design features of products to be manufactured.
- A fantastic voyage through the human body.
- Walking through proposed design for an airline terminal.
- As a tool for design by an architect.

2.8. Limitations and Disadvantages of Computers

Though the benefits and applications of computers are numerous, computers still have certain limitations and drawbacks. A computer is a machine and obviously has no intelligence of its own. Each and every instruction must be given to the computer for doing a task. Man has intelligence and it is the man who invented computer and gives it all the instructions and logic to work. The main drawback of computer is that it cannot take decisions on its own.

Computers are not versatile like human beings. They can perform limited functions. Input, output and processing the data are the basic functions performed by a computer. They perform tasks according to the instructions given by human beings. They do not have human like intelligence. Although

scientists are trying to provide human knowledge and intelligence to the computers through emerging technology of artificial intelligence, but still they are machines. They cannot possess all the knowledge and intelligence of a human being, so, computers cannot replace human beings at all.

Notes

Health Risks with Computers

Some of the health risks associated with computers are:

- Strain in eyes and muscles, backaches, and repetitive motion disorders
- Radiation emitted by monitor increases people's risk of brain tumors, miscarriage, and birth defects
- Psychological stress due to the prolonged, repetitive activity associated with some kinds of data entry jobs
- Internet addiction
- The above stated risks can be avoided by following precautions:
- Taking regular breaks while working for a long time on computers
- Typing at a keyboard placed lower than one's elbows using a wrist pad
- Sitting in an ergonomically designed chair
- Using an anti-glare screen and placing the monitor eighteen inches from the eyes.
- Using Internet for limited time and useful purposes.

2.9. Key Point Summary

- Computers are used in various areas of business functions such as accounting, inventory, sales and marketing, manufacturing and human resource development.
- Office automation systems are used to perform the basic functions of an office viz. Document generation, Document processing, Document distribution and Archival storage.
- Office automation systems are of four types—Document management systems, Support systems, Communication systems and Teleconferencing systems.
- Computers are extensively used in various scientific research programmes and medicines.
- Computers have brought dramatic changes in the field of education.
- Computers also provide entertainment to the user through Computer games, Graphics, Multimedia, Animation and Internet.
- The major application areas of computers in the field of data communications and telecommunications are Networking, Client/server computing, Internet, Communi-cation systems and Teleconferencing system.
- Videotext, Workstations, Electronic mail, Internet and Intranet are computer based communication systems.
- The teleconferencing systems are of three types—Audio teleconferencing, Video conferencing and Computer conferencing.

Notes

- All organisations need information systems for processing of their routine transactions.
- An information system can either be manual or computerised.
- The six major types of information systems for various management levels are ESS, DSS, MIS, KBS, OAS and TPS.
- Artificial intelligence and Virtual reality are the major emerging information technologies.
- The major application areas of AI research are Expert systems, Robotics, Natural Language Processing, Computer vision and Neural network.
- Virtual reality systems can be used for applications like Flight simulation in indoor games, Explanation of the design features of products to be manufactured, etc.
- Computers have certain limitations. They are not versatile like human being and do not have human like intelligence.

2.10. Review Questions

1. Do we need computers ? Explain various uses of computers in brief.
2. Discuss the role of computer in business and industry.
3. Discuss the role of computers in medicine. List the important computerised devices used for diagnosis of patients.
4. How do computers help students in distance learning education ?
5. What is computer based teaching ? Discuss its role in the field of education.
6. What is office automation ? Discuss the various types of office automation systems.
7. Discuss the role of computers in Science.
8. What are communication systems ? Discuss the various computer based communication systems.
9. Discuss the role of teleconferencing systems for an organisation.
10. What is Artificial Intelligence ? Discuss its applications.
11. What is Virtual Reality ? Discuss its application in brief.
12. Write short notes on the following :
    (*a*) Limitation of computers
    (*b*) Health risks with computers.

Unit–3

Notes

Basic Computers Organisation

Structure

3.1. Introduction
3.2. Hardware and Software
3.3. Input/Output Unit
3.4. Central Processing Unit
3.5. Memory Unit
3.6. Storage UNIT
3.7. Motherboard
3.8. Cards, Ports and Cords
3.9. Power Supply
3.10. Parallel Machines
3.11. Future of Processor
3.12. Speed of Computer
3.13. Key Point Summary
3.14. Review Questions

3.1. Introduction

The internal architectural design of computers differs from one model to another, however the basic components of a computer remain the same for all models. The diagram of a generalised architecture of a computer system is shown in figure 3.1. A complete computer installation including the central processing unit, the peripherals such as hard disk drives, floppy disk drives, monitor, printer, mouse and operating system which are designed to work and interact with each other and with the user is called a *computer system.*

A computer system has the following main physical components :

(*a*) Input/Output Unit

(*b*) Central Processing Unit (CPU)

(*c*) Memory Unit

Besides the above main components, a computer system has other components such as Motherboard, Powersupply, Storage Devices, Ports, Cards and Cords. All the devices of computer except motherboard and CPU are called *peripheral devices.* In this chapter, we will discuss all these components in detail.

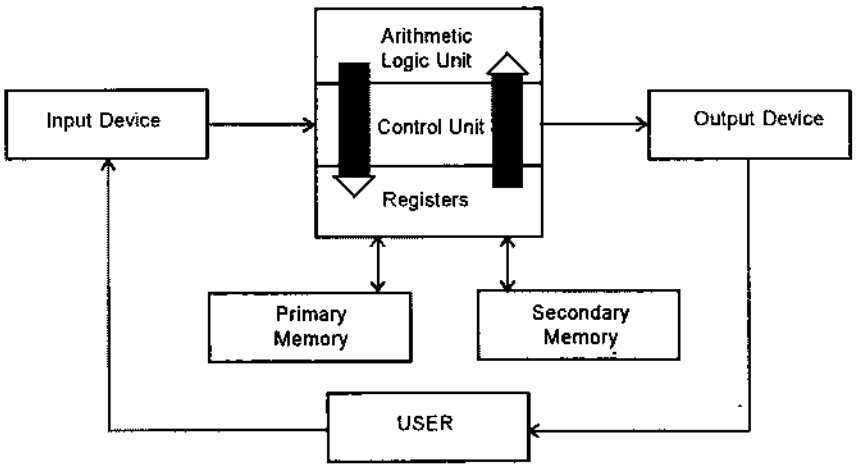

Fig. 3.1: Figure 3.1 Functional diagram of a generalised architecture of a computer system

3.2. Hardware and Software

Computer components can be broadly divided into two categories—Hardware and Software. Hardware refers to any physical component of a computer. For example, CPU, Monitor, Keyboard, Hard disk, Floppy disk etc. are physical components and thus, are hardware. Software refers to the programs, which are required to operate the computer. For example, DOS (Disk Operating System), BASIC, COBOL, dBASE, Accounting Software, etc. are all software. An analogy of hardware can be the book which you are reading and then software would be the text written on this book. Another analogy could be-'brain' is a hardware but 'memory stored in brain' is a software.

Both hardware and software are dependent on each other. CPU, Memory unit, Hard disk etc. are useless unless they are provided with instructions and data for storage and processing. Similarly, BASIC or COBOL language has no importance unless they are used along with various hardware components of the computer.

3.3. Input/Output Unit

We know that the computer is a machine that processes the input data according to a given set of instructions and gives the output. Before a computer does processing, it must be given data and instructions. After processing, the output must be displayed or printed by the computer. The unit used for getting the data and instructions into the computer and displaying or printing the output is known as an Input/Output unit (I/O unit).

The input unit is used to enter data and instructions into a computer. There are many peripheral devices, which are used as input/output units for the computer. The most common form of input device is known as a *terminal*. A terminal has an electronic typewriter like device, called keyboard along

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with a display screen, called *Visual Display Unit* (VDU) or *monitor*. Keyboard is the main input device while the monitor is considered an output device. There are some other common input devices like mouse, punched card, tape, joystick, scanner, modem etc., which we shall discuss in the next chapter (Chapter 4–Input and Output Devices). Monitor, printer and plotter are the main peripheral devices used as output units for the computer.

3.4. Central Processing Unit

Central Processing Unit (CPU) is the main component or "brain" of a computer, which performs all the processing of input data. Its function is to fetch, examine and then execute the instructions stored in the main memory of a computer. In microcomputers, the CPU is built on a single chip or Integrated Circuit (IC) and is called as a *Microprocessor*. The CPU consists of the following distinct parts :

1. Arithmetic Logic Unit
2. Control Unit (CU)
3. Registers
4. Buses
5. Clock

Let us discuss these in brief.

Arithmetic Logic Unit

The arithmetic and logic unit of CPU is responsible for all arithmetic operations like addition, subtraction, multiplication and division as well as logical operations such as less than, equal to and greater than. Actually, all calculations and comparisons are performed in the arithmetic logic unit.

Control Unit

The control unit is responsible for controlling the transfer of data and instructions among other units of a computer. It is considered the "Central Nervous System" of computer, as it manages and coordinates all the units of the computer. It obtains the instructions from the memory, interprets them and directs the operation of the computer. It also performs the physical data transfer between memory and the peripheral device.

Registers

Registers are small high-speed circuits (memory locations) which are used to store data, instructions and memory addresses (memory location numbers), when ALU performs arithmetic and logical operations. Registers can store one word of data (1 word = 2 bytes & 1 byte = 8 bits. Details of BITS & BYTES are described in Chapter 6–Data Representation and Computer Arithmetic) until it is overwritten by another word. Depending on the processor's capability, the number and type of registers vary from one CPU to another. Registers can be divided into six categories viz. General purpose registers, Pointer registers, Segment registers, Index registers, Flags register

and Instruction pointer register, depending upon their functions. The detailed functions of each and every register will be discussed in Chapter 7–Computer Architecture.

Notes

Buses

Data is stored as a unit of eight bits (BIT stands for Binary Digit i.e., 0 or 1) in a register. Each bit is transferred from one register to another by means of a separate wire. This group of eight wires, which is used as a common way to transfer data between registers is known as a bus. In general terms, bus is a connection between two components to transmit signal between them. Bus can be of three major types viz. Data bus, Control bus and Address bus. The data bus is used to move data, address bus to move address or memory location and control bus to send control signals between various components of a computer.

Clock

Clock is another important component of CPU, which measures and allocates a fixed time slot for processing each and every micro-operation (smallest functional operation). In simple terms, CPU is allocated one or more clock cycles to complete a micro-operation. CPU executes the instructions in synchronisation with the clock pulse.

The clock speed of CPU is measured in terms of *Giga Hertz* (GHz) or Billions of Cycles per second. The clock speed of CPU varies from one model to another. CPU speed is also specified in terms of *Millions of Instructions Per Second* (MIPS) or *Million of Floating-Point Operations Per Second* (MFLOPS).

3.5. Memory Unit

Memory Unit is that component of a computer system, which is used to store the data, instructions and information before, during and after the processing by ALU. It is actually a work area (physically a collection of integrated circuits) within the computer, where the CPU stores the data and instructions. It is also known as a *Main/Primary/Internal Memory*. It is mainly of the following three types:

(*a*) Read Only Memory (ROM pronounced as "Ra-om")

(*b*) Random Access Memory (RAM pronounced as "R-aem")

(*c*) Complementary Metal Oxide Semiconductor Memory (CMOS)

Besides the above memories, some computers have special types of memories, which are :

(*a*) Flash Memory

(*b*) Cache Memory

(*c*) Virtual Memory

(*d*) RAM Disk

Let us discuss all these memories in detail.

Notes

Read Only Memory

Read Only Memory is an essential component of the memory unit. We know that the computer, being a machine, itself has no intelligence or memory and requires instructions, which are given by man. Whenever the computer is switched on, it searches for the required instructions. The memory, which has these essential instructions, is known as Read Only Memory (ROM). This memory is permanent and is not erased when the system is switched off. So, ROM is a non-volatile memory. As it appears with its name, it is read type of memory i.e. it can be read only and not be written by user/ programmer. The memory capacity of ROM varies from 64 KB to 256 KB (1 Kilobyte = 1024 bytes) depending on the model of computer.

ROM contains a number of programs (set of instructions). The most important program of ROM is the *Basic Input Output System* (BIOS, pronounced as "bye-Os") which activates the hardware (physical components of computer) such as keyboard, monitor, floppy disk etc. in communicating with the system and application software (set of instruction or programs).

Types of Rom. There are many types of ROM available for microcomputers like Mask ROM, PROM, EPROM, EEPROM and EAPROM.

(*a*) *Mask ROM.* Mask ROM is the basic ROM chip. In this type of ROM, the information is stored at the time of its manufacturing. So, it cannot be altered or erased later on.

(*b*) *PROM.* PROM stands for *Programmable Read Only Memory.* In this type of ROM, the information is stored by programmers after its manufacturing. It also cannot be altered or erased later on. The information of PROM can be programmed only once after manufacturing. It cannot be altered or erased later on.

(*c*) *EPROM.* EPROM stands for *Erasable Programmable Read Only Memory.* It is similar to PROM, but its information can be erased later on by ultra violet light and it can be reprogrammed. A window on the top of an EPROM chip allowed the programmer to reprogram the chip using a chip burner

(*d*) *EEPROM.* EEPROM stands for *Electrically Erasable Programmable Read Only Memory.* It is similar to EPROM, but its information can be erased by using an high voltage current. The programmer flash an electric charge through the EEPROM chip to reprogram it's code, Most of the BIOSs used today have EEPROMS and can be flashed while they are still connected to the motherboard. A simple software utility can rewrite an entire BIOS having EEPROMS.

(*e*) *EAPROM.* EAPROM stands for *Electrically Alterable Read Only Memory.* As compared to EPROM and EEPROM, the information stored in EAPROM can be altered later.

Random Access Memory

Random Access Memory (RAM) is another important component of the Memory Unit. It is used to store data and instructions during the execution

of programs. Contrary to ROM, RAM is temporary and is erased when the computer is switched off. So, RAM is a volatile memory. RAM is a read/ write type of memory, and thus can be read and written by the user/ programmer. As it is possible to randomly use any location of this memory, therefore, this memory is known as random access memory. The memory capacity of RAM varies from 640 KB to several megabytes (1 Megabyte = 1024 KB) with different models of PC.

Types of RAM. There are two types of RAM used in PCs-Dynamic and Static RAM.

(*a*) *Dynamic RAM (DRAM).* The information stored in Dynamic RAM has to be refreshed after every few milliseconds, otherwise it is erased. In other words, DRAM must be continuougly rewritten in order to maintain its data. This is done by placing the memory on a refresh circuit that rewrites the data several hundred times per second. DRAM is used for most system memory because it is cheap and small. DRAM has higher storage capacity and is cheaper than Static RAM. It is based on concept of a transistor and capacitor used to store one bit of data as an electrical charge. A charged capacitor represents a 1 and discharged one 0. Like a battery, the capacitor holds a charge and then discharges it.

Types of DRAM. There are several types of DRAM, which are described below:

- Fast Page Mode DRAM (FPM DRAM). FPM DRAM is only slightly faster than regular DRAM. It uses a slightly more efficient method of calling data from the memory. It's speed is 28.5 MHz.
- Extended Data Out DRAM (EDO DRAM). EDO memory can simulataneously read new data while refreshing the old one. Its speed is 125 MHz. It is the most common type of memory for most users. Its speed is 40 MHz.
- Burst EDO DRAM (BEDO DRAM). This is basically EDO DRAM with combined pipelining technology. The result is a much faster EDO memory chip capable of working with faster bus speeds. It's speed is 66 MHz.
- Synchronous DRAM (SDRAM). SDRAM is the latest standard for PC memory. Its speed is synchronous, meaning that it is directly dependent on the clock speed of the entire system. It is designed to support CPU with clock speeds over 100 MHz.
- RAMBus DRAM (RDRAM). It is still being developed by Intel that may prove to be better than SDRAM. Its goal is to get rid of the latency (the time taken to access memory) by actually narrowing the bus path and treating the memory bus as a separate communication channel. Its speed is 600 MHz.
- Video RAM (VRAM). It is specially designed for video display adapters.

Notes

(b) *Static RAM (SRAM).* The information stored in Static RAM need not be refreshed, but it remains stable as long as power supply is provided. SRAM is costlier but has higher speed than DRAM.

Types of RAM Chips. There are following four types of RAM chip:

(a) *SIP (Single Inline Package).* In this type of RAM chip, all leads (connections) protrude from one side of the package.

(b) *DIP (Dual Inline Package).* In this type of RAM chip, the microminiature electronic circuits etched on a silicon wafer are enclosed in a rectangular housing of plastic or ceramic and connected to downword pointing pins protruding from the longer sides of the chip.

(c) *SIMM (Single Inline Memory Module).* It is a small circuit board designed to accommodate surface amount chips. It has 30 or 72 pins. One 72-pin SIMM is required to make a bank in a 386 or 486, two 72-pin SIMM's are required to make a bank in a Pentium or Pentium Pro. A 30-pin SIMM can have as few as two or as many as nine individual DRAM chips. Regardless of the number of DRAM chips, a 30-pin SIMM is 8 bits wide (one byte).

(d) *DIMM (Dual Inline Memory Module).* It is similar to a SIMM but contains more memory. A DIMM has 168 pins on the module.

Complementary Metal Oxide Semiconductor Memory

Complementary Metal Oxide Semiconductor (CMOS) memory is used to store the system configuration, date, time and other important data. When the computer is switched on, BIOS matches the information of CMOS with the peripheral devices and displays error in case of mismatching.

Flash Memory

Flash memory is a memory chip that holds its content without power. It is derived from the EEPROM chip technology. Flash memory is so called as it can be erased "in a flash",. Unlike RAM chips, in which a single byte can be written flash memory must be erased and written in fixed blocks ranging from 512 bytes to 256 K. Flash memory is cheaper and more devise. It is used to replace ROM BIOS chips so that BIOS could be updated.

Cache Memory

Cache memory is a temporary storage area where the most recently called data and instructions from RAM are stored by the processor. When a processor needs an instruction from RAM, it first looks for that instruction in cache memory and, because some instructions are called frequently it, finds it there often. Cache memory speeds up processing. Some personal computers have cache memory chips hardwired onto the motherboard. Operating systems also are typically capable of setting aside a portion of RAM to be used as cache memory and the size of that cache can be set by the user. In addition, many expansion cards contain caches for specific purposes, such as

for storing digitised sound or video. Cache memory improves performance of computer by storing the frequently used data and instructions.

Working of Cache Memory. Cache memory differs from regular memory in that it involves a "guess". While answering some mathematical question, sometimes you guess without doing calculations.

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Cache memory in a computer works almost the same way. It works in the following sequence;

1. The Cache controller guesses what application thread or data the CPU will need next and writes it from DRAM into the cache SRAM.
2. When the CPU needs data or instruction from RAM, first CPU looks for them in cache memory and if they are found, they are accessed 3 to 5 times faster as compare to accessing from RAM.

Virtual Memory

Virtual memory is a portion of the external memory (generally a hard disk) used as an extension of its immediate access memory.

Typically Hard Disk Drives (HDD) are used to store programs and data files. Another way to use a HDD is to designate a portion of it to be used as virtual memory. When using virtual memory, a computer treats a part of HDD connected to it as additional RAM. If the user has the necessary free HDD space, using virtual memory will enable him or her to work with large programs and data files without installing additional RAM. Although virtual memory provides more memory to computer, it has following drawbacks.

- Virtual memory is slower than RAM because accessing a hard drive (which requires a mechanical process) is slower than accessing RAM (which involves no mechanical activity).
- Virtual memory takes up hard disk space that may or may not be available. A virtual memory swaps file on a hard disk that adds 20 MB of virtual RAM requiring 40 MB, or twice the amount, of free hard disk space. Relying on virtual memory when the hard drive is near capacity can lead to performance and reliability problems.
- Some application programs may not make use of virtual memory, and some may require it when virtual memory could be turned off.

Ram Disk

You can also store various types of information, including lookup tables from a database itself by creating a dummy hard disk within the RAM itself. This disk is accessible just like any other hard disk, except that its contents are completely wiped off when the machine power is reset. Thus, a RAM disk is used for lookup tables or non-critical data, which is not frequently updated and requires instant access.

3.6. STORAGE UNIT

Prior to the advent of computer, all data were stored manually on papers. Now-a-days when computer has become an essential part of

Notes

every organization, most data are stored in computers. Primary memory (especially RAM) stores the data, instructions and information temporarily during processing by CPU. When the computer is switched off, this memory gets erased. How does a computer store the data, information and software permanently, so that they can be retrieved whenever required? Certainly, there must be a storage unit in the computer. The storage unit of the computer consists of different storage devices such as Hard Disk Drive, Floppy Disk Drive, Compact Disk Drive, etc. The storage unit is also called *Secondary Memory Unit*. We will study about various storage devices in chapter 5– Storage Devices.

3.7. Motherboard

Motherboard, also called as *System Board*, is the most important hardware component of a microcomputer. Motherboard is so called as all the other boards (printed circuit boards having chips or other electronic components) of the computer are connected to this board, hence it is like the mother of all other boards.

Components of Motherboard

A motherboard contains the CPU chip, Memory chip (ROM and RAM chips), I/O interface, expansion slots and many other logic circuits as shown in figure 3.2. It may also contain a math's co-processor chip. CPU or processor chip is the main component of a motherboard. The types of CPU chip (8088/ 80286/ 80386/ 80486 etc.) vary from one model of PC to another. The function of maths coprocessor chip (8088/ 80287 etc.) is to support the CPU chip in processing of mathematical calculations.

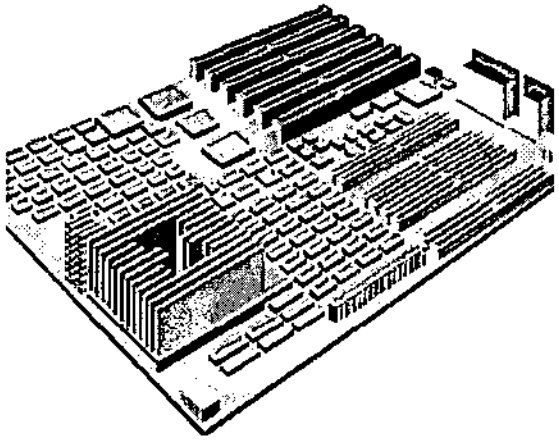

Fig. 3.2: Motherboard

Memory chips are physically installed on the motherboard by different packing methods. There are three different types of packing of RAM chips—DIP, SIMM and SIPP. DIP (*Dual Inline Package*) is the most common packing, having a small rectangle box with leads on both sides. SIMM (*Single Inline Memory Module*) packing contains a number of chips soldered on an expansion

board having an edge connector. SIPP (*Single Inline Pin Package*) is similar to SIMM, but uses pin rather than an edge connector.

Expansion slots are connectors on motherboard where expansion cards like display card, hard disk controller card, etc. can be connected. I/O interface is the channel between the CPU andperipheral devices (keyboard, monitor, etc.).

3.8. Cards, Ports and Cords

Cards are the printed circuit boards, which are used to hold the chips (integrated circuits). There are many types of cards used in a PC, the important ones are Video

Card, Sound Card, I/O Card, Controller Card and Memory Card. Video card (Display Card) generates the text and graphic images for the monitor while the sound card generates the sound. Pentium computers, generally, use a PCI (Peripheral Component Inter connect) video card to speed up graphics. I/O Card provides a place for connecting the mouse and printer. Cables of hard disk and floppy disk are connected to controller cards. Memory Card provides a place for memory chips. Some of the cards are shown in figure 3.3.

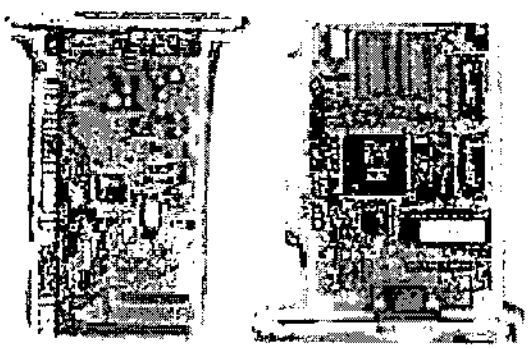

Fig. 3.3: Some cards

The computer has several components, which are used as pathway for flow of data. The rear of a PC has many empty holes or external sockets called ports or *connectors*. There are many types of ports in a PC, the most important ones are Serial Port, Parallel Port, Game Port and Video Port. Serial Port is used to connect a mouse, modem or scanner. *Parallel Port* is generally used to connect a printer. *Game Port* is used to connect the joystick while *Video Port* is a connector for the monitor.

Cords are the cables used to plug into the ports. There are different types of cables for connecting different types of input, output and storage devices. The important cords used in a PC are keyboard cords, power cords, monitor cords and printer cords.

3.9. Power Supply

Power supply is considered as the 'Heart' of a PC. A computer requires a clean and steady power source for working properly. Power supply is that important hardware, which provides the power source to a computer. It

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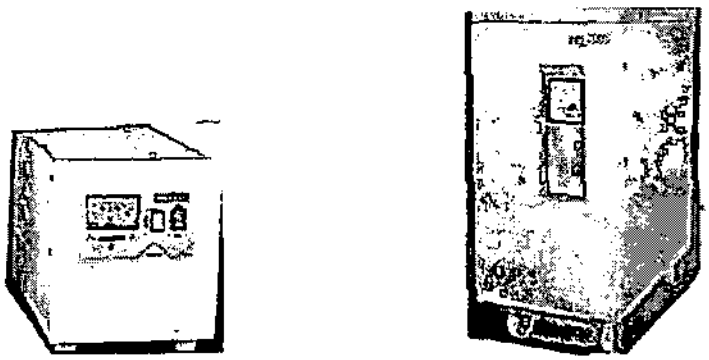
provides a voltage range of 4.95 to 5.25 volts for the highest performance of the system. Power supplies vary in size and power (in watt). An *Uninterrupted Power Supply* (UPS) keeps the computer running for a few minutes even when the electricity supply goes off. UPS is not a part of computer and is purchased separately. It is optional but mostly preferred to CVT (*Constant Voltage Transformr*) The pictures of CVT and UPS are shown in figure 3.4.



CVT UPS

Fig. 3.4: Constant Voltage Transformer (CVT) and Uninterrupted Power Supply (UPS)

3.10. Parallel Machines

A computing machine having many ALUs or complete CPUs, which operate in parallel, is called a parallel machine. According to M.J. Flynn, there are following three categories of parallel machines:

(*a*) SISD (Single Instruction Single Data streams)

(*b*) SIMD (Single Instruction Multiple Data streams)

(*c*) MIMD (Multiple Instruction Multiple Data streams)

Let us discuss these in detail.

SISD Machine

An SISD machine (*Single Instruction Single Data streams*) has one instruction stream and one data stream. In this machine instructions are fetched from memory and executed by single CPU one by one. The traditional von Neumann machine is an SISD machine. The SISD machine has the limited features of parallelism. Some machines have multiple ALUs, each of which performs a single operation. Some machines have a CPU consisting of multiple processing units, each of which execute a separate instruction in each time interval. Such machines are called *Pipeline Machines.*

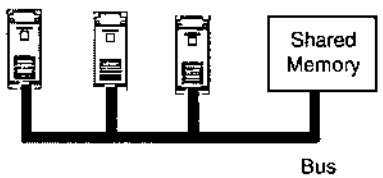
SIMD Machine

An SIMD (*Single Instruction Multiple Data streams*) machine has one instruction stream and multiple data streams. In this machine, multiple data sets are executed by a single CPU by two approaches. In one approach, the

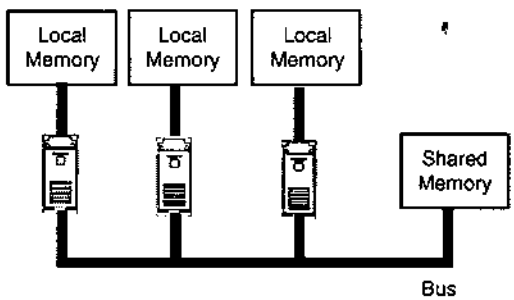
ALU is a vector ALU, which performs an operation on two input vectors and generate an output vector as result. This category of computers is called *Vector Machine*. In another approach, the machine consists of a square grid of processor and memory elements. Each unit of processor user its own data stored in its own memory. Such machines are called *Array Machines*.

MIMD Machine

An MIMD (*Multiple Instruction Multiple Data streams*) machine: This machine has multiple instruction streams and multiple data streams. In this machine, different CPUs execute different instruction sets either sharing a common memory or using their own local memories as shown in figure 3.5. An MIMD machine is also called a *Multiprocessing System*.



(*a*) A multiprocessor with shared memory



(*b*) A multiprocessor with local memories

Fig. 3.5: Two architectures of MIMD machines

Multiprocessing System. A multiprocessing system is computer system having several CPUs, which execute programs in parallel. There are many types of organisation of a multiprocessing system, some of which are described below:

- In some multiprocessing systems, several CPUs work together to do the main processing. In case of breakdown of one CPU, other CPUs perform its function.
- In some systems, each CPU is assigned a specific type of function.
- In some systems several CPUs form a client/server type of network. The main CPU of server is called the *Back-end Processor* while CPUs of clients are called *Front-end Processor*.

The basic organisation of a multiprocessing system has the following main components as shown in figure 3.6.

- Several CPUs for processing

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- Several I/O processor (channels) for improving Input/output performance
- Memory shared or separate to each CPU

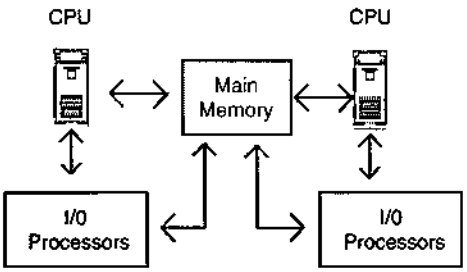

Fig. 3.6: An organisation of a multiprocessing system

3.11. Future of Processor

The processor is a collection of very large number of integrated circuits, which further consist of transistors connected by tiny wires. Since electrons take a very small but finite time to travel through circuits, packing more of these into a smaller space make processors faster and more efficient. Gordon Moore, co-founder of Intel (a leading processor manufacturer) predicted in the mid-1960s that the number of transistors that could be packed onto a chip would double every two years while the price would decrease by half. This prediction is referred as *Moore's law*. This law has proved to be accurate, though the pace of change has accelerated in recent years and will continue to do so in the foreseeable future.

In addition to packing more switches and more wires into smaller spaces, scientist are rethinking the basic architecture of processors, so that computers will become more efficient, reliable and flexible. Let us discuss the various developments in processors' technology.

CISC Processor

Most processors in personal computers produced before 1995 were *Complex Instruction Set Computing*, (CISC) chips. These chips contain many instructions and enable software developers to create programs capable of carrying out complex tasks. The main drawback of CISC chips is that they need an interpreter to process commands. So, the overall performance of computer is effected because instructions must be processed by the interpreter.

RISC Processor

The latest design for processor uses *Reduced Instruction Set Computer* (RISC) chip that keep instruction set small. RISC chips do not need interpreter to process command, therefore they are faster than CISC chip. Recently, many desktop computers and workstations have begun using RISC processors. RISC processor are also used in larger workstation that run the Unix operating system.

Simultaneous Instruction Processor

One limitation of processors in the past has been that no matter how small or how fast they were, they could process in the end, only a single instruction at a time. New simultaneous instruction processor designs are changing these limitations, making it possible for concurrent instructions to be processed by the same processor. As the number of concurrent instructions increases. the speed of processing increases.

ASIC Chip

Another important development in processor technology is the widespread use of Application-Specific Integrated Circuit (ASIC). The microprocessors inside computers are general-purpose devices. An ASIC, in contrast is optimised to carry a few functions specific to some particular application. As an ASIC does not have to carry all the functions of a full-fledged microprocessor, it can be much smaller. ASICs are now used in a wide range of products, from coffee makers to smart credit cards, and to store Personal Identification Numbers, (PINs) on embedded chips rather than on magnetic strips. In the future, smart cards containing digital money may be used in lieu of coins to make telephone calls on public booths and to pay parking meters. At an ATM machine, one might download money to the card that will then be used for routine purchases.

FPGA Chip

The recent development of processors is that they may contain *Field-Programmable Gate Arrays* (FPGAs). A processor contains circuits organised into logic gates. A given gate performs the function of specific logical operator such as AND, OR, or NOT. Complex functions like addition are performed by connecting many of these gates together. In a processor that contains FPGAs, the functions of logic gates and connections between the gates can be modified during processing. So, the processor, can change its configuration on the fly to optimize itself for specific applications. These configurable computing processors are especially useful for tasks that involve rapid adaptation to changing input, such as pattern recognition for reading handwriting, decoding or encoding speech, searching image databases, targeting projectiles, or avoiding collisions of automobiles or aircraft.

3.12. Speed of Computer

Computers help you to do your work efficiently. The speed of computer has become a critical factor while selecting a machine. How quickly your computer runs, that depends on the following criteria:

(*a*) *Processor.* Newer processors (such as Pentium-4) are faster than older ones (such as Pentium III).

(*b*) *Clock Speed.* Clock speeds on personal computers vary considerably. Today, personal computers come with clock speed in the range of Giga Hertz.

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(c) *Cache Memory*. Cache memory if present in your computer can speed up processing by reducing the number of calls that the processor makes to RAM.

(d) *Data Bus*. Other factors being equal, a processor that has a 64-bit data bus is twice as fast as one with a 32-bit data bus.

(e) *Math Co-processor*. Mathematics-based applications can be speeded up by adding a math co-processor to relieve the processor of some calculations. A math co-processor is a special chip or a part of the processor itself that is designed especially to process numbers that are very large or very small.

(f) *RAM Size*. RAM in a computer should be sufficient enough to load the operating system, application programs, and files of whatever size the user commonly works with.

(g) *A Dedicated Audio, or Graphics Processor*. A user who will be doing intensive audio, video, or graphics work may want to add an expansion card with a processor.

3.13. Key Point Summary

- A computer system has mainly three components—(*a*) Input/Output unit, (*b*) Central Processing Unit (CPU), and (*c*) Memory unit.
- Computer components are divided into two categories—Hardware and Software.
- Keyboard and mouse are the main input devices of computer.
- The CPU consists of Arithmetic Logic Unit, Central Unit, Registers, Buses and Clock.
- There are many types of ROM available for microcomputer like Mask ROM, PROM, EPROM, EEPROM and EAPROM.
- There are two types of RAM used in PCs—Dynamic and Static RAM.
- There are four types of RAM Chips—SIP, DIP, SIMM and DIMM.
- Some computers have special types of memories, which are Flash Memory, Cache Memory, Virtual Memory and RAM Disk.
- A motherboard contains the CPU Chip, Memory chips, I/O Interface, Expansion slots and many other logic circuits.
- Cards, Ports and Cords are the other important components of computer.
- Power supply provides the power source to a computer.
- Uninterrupted Power Supply (UPS) or Constant Voltage Transformer (CVT) is also required to use a computer.
- There are three categories of parallel machines (computing machines having many ALUs or CPUs)—SISD, SIMD and MIMD.
- An SISD (Single Instruction Single Data streams) machine is also called Pipeline machine.
- An SIMD (Single Instruction Multiple Data streams) machine is of two types—(*a*) Vector machine and (*b*) Array machine.

- An MIMD (Multiple Instruction Multiple Data streams) machine is also called a multiprocessing system.
- In a multiprocessing system, there are two types of CPUs—(*a*) Back-end processor and (*b*) Front-end processor.
- Moore's law predicts the future of processor.
- Various developments in processors' technology are—(*a*) CISC processor, (*b*) RISC processor, (*c*) Simultaneous instruction processor, (*d*) ASIC chip and (*e*) FPGA chip.
- The speed of computer depends on various criteria such as Processor, Clock speed, Cache memory, Data bus, Math co-processor, RAM size and graphics processor.

3.14. Review Questions

1. What is a computer system ? Describe in brief the architecture of a computer system.
2. Which component of a computer is generally called 'brain' of computer and why ? Describe the functions of the distinct parts of this component.
3. What is ROM ? How does it differ from RAM ?
4. What is the difference between Hardware and Software ?
5. Name various types of ROM and describe their main characteristics.
6. How does a static RAM differs from a Dynamic RAM ? Which RAM would you prefer in computer and why ?
7. Write the full form of following abbreviations :
   (*a*) VDU (*b*) CPU
   (*c*) CMOS (*d*) EAPROM
8. Write the difference between following :
   (*a*) SDRAM and RDROM
   (*b*) EDO DRAM and BEDO DRAM
   (*c*) SIP and DIP
   (*d*) SIMM and DIMM
9. Write short notes on the following :
   (a) Flash memory
   (b) Cache memory
   (c) RAM disk
10. What is Virtual memory ? Discuss its importance in a computer.
11. What is Motherboard ? Explain its components in brief.
12. What is the difference between Cards and Cords ?
13. What is a port ? Name any four ports.
14. What is the difference between CVT and UPS ?

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15. What are parallel machines ? Explain the difference among SISD, SIMD and MIMD machines.
16. What is the difference between following :
    (*a*) Vector machine and Array machine
    (*b*) Front-end processor and Back-end processor
17. What is Moore's Law ? Discuss various development in all processor's technology.
18. Explain the various criteria which decide the speed of a computer.

Unit–4

Input and Output Devices

Notes

Structure

4.1. Introduction
4.2. Basic Input Devices
4.3. Special Input Devices
4.4. Basic Output Devices
4.5. Special Output Devices
4.6. Emerging Input/Output Devices
4.7. Role of Input and Output Devices
4.8. Key Point Summary
4.9. Review Questions

4.1. Introduction

Input Devices are used to input data, information and instructions into the RAM. Common input devices include Keyboard, Mouse, Joystick, Trackball, Touch Screen, Light Pen, Digitizer, Scanner, Digital Camera, MICR (Magnetic Ink Character Recognition), OMR (Optical Mark Reader), OCR (Optical Character Reader), Bar Code Reader and Voice-Input Device. Input Devices are classified into the following two types :

(*a*) Basic Input Devices

(*b*) Special Input Devices

Output devices are hardware components, which are used to display or print the processed information. Common output devices include Monitor, Printer, Plotter, Speaker and COM (Computer Output Microfilm) device. Output devices are also classified into the following two types:

(*a*) Basic Output Devices

(*b*) Special Output Devices

In this chapter, we are discussing below the structure, working and uses of these basic and special input/ output devices.

4.2. Basic Input Devices

The input devices, which have become now essential to operate a today's PC are called Basic Input Devices. These devices are always required for basic input operations. These devices include Keyboard, Mouse and Microphone. Today every PC has these devices as shown in figure 4.1. Let us discuss them.

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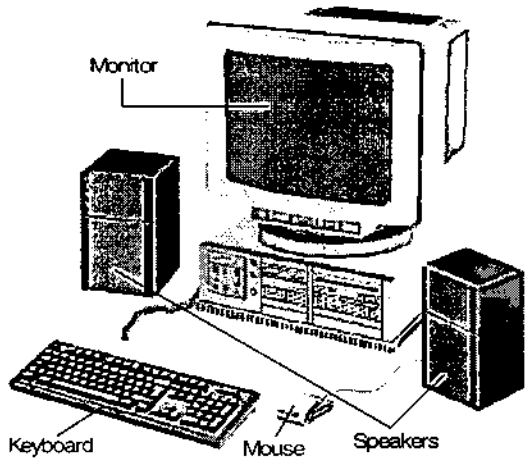

Fig. 4.1: A Personal computer having basic input devices

Keyboard

Keyboard is the main basic input device of a computer. It is the most commonly used means by which you can communicate with a computer. It consists of various types of keys that are operated through pressure applied by finger. When any key is pressed, an electronic signal is produced. A keyboard encoder that sends a binary code corresponding to the key pressed detects this signal

Types of Keyboards. There are mainly two types of Keyboard—QWERTY and Dvorak.

(*a*) *QWERTY Keyboard.* It is the most widely used standard keyboard throughout the world. It consists of the standard typewriter layout plus some additional keys. It contains three types of keys–alphanumeric keys, special keys and function keys. Alphanumeric keys such as A, B, C, 1, 2, etc. are used to type alphabets and numbers. Special keys such as <Shift>,<Ctrl>,<Alt>,<Home>, <Scroll Lock>, etc. are used for special functions. Function keys such as <F1>,<F2>,<F3>, etc. used to give special commands depending upon the software used. The location of various types of keys is shown in figure 4.2. This keyboard is called QWERTY keyboard because the top of alphabet keys begin with the letters Q, W, E, R, T and .

Fig. 4.2: A QWERTY keyboard

(*b*) *Dvorak Keyboard.* The Dvorak keyboard is a keyboard layout developed by August Dvorak and William L. Delayed as an alternative to the popular QWERTY keyboard. The Dvorak keyboard was designed to speed typing by placing the most frequently used keys on the home row as shown in figure 4.3. In addition the pair of letters that usually occur sequentially were separated so that the hands could alternate type them. Although the QWERTY keyboard is the standard world wide, in the future you may find using Dvorak keyboard easier and more efficient than QWERTY keyboard.

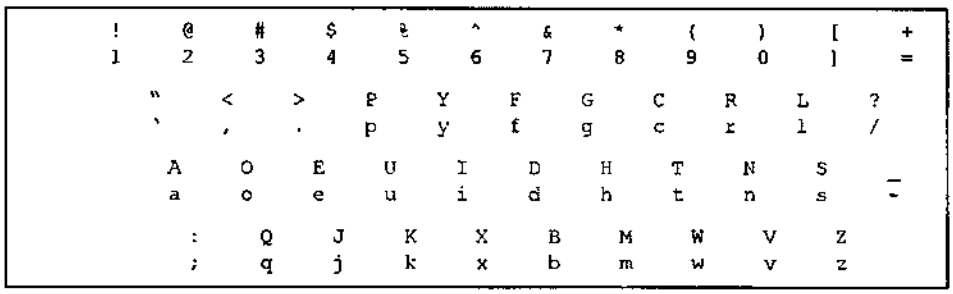

Fig. 4.3: Keys layout of the Dvorak keyboard

Using QWERTY keyboard. Today most PCs have QWERTY keyboard. The function of important keys on this keyboard are described below:

(*a*) *Using Arrow Keys.* Most keyboards provide two sets of arrow keys. The first set lies on bottom of the keyboard, while the second set lies on the numeric keypad. There are four arrow keys on each set-up. The Up Arrow key moves cursor on the previous row the Down Arrow key moves cursor on the next row, the Left Arrow key moves cursor on the left character and the Right arrow key moves cursor on the right character while you work on a Word Processing document. Normally, you use first set of arrow keys. If you want to use the second set located on numeric keypad, you must press the NumLock key as described in the next point.

(*b*) *Using NumLock Key.* When you switch on the computer, the NumLock key is ON. It means you can use the number keys of the numeric keypad. To make the NumLock OFF press it. Now, the number keys work as arrow keys. So, the NumLock Key is a toggle key used to switch between functioning of arrow keys and number keys.

(*c*) *Using CapsLock Key.* CapsLock key is pressed to toggle between CapsLock operations ON or OFF. When CapsLock is ON (displaying a LED light), upper case letters are typed when you press alphabet keys otherwise lower case letters are typed.

(*d*) *Using the Shift Key.* When CapsLock is off, you can type any alphabet in upper case by simultaneous pressing and holding Shift key. Similarly you can type any alphabet in lower case even if CapsLock is ON. There are two Shift keys on the left and the right side of the

keyboard as per the convenience of right-handed and left-handed users respectively. Shift key is also pressed to type the symbols written on upper position of number keys.

(*e*) *Using Ctrl and Alt Keys.* The function of these keys depend upon the operating system or software used. There are two sets of Alt and Ctrl keys just like Shift keys.

(*f*) *Using Function Keys.* There are 12 function keys on the keyboard. The function of these keys also depends upon the operating system or the program used.

(*g*) *Using Insert Key.* Insert key is used to toggle between insert mode and overwrite mode. When Insert key is ON, whatever you write is inserted between characters of the text. When Insert key is off, the existing characters are overwritten by the newly typed characters.

(*h*) *Using Delete and Backspace Key.* Backspace key is pressed to delete the existing text from the right most character. Delete key is pressed to delete the character on current cursor position.

(*i*) *Using Home and End Keys.* The function of these keys depend upon the software which you are using.

(*j*) *Using PageUp and PageDown Key.* PageUp key is pressed to go to the previous screen and PageDown key is pressed to go to next screen while you work in a word processor or other application software.

(*k*) *Using Tab Key.* Tab key is pressed when you want to jump a block of characters during typing of a text or document.

(*l*) *Using Esc Key.* Esc Key, which is located on the left most and the top most position of the keyboard, is pressed to cancel a command of a dialog box.

(*m*) *Combination of Various Keys.* Various keys can be used in a number of combinations for giving special commands of the software used. For example, Ctrl+S keys are pressed together to save a document; Ctrl+C keys are pressed to copy text of the document and Ctrl+Alt+Del keys are pressed to warm boot your system (for details on booting of the system, see chapter 8 – Software).

Mouse

Mouse is another basic input device of a computer. It is a pointing device used to move cursor, draw sketches/ diagrams, selecting a text/object/ menu item, etc. on monitor screen while working on windows (graphics based operating environment of computer). Mouse is a small, palm size box containing three buttons and a ball underneath as shown in figure 4.4 which senses the movement of the mouse and sends the corresponding signals to CPU on pressing the butons.

Fig. 4.4: A mouse

Using a Mouse. You can use the mouse in following ways:

(*a*) *Holding.* You can hold the mouse with right for left hand by putting your finger on the left button as shown in figures 4.5 (a) and 4.5().

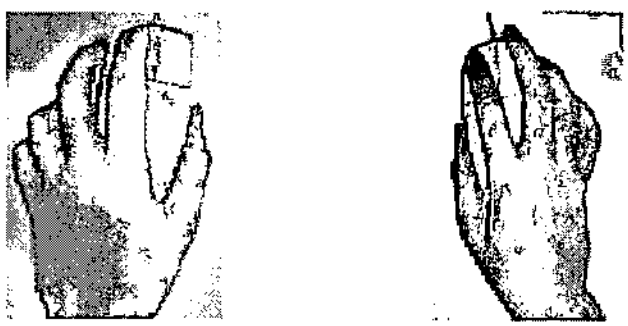

Fig. 4.5: (a) Holding mouse with left hand (b) Holding mouse with right hand

(*b*) *Pointing.* When you slide the mouse on the mouse pad, the pointer or arrow moves on the screen.

(*c*) *Clicking.* Gently pressing and releasing the left mouse buttons, while keeping your hand on the mouse, is one of the ways to give a command to the computer. When you move the pointer over text, picture and menu, the arrow pointer changes to various shapes.

(*d*) *Double-click.* Pressing mouse button twice quickly is called double-click. Sometimes you need to double click the mouse on icon for giving some commands (e.g. opening a file).

(*e*) *Dragging.* Moving the mouse along with pressing and holding the left mouse button is called dragging. Sometimes you need to drag the mouse (e.g. while working on graphics).

Microphone

A microphone (sound recorder) is also a basic Voice-input device of computer. It is used to store voice data consisting of recorded message or synthesized sound using a GUI operating system such as Windows as shown in figure 4.6. Microphone converts sound waves into analog electrical signals, which are further converted to digital fom in a PC.

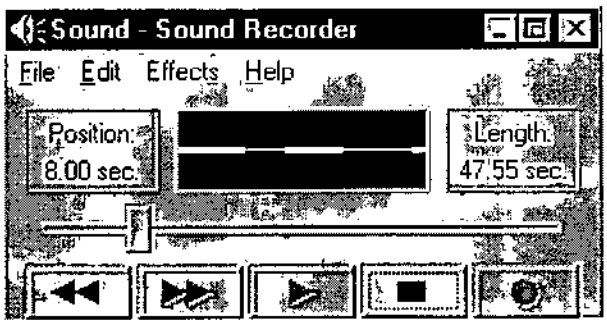

Fig. 4.6: A view of windows screen for recording of voice

4.3. Special Input Devices

The input devices, which are not essential to operate a PC are called Special Input Devices. These devices are required for special input operations. These devices include Scanner, Digital Camera, Touch Screen, Light Pen, Trackball, Joystick, Digitizer, Optical Mark Reader, Optical Character Reader, Bar Code Reader and Magnetic Ink Character Recognition (MICR) Device. Let us discuss these.

Scanner

Scanner is widely used in Desktop Publishing (DTP) applications. It is used for digitising images such as photographs, forms, documents, etc. into computer memory. There are many types of scanners as shown in figure 4.7. Some scanners can also read text by converting them to digital code. The scanners are very useful for converting the typed pages into word-processing files. Graphics scanners convert a printed image into video image without converting it to digital code. You also need the software to install and us the scanner

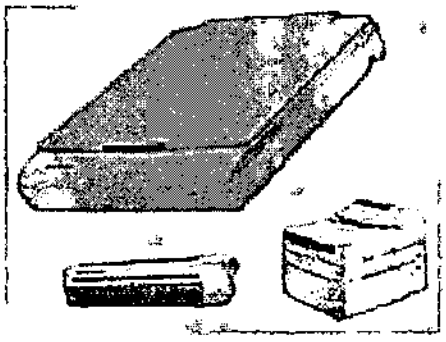

Fig. 4.7: Various types of scanners

Scanning of Images. A scanner is somehow like a photocopy machine. A photocopy machine copies the contents of one page to another while a scanner stores the copy as an electronic image within a file on disk. For displaying an image, the monitor combines different shades of three basic colours (Red, Green and Blue), representing upto 16-million different colours. When you scan an image, your scanner

determines the image's red, green, and blue colour components, and then saves them to a file on disk. Although most new scanners determine an image's colour components in one step, you can think of a scanner using three steps. The image's colour components are determined by reflecting red, green and blue lights from the image. The image's red, green, and blue components are combined to build the composite image. You can also scan an image with various resolutions depending upon the scanner used. The image is sharper when resolution is high, but the size of image file becomes large.

Scanning of Text. A scanner can be used to scan the paper documents. The scanner creates an electronic image of the document. So, a graphic file is created always whether you scan a picture or a document. In order to create text from the scanned document, you need special software called OCR (Optical Character Recognition) software. This software converts the image into text. This converted text is never 100% accurate (because some character are not scanned correctly) and needs to be edited using a word processor. The scanned paper documents can also be used with fax software for sending electronic image to another user using a PC. As scanners are cheaper than fax machines, most people prefer them for sending faxes.

Built-in Scanner. Now-a-days, some PCs have built-in photographic scanner within the system unit. In such scanners, you can insert the photo or document into the scanner's slot just like an ATM machine.

Digital Camera

Digital Camera is a type of camera that records images in an electronic format, storing the images either on a disk or on a special memory, called flash memory.

A digital camera uses a CCD (Charge-coupled Device) element to capture the image through the lens when the photographer releases the shutter in the camera. The image captured by the camera can be transferred to the PC in two ways, depending upon how the camera store them. If the camera stores the images on the floppy disk, you can simply insert the floppy disk in your PC disk drive and copy to the hard disk. If the camera stores the images in its flash memory (A small plastic device having 8 to 32 MB memory), they are downloaded by the cable connected to your PCs serial port using the software supplied with the camera. As the electronic images captured by digital camera can be manipulated and processed much like the image from a scanner, the digital camera is a popular input device of multimedia computer.

Touch Screen

Some special VDU devices have touch sensitive screens. These screens are sensitive to human fingers and act as tactile input devices. Using the touch screen, a user can point to a selection on the screen instead of pressing keys as shown in Figure 4.8. Touch screen helps the user in getting the information quickly. It is mainly used in hotels or airports to convey information to visitors.

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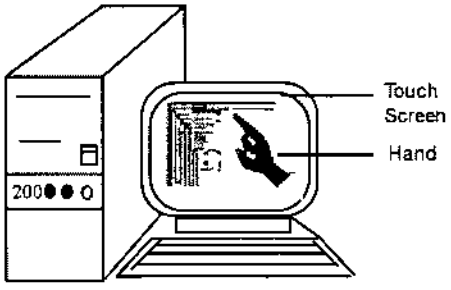

Fig. 4.8: Demonstration of touch screen

Light Pen

Light pen (similar to a pen) is a pointing device, which is used to select a displayed menu item or draw pictures on the monitor screen as shown in figure 4.9. It consists of a photocell and an optical system placed in a small tube. When its tip is moved over the monitor screen and pen button is pressed, its photocell-sensing element detects the screen location and sends the corresponding signal to the CPU.

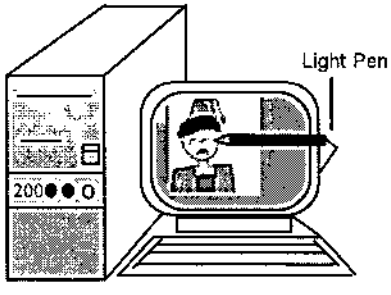

Fig. 4.9: Demonstration of a light pen

Trackball

A trackball looks like a mouse, as the roller is on the top with selection buttons on the side as shown in figure 4.10. It is also a pointing device used to move the cursor and works like a mouse. For moving the cursor in a particular direction, the user spins the ball in that direction. It is sometimes considered better than mouse, because it requires little arm movement and less desktop space. It is generally used with portable computers.

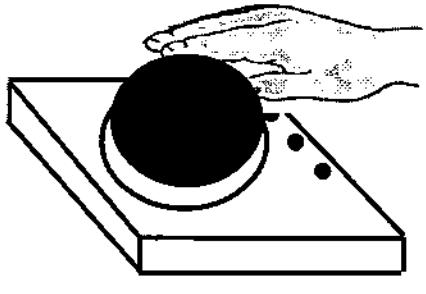

Fig. 4.10: A trackball

Joystick

Joystick is also a pointing device, which is used to move cursor position on a monitor screen. Joystick is a stick having a spherical ball at its both lower and upper ends as shown in figure 4.11. The lower spherical ball moves in a socket. The joystick can be moved in all four directions. The function of joystick is similar to that of a mouse. It is mainly used in Computer Aided Designing (CAD) and playing computer games.

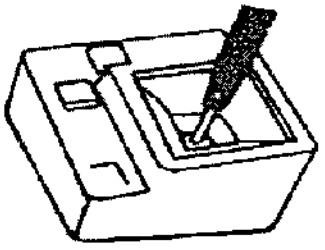

Fig. 4.11: A joystick

Digitizer

Digitizer is used to create drawings and pictures using a digitizer tablet by a process called digitizing. Digitizing is a process by which graphic representations are converted into digital data. The digitizer consists of 3 main parts—a flat surface called tablet, a small hand held mouse-like device called puck and a special pen like device called stylus as shown in figure 4.12. The puck is used to input existing drawings into the computer. The stylus is used to trace existing drawings placed on the tablet. It is also used to draw new drawings on a piece of paper placed on tablet. The user makes contact to the tablet with stylus. As the stylus is connected to the tablet by a wire, the traced image is stored in RAM and displayed on the monitor.

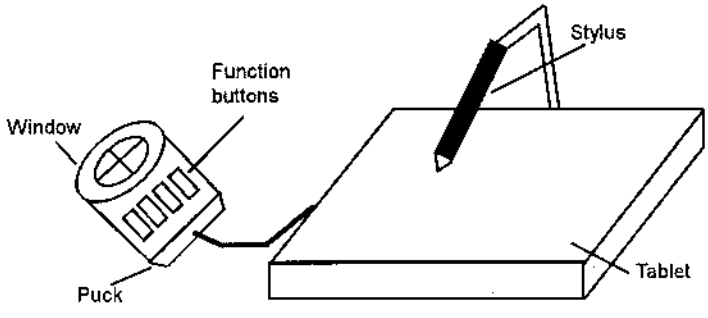

Fig. 4.12: A digitizer

Optical Mark Reader (OMR)

Optical Mark Reader is a special type of optical scanner used to recognise the type of mark made by pen or pencil. It is used where one out of a few alternatives is to be selected and marked. It is especially used for checking the answer sheets of examination having multiple choice questions. The answer sheet contains special marks such as squares or bubbles. The student fills in

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these squares with soft pencil or ink to indicate the correct choice as shown in figure 4.13. The OMR detects these marks and sends the corresponding signals to the processor. If a mark is present, the amount of reflected light is reduced and, thus, OMR detects the presence of mark for each and every answer. Optical Mark Readers are widely used for almost all-competitive examinations having objective type questions.

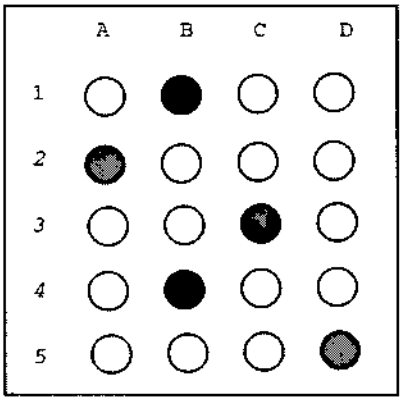


Fig. 4.13: A sample of answer sheet that is checked by Optical Mark Reader (OMR)

Optical Character Reader (OCR)

Optical Character Reader is an optical scanner, which is capable of detecting alphanumeric characters typed or printed on paper using an OCR font. The text, which is to be scanned is illuminated by a low-frequency light source. The dark areas on the text absorb the light while light areas reflect it. The photocells of OCR device receive this reflected light and provide binary data corresponding to dark and light areas. OCR devices are used for large volume applications like reading of passenger tickets, computer printed bills of credit card companies and reading of ZIP codes in postal services.

Bar Code Reader

Bar Code Reader is an optical scanner used for reading bar-coded data (data in form of light and dark lines) as shown in figure 4.14. The bar-coded

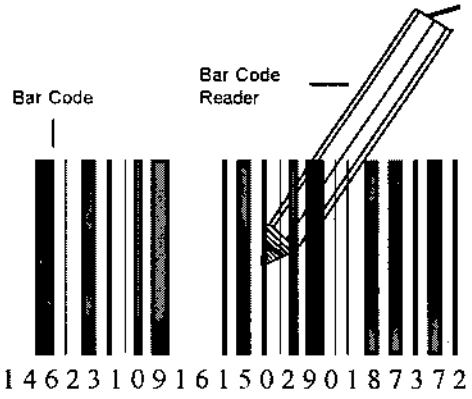
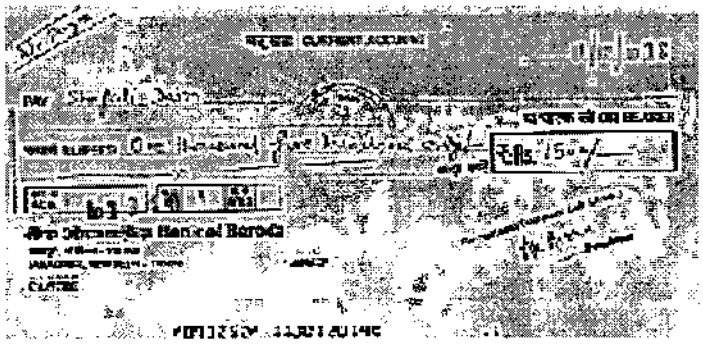


Fig. 4.14: A bar code reader

data consists of a number of bars of varying thickness and spacing between them. The bar code reader reads the bar coded data and converts it into electrical pulses, which are then processed by computer. Bar-coded data is generally used in labeling goods, numbering the books or encoding ID or A/c numbers.

Magnetic Ink Character Recognition (MICR)

Magnetic Ink Character Recognition is used to recognise the magnetically-charged characters, mainly found on bank cheques as shown in figure 4.15. The magnetically-charged characters are written by a special ink called magnetic ink. MICR device reads the patterns of these characters and compares them with special patterns stored in memory. Using MICR device, a large volume of cheques can be processed in a day. MICR is widely used by the banking industry for he processing of cheques.



Magnetically-Charged Characters

Fig. 4.15: A cheque showing magnetically-charged characters that can be read by an MICR device

4.4. Basic Output Devices

The output devices, which have become now essential to get the output on a today's PC are called Basic Output Devices. These devices are mostly required for basic output operations. These devices include Monitor, Printer and Speakers/Headphone as shown in figure 4.16. Let us discuss them.

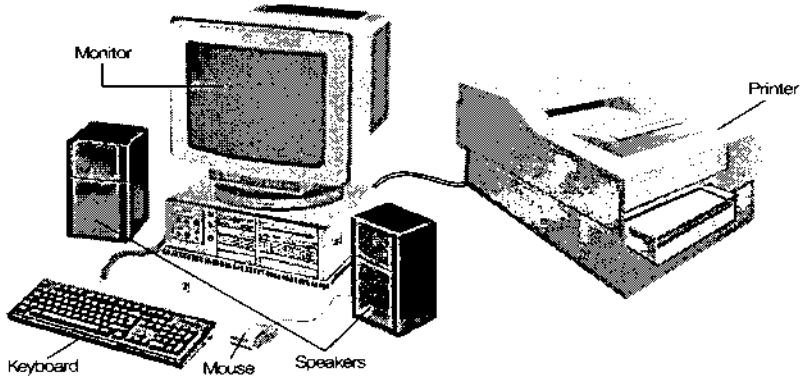


Fig. 4.16: A computer with basic output devices

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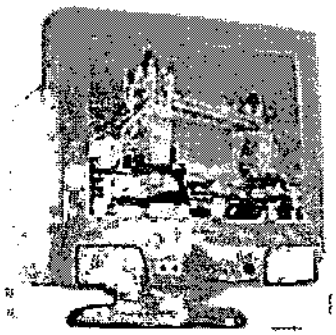
Monitor

Visual Display Unit (VDU), commonly called monitor is the main output device of a computer. It consists of a Cathode Ray Tube (CRT), which displays characters as output. It forms images from tiny dots, called pixels, that are arranged in a rectangular form. The sharpness of the image (screen resolution) depends upon the number of the pixels.

Types of Monitors. There are different kinds of monitors depending upon the number of pixels. Depending upon the resolution, monitors can be classified as follows:

1. CGA (Color Graphics Adapter)
2. MDA (Monochrome Display Adapter)
3. HGA (Hercules Graphics Adapter)
4. EGA (Enhanced Graphics Adapter)
5. VGA (Video Graphics Adapter)
6. SVGA (Super VGA)

The differences between these monitors are outlined in table 4.1. Depending upon colour of display, monitors can be classified as Monochrome (with single color black/white display) and Color (with all colours display) Monitors. The pictures of two different models of color monitors are shown in figure 4.17.



15" Multimedia Color Monitor

20" Color Monitor

Fig. 4.17: Two models of color monitors

Table 4.1: Comparison among different types of monitors

Type of Monitor	Display Type	Text Resolution	Graphics Resolution (Pixels)
CGA	Text & Graphics	Fair quality	320 × 200
MDA	Text only	Good quality	-
HGA	Text & Mono Graphics	Fair quality	320 × 200
EGA	Text & Enhanced Graphics	Good quality	640 × 350

VGA	Text & Video Graphics	Much better than all the above	640 × 480
SVGA	Text & Video Graphics	Best quality	1600 × 1280

Printer

Printer is the basic output device, which is used to print information on papers. Printers are essential for getting output of any computer-based application. There are many types of printers, which are classified on various criteria as illustrated in Figure 4.18. Printers are broadly categorised into two types—Impact and Non-impact printers. Let us discuss these in detail.

(*i*) **Impact Printers.** The printers that print the characters by striking against the ribbon and onto the paper, are called Impact Printers. These printers are of two types—(a) Character; and (b) Line printers.

(*a*) *Character Printers.* These printers print one character at a time. These printers can be further classified into two types–Daisy Wheel and Dot Matrix Printers.

Daisy Wheel Printers. These printers print the characters by a mechanism, called daisy wheel that uses a plastic or metal hub with spokes. The characters are embossed on the radiating spokes and printed by striking these spokes against the ribbon and paper. Daisy Wheel printers give a good quality but they are expensive than Dot Matrix printers.

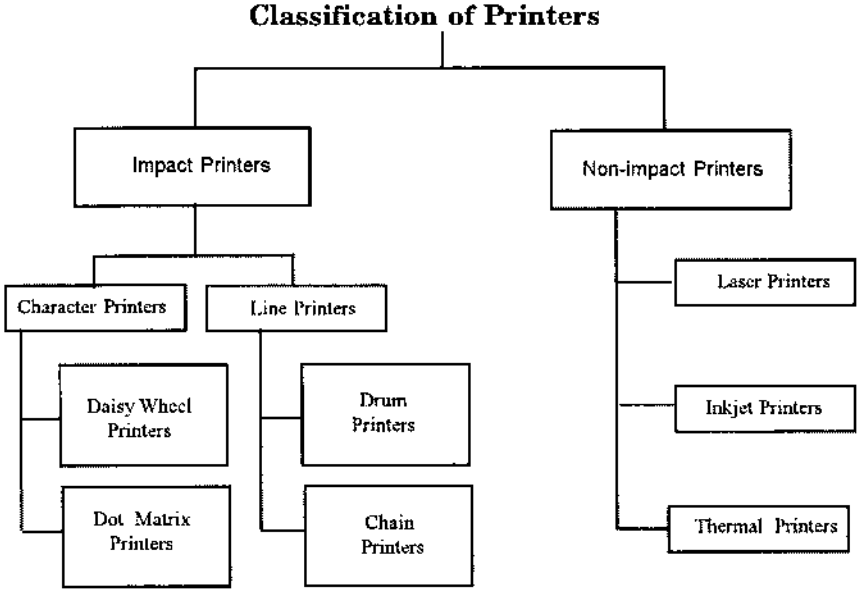


Fig. 4.18: Classification of printers

Dot Matrix Printers. These printers print the characters by putting dots onto the paper. They do not give better printing quality than daisy wheel printers, but are faster in speed. The printing speed of a dot matrix printer can be upto 360

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cps (characters per second). They are widely used with microcomputers in most of the offices. A picture of a dot matrix printer is shown in figure 4.19.

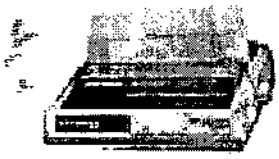

Fig. 4.19: A dot matrix printer

(*b*) *Line Printers.* These printers print one line at a time. Their printing speed is much more than character printers. A picture of a line printer is shown in figure 4.20. They are also of two types–Drum Printers and Chain Printers.

Fig. 4.20: A line printer

Drum Printers. These printers print the line by a rotating drum having a ring of characters for each print position. The hammer strike each character of the drum simultaneously so that entire line is printed for one full rotation of the drum. These printers are also called Barrel Printers. The printouts obtained from these printers have even character spacing but uneven line height.

Chain Printers. These printers print the line by a rotating chain having ring of characters for each print position. Their printing mechanism is similar to drum printers. The printouts obtained from these printers have uneven character spacing but even line height.

(*ii*) **Non-impact Printers.** The printers that print the characters without striking against the ribbon and onto the paper, are called Non-impact Printers. These printers print a complete page at a time, therefore, also called as Page Printers. Page printers are of three types—(*a*) Laser Printers, (*b*) Inkjet Printers, and (*c*) Thermal Printers.

(*a*) *Laser Printers.* These printers look and work like photocopiers as shown in figure 4.21. They are based on laser technology,

which is the latest development in high speed and best quality printing. In these printers, a laser beam is used to write the image on a paper. First, the image is formed by electrically charging thousands of dots on a paper by laser beam. Then, the paper is sprayed with a toner having the opposite charge and is passed over a heated roller to make the image permanent.

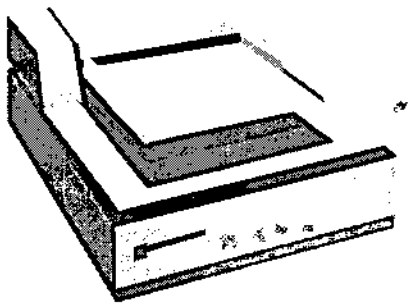

Fig. 4.21: A laser printer

Laser printers are very popular and have become an essential part of Desk Top Publishing (DTP). Although laser printers are costlier than dot matrix, they are generally preferred in all offices due to their best quality of printing. There are many models of laser printers depending upon the speed and number of dots printed. The latest model of laser printer is 1200 DPI (Dots Per Inch), which can print 10 pages/minute. Some high speed laser printers give a speed of upto 100 pages/minute.

(*b*) *Inkjet Printers.* These printers print the characters by spraying the paper with electrically charged ink. These printers give better quality than character printers but not better than laser printers. They are cheaper than laser printers, hence, used widely in many offices. They also offer an option of using colour cartridges for multi-color printing. A picture of an inkjet printer is shown in figure 4.22.

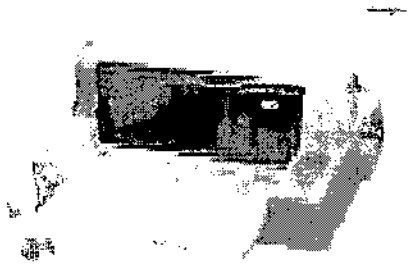

Fig. 4.22: An inkjet printer

(*c*) *Thermal Printers.* These printers print the characters by melting a wax-based ink off a ribbon onto a special heat sensitive paper. They give Letter quality printing but are relatively expensive in maintenance than other printers.

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Speakers/ Headphone

Speakers is another basic output device of Today's computer, which is used to produce sound and music. There are many models of stereo speakers with different size and volume capacities (350 W, etc.).

Headphone is also a basic output device of a computer, which is used mainly on Internet to listen sound and music. It generally comes as a set with a microphone.

4.5. Special Output Devices

The output devices, which are not essential to get the output on a computer, are called Special Output Devices. These devices are not required for basic output operations, but are used for special purposes. These devices include Plotter and Computer Output Microfilm (COM). Let us discuss about them.

Plotter

Plotter is an important output device, used to print high quality graphics and drawings. Although the graphics can be printed on printers, the resolution of such printing is limited on printers. Plotters are generally used for printing/ drawing graphical images such as charts, drawings, maps, etc. of engineering and scientific applications. Some important types of plotters are shown in figure 4.23 and are discussed below:

(*i*) **Flat Bed Plotters.** These plotters print the graphical images by moving the pen on stationary flat surface material. They produce very accurate drawings.

(*ii*) **Drum Plotters.** These plotters print the graphical images by moving both the pen and the drum having paper. They do not produce as accurate drawings as printed by flat bed plotters.

(*iii*) **Inkjet Plotters.** These plotters use inkjets in place of pens. They are faster than flat bed plotters and can print multi-colored large drawings.

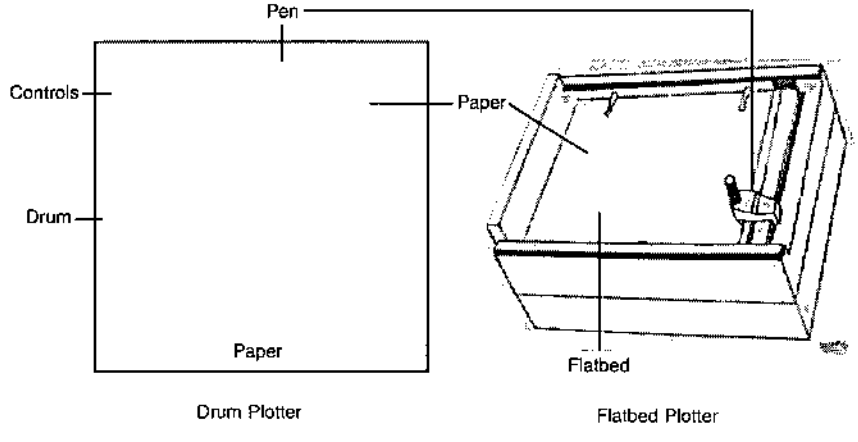

Fig. 4.23: Various types of plotters

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Computer Output Microfilm (COM)

Computer Output Microfilm (COM) is a technique to produce output on a microfilm media (microfilm reel or microfiche card) as shown in figure 4.24. A microfilm is a continuous film strip that can store several thousands miniaturized document pages. A microfiche card is a 4 by 6 inch film sheet, which can store several hundred pages.

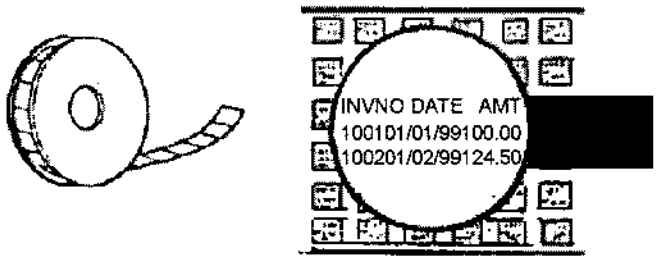

Fig. 4.24: Computer output microfilm

The process of producing microfilm or microfiche takes place on a special COM unit. The information recorded on the microfilm is read with the help of a microfilm viewing system. It is generally easier to read a microfiche than microfilm. Computer Output Microfilm is particularly useful for organisations, which need to store and manipulate large amount of data. It helps them in tremendous savings in paper and document handling costs.

4.6. Emerging Input/Output Devices

Recently major advances have been made recently in input and output technology. The emerging input devices are :

1. **Portable Screen.** On this screen, you will be able to write and may become a reliable choice for input.
2. **Voice Keyboard.** You would be able to make your keyboard speakable using a software. The keyboard will speak your documents when you will type them. So, it will help you to avoid typing errors.
3. **Speech Recognition Devices/Software.** These devices/software will recognise your speech and convert voice-data into digital form. Although these software are still available, they are not very reliable.
4. **Language Translator Devices/Software.** Scientists are trying to develop such devices/software, which would translate input given in are language into another.
5. **Handwriting Recognition Devices/Software.** These devices/ software would recognise your handwriting precisely and store the text in the computer.

The emerging output devices are described below:

1. **High Resolution LCD Monitor.** Scientists are trying to develop

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new kinds of liquid crystals that will provide high resolution LCD (Liquid Crystal Display) monitor.

2. **Flat-panel Monitor.** These monitors could be mounted on walls and would have extremely high resolution. The whole wall of your room could become a monitor.
3. **Retinal Monitor.** These monitors would focus the output directly on to the retina of eye. This technology called Virtual Retinal Display (VRD) is still under Research and Development.

4.7. Role of Input and Output Devices

You know, CPU (Central Processing Unit) is the main part of all types of computers. It can not function without input and output devices. Therefore, input and output devices are the peripherals or peripheral devices of a computer. Although the detailed function of various input and output devices have been explained in the chapter, we are summarising them in table 4.2.

Table 4.2: Function of various input and output devices of a PC

Name of Device	Input/Output	Function
Keyboard	Input Device	Standard device of every PC, used to enter data and to give commands.
Mouse	Input Device	Pointing devices used to move cursor, draw diagrams, select menu items, etc. while working on Windows.
Microphone	Input Device	Voice-input device used to record sound.
Scanner	Input Device	Used to scan document and photograph by converting them into electronic images.
Digital Camera	Input Device	Used to record images in an electronic format
Touch screen	Input Device	Used to point to a selection.
Light Pen	Input Device	Used to select a menu item or draw figure on the monitor screen
Trackball	Input Device	Pointing device that works like a mouse.
Joystick	Input Device	Pointing device used in CAD and playing games on a PC.
Digitizer	Input Device	Used to create drawings and pictures
OMR	Input Device	Optical scanner used to recognise the type of make made by pen or pencil
OCR	Input Device	Optical scanner, used to detect typed or printed characters.
Bar Code Reader	Input Device	Used to read bar-coded data generally found on goods.

MICR	Input Device	Used to recognise the magnetically charged character found mainly on cheques.
Monitor	Output Device	Standard device of all PCs for displaying information on screen.
Printer	Output Device	Standard device for all computers for printing information on Papers.
Speaker and Headphone	Output Devices	Used to hear sound and music on a multimedia computer on Internet
Plotter	Output Device	Used to print high equality drawings
COM	Output Device	Used to produce output on a microfilm media.

4.8. Key Point Summary

- Input devices are of two types—(*a*) Basic Input Devices, and (*b*) Special Input Devices.
- Keyboard, Mouse and Microphone are the basic input devices.
- There are mainly two types of keyboard—QWerty and Dvorak.
- The important keys on Qwerty keyboard are CapsLock, Shift, NumLock, Ctrl, Alt, Delete, Backspace, Insert, Home, End, Esc, PageUp, PageDown, Tab, Arrow and Function keys.
- We can use the mouse in various ways such as holding, pointing, clicking, double-clicking and dragging.
- The special input devices include Scanner, Digital Camera, Touch Screen, Light Pen, Trackball, Joystick, Digitizer, Optical Mark Reader, Optical Character Reader, Bar Code Reader and Magnetic Ink Character Recognition (MICR).
- Scanner is widely used in Desktop Publishing (DTP) applications.
- Digital Camera records the images in an electronic format by storing them on a disk or flash memory.
- Using the touch screen, a user can point to a selection on the screen instead of pressing keys.
- Light pen is used to select a displayed menu item or draw pictures on the monitor screen.
- A trackball looks and works like a mouse.
- Joystick is mainly used in Computer Aided Designing (CAD) and playing computer games.
- Digitizer is used to create drawings and pictures using a digitizer tablet.
- Optical Mark Reader (OMR) is used for checking the answer sheets of examination having multiple choice questions.
- Optical Character Reader (OCR) is capable of detecting alphanumeric characters typed or printed on paper.
- Bar Code Reader is used for reading data in the form of light and dark

lines.

- MICR is widely used by the banking industry for processing of cheques.
- Output devices are also of two types—(*a*) Basic Output Devices, and (*b*) Special Output Devices.
- Monitor, Printer and Speakers/Headphone are the basic output devices of a computer.
- Depending upon the resolution, monitors can be classified as CGA, MDA, HGA, EGA, VGA and SVGA.
- Printers are broadly categorised into two types—Impact and Non-impact Printers.
- Impact printers are of two types—(*i*) Character; and (*ii*) Line printers.
- Character printers can be further classified into two types—Daisy Wheel and Dot Matrix Printers.
- Line printers are of two types—Drum Printers and Chain Printers.
- Non-impact printers (Page Printers) are of three types—(*i*) Laser Printers, (*ii*) Inkjet Printers, and (*iii*) Thermal Printers.
- The special output devices include Plotter and Computer Output Microfilm (COM).
- Plotters are of three types—(*a*) Flat Bed Plotters, (*b*) Drum Plotters, and (*c*) Inkjet Plotters.
- The emerging input devices are Portable Screen, Voice Keyboard, Speech Recognition Devices, Language Translator Devices and Handwriting Recognition Devices.
- The emerging output devices are High Resolution LCD Monitor, Flat-panel Monitor and Retinal Monitor.

4.9. Review Questions

1. Name the basic input devices of a PC and explain their functions in brief.
2. What is a trackball ? How does it differ from mouse and joystick ?
3. Name the input device used :
   (*a*) to create drawings and pictures
   (*b*) for digitizing photographs and documents.
4. Classify the following devices into an Input (I) and Output (O) Device and write their main functions :

(*a*) Touch Screen	(*f*) Monitor
(*b*) Light Pen	(*g*) Speaker
(*c*) Plotter	(*h*) COM
(*d*) Joystick	(*i*) OCR
(*e*) OMR	(*j*) Headphone

5. Explain the differences between CGA, EGA and SVGA monitors. Which of these monitors has the best quality display ?

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6. What is the difference between Impact and Non-Impact Printers? Classify the following category of printers as impact (I) or non-impact (N) printer and write their functions :
   (*a*) Laser Printers
   (*b*) Thermal Printers
   (*c*) Drum Printers
   (*d*) Inkjet Printers
   (*e*) Chain Printers
   (*f*) Daisy Wheel Printers
   (*g*) Dot Matrix Printers.
7. Explain the difference between Character, Line and Page Printers. Give examples.
8. Name some of the output devices used with computer systems. Explain their applications.
9. Compare the advantages and limitations of a mouse and a keyboard as data input devices.
10. What is a Qwerty keyboard ? How does it differ from Dvorak keyboard ?
11. Write the functions of the following keys on a Qwerty keyboard :
    (*a*) CapsLock
    (*b*) NumLock
    (*c*) Tab
    (*d*) Ctrl
    (*e*) Alt
    (*f*) Shift
    (*g*) Insert
    (*h*) Function Keys
    (*i*) Backspace
    (*j*) Esc
12. Define the following terms :
    (*a*) Pointing
    (*b*) Clicking
    (*c*) Double-click
    (*d*) Dragging
13. What is scanner ? How does it work ?
14. Describe the working of a Digital Camera.
15. Write the functions of the following input devices :
    (*a*) MICR
    (*b*) Bar Code Reader
16. What is a plotter ? Describe various types of plotters.
17. Write a short note on emerging input and output devices of computer.

Unit–5

Notes

Storage Devices

Structure

5.1. Introduction
5.2. Need of Computer Storage
5.3. Evolution and Kinds of Computer Storage
5.4. Magnetic Storage Devices
5.5. Optical Storage Devices
5.6. Magneto-Optical Storage Devices
5.7. Holography Storage: An Emerging Storage Technology
5.8. Key Point Summary
5.9. Review Questions

5.1. Introduction

We have discussed in chapter–3 (Basic Computer Organisation) that the primary memory (especially RAM) stores the data, instructions and information temporarily during processing by CPU. When the computer is switched off, this memory gets erased. A computer stores the data, information and software permanently in its storage devices, so that they can be retrieved whenever required. In this chapter, we will discuss about different storage devices, sometimes also called as secondary memory devices.

There are many storage devices used with microcomputers, which are explained throughout the chapter. Before discussing about various storage devices, let us first distinguish between manual storage and computer storage.

5.2. Need of Computer Storage

Prior to the advent of computer, all data was stored manually on papers. Now-a-days when computer has become an essential part of every organization, most data are stored in computers. Storage of data on computer has its own advantages over on manual storage. Although manual storage of data has many drawbacks, it is still required due to some legal and financial obligations. The differences between manual and computer storage are described in table 5.1.

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Table 5.1: Difference between manual and computer storage

Manual Storage	Computer Storage
1. Data is stored on papers by using ink or writing material.	1. Data is stored on external storage devices generally in magnetised form.
2. Small amount of data can be stored on a paper. For instance, you can store about 500 words on one paper.	2. A very large volume of data can be stored on an external storage device. For Instance, you can store more than 500 pages on one floppy disk.
3. Storage and retrieval of data do not require any electronic media or electricity.	3. If you want to store data on a computer storage device, or you want to retrieve that, you required an electronic media (computer) and off course electricity.
4. You require a large space for keeping manually stored data.	4. A very less space is required to keep floppies, hard disks, tapes or CDs.
5. Sequential and random retrieval (reading and searching) of data is very time consuming.	5. You can sequentially read or randomly search any data within few seconds.
6. Data cannot be changed or destroyed easily.	6. You can change or delete any data very easily (if data is not being secured).
7. Data is more secure in manual media, (you can keep your confidential files in lockers).	7. Data is generally considered less secure in computer media. This is actually due to non-implementation of security procedures by the computer users. If adequate security procedures are followed, data is also very secure in computer.

5.3. Evolution and Kinds of Computer Storage

The development of various kinds of computer storage device are described below:

1. **Punch Card.** Development of storage devices for computers begin in 1800, when Jacquard invented the first punch card for storing data. Punch card is an input medium made for stiff paper that stores bits of data in column containing pattern of punched holes. Punch cards were used in an electromechanical machine invented by Herman Hollerith in the late 1800 for processing data.
2. **Paper Tape.** In 1857, Sir Charles Wheatstone used paper tape to store data. Paper tape is a continuous strip of paper on which data can be encoded by punching patterns of holes. Laminates of paper

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and polyester were also used in place of paper for making paper tapes, which are also called as punching tapes.

3. **Magnetic Tape.** In the early 1950's magnetic tapes were invented to store a large volume of data. Magnetic tape strip is a thin strip of polyester film coated with magnetic material. It is the oldest storage device available for microcomputer. It is still being used on some computers for storing data as backups.
4. **Magnetic Drum.** In around 1952, magnetic drum was introduced as a storage device. The magnetic drum is cylindrical in shape whose curved outer surface is coated with a magnetic material in which data can be recorded in parallel tracks.
5. **Hard Disk.** The first Hard Disk was introduced in 1957 by IBM, which was called IBM RAMAC 350 disk storage system. This hard disk had fifty 24" diameter platters, which could store five million characters. In 1973, IBM introduced the IBM 3340 hard disk unit known as Winchester disk. In 1980, Seagate Technologies announced the first Winchester 5.25" hard disk drive. Hard disk is made of one or more aluminium or glass platters, coated with a ferromagnetic material. It is the primary computer storage device of all present day computers.
6. **Floppy Disk.** In 1967, IBM built the first floppy disk. It is made of a plastic disk coated with magnetic material, which is sealed inside a square plastic jacket. There are 3 types of floppy based on their sizes—8, $5^1/4$" and $3^1/2$" introduced in 1971, 1972 and 1980 respectively.
7. **Compact Disk Read Only Memory (CD ROM).** Compact Disk Read only Memory (CD ROM) is a form of compact disk (CD) introduced in 1983. Compact disk is a metal disk, 120 mm in diameter on which digital data is stored by optical means using a laser beam. CD ROMs are the most popular storage device for storing high volume data in the form of audio, video and text.
8. **Cartridge Disk (Zip Disk).** Cartridge Disk is a removable hard disk packed inside a plastic case that can be removed from the drive that reads from and writes to it. Zip disk is a popular model of cartridge disk that can store over 100 MB of data using a Zip drive. Zip disk loops like a 31/2 floppy disk. However, a Zip disk is actually quite a bit bigger than a standard floppy. To use a Zip disk, you must either have a Zip drive or have access to a drive, which can be connected to the system. Zip drives are generally external drives, but many PC manufacturers are now including Zip drives within their system unit.
9. **Magneto-Optical Disk (MO Disk).** Magneto-Optical Disk (MO Disk), introduced in middle of 1990's uses a combination of both magnetic and optical technologies MO Disks are removable cartridges that comes in two size—$3^1/2$" and $5^1/4$".

10. **DVD ROM/RAM (Digital Video Disk ROM/RAM).** DVD ROM and DVD RAM disks are optical disks having a storage capacity of 4.7 GB and 5.2 GB respectively. These disks are becoming the next generation's new standard for higher capacity removable media.

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Having a brief overview of various storage devices, we can classify the currently available storage devices into the following three categories:

1. Magnetic Storage Devices
2. Optical Storage Devices
3. Magneto-optical Storage Devices

We are discussing all these devices in the subsequent part of the chapter.

5.4. Magnetic Storage Devices

Magnetic storage devices are the most widely used storage devices where data is stored on a magnetised material. They include Magnetic Tape, Cartridge Tapes, Hard Disk and Floppy Disk.

Magnetic Tape

Magnetic tape is the oldest storage device available for microcomputers. It is generally used to store a large volume of data that is needed to be sequentially accessed and processed. The tape is made up of a plastic ribbon coated with an iron-oxide material, which can be magnetised as shown in figure 5.1. The data stored on tape can be read as well as erased and written again.

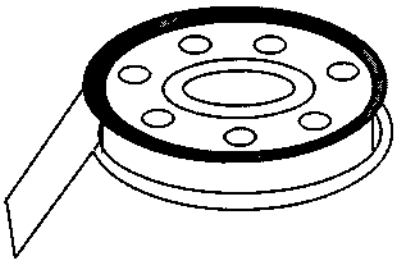

Fig. 5.1: A magnetic tape

Magnetic tape is a sequential access storage device, hence it is not possible to read the data randomly or directly. Therefore, magnetic tapes are suitable only for storing data for backups and batch mode applications and not for on-line applications.

Structure and Working of Magnetic Tape Drives. A magnetic tape drive consists of two spools on which a magnetic tape is wound. A set of nine heads is mounted between the two spools, which record information on nine parallel tracks. Each tracks except the ninth one stores a bit of information. The ninth track stores a parity bit for each byte. The parity bit is used for detecting errors that may arise due to the loss of a bit during data input or output operations. There are two types of parity bits- even-parity and odd-parity. In even parity, an additional 1 bit is added to the code (EBCDIC/ASCFI) if there is an odd

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number of 1 bits in the code in order to make an even number of bits. Similarly in odd parity an additional 1 bit is added to the code if there is an even number of 1 bits in the code, It produces an odd number of parity. Data recording on a track magnetic tape using 8-bit EBCDIC/ASCII code format is illustrated in figure 5.2.

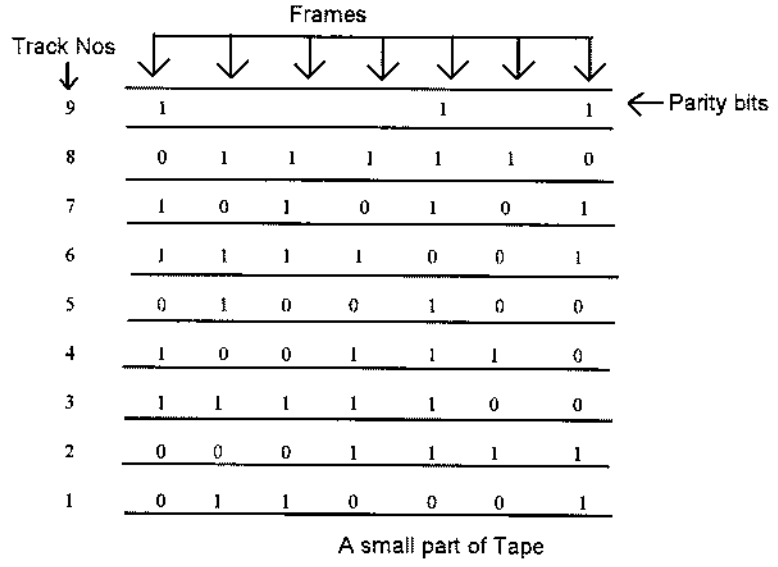

Fig. 5.2: Data recording on a 9 track magnetic tape using 8-bit EBCDIC/ASCII code

Inter-Block Gap (IBG). As the data is recorded and retrieved sequentially in tapes, it is arranged as a group of records, called a block. After each block, a gap is provided which is called an Inter-Block Gap (IBG). On a standard half an inch tapes, the inter-block gap is about 0.6 inches. As the speed of tape motion is very high (about 100 inches per second) inter-block gap is also provided in the beginning of the tape, which provides it a sufficient time to accelerate to its full speed, before recording or retrieving the data. Besides the inter-block gaps, file markers are also provided before the beginning and end of each file. The file marker gaps are larger than the inter-block gaps as shown in figure 5.3. The beginning of tape (BOT) and the end of tape (EOT) are indicated by metal foil stucked in the tape.

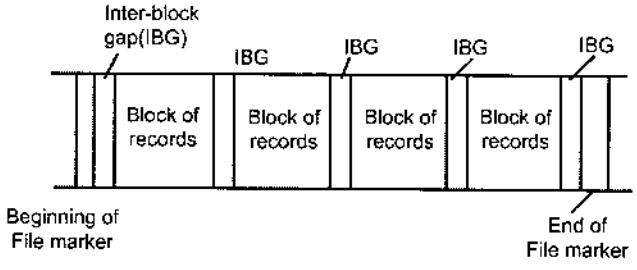

Fig. 5.3: Organisation of blocks and files on a tape

Advantages of Magnetic Tape. Although magnetic tapes are the oldest storage devices, they offer following advantages:

(*a*) *High Storage.* The storage capacity of a magnetic tape is very high because it can be made thousands feet long and one inch of a tape can store thousand of characters. The recording density of the tape is expressed as the number of bits per inch (bpi) such as 800 bpi, 1600 bpi, 3200 bpi, 6250 bpi, etc.

(*b*) *Long Lasting.* The data stored on tapes is highly secure as tapes do not get damaged for many-many years provided they are stored in dust free atmosphere. Therefore, tapes are mainly used to store a large volume of data for back up purpose i.e., archival storage.

(*c*) *Portable.* Tapes can be carried from one place to another very easily and safely. So, they are also used to transfer data from one computer to another.

Due to the above advantages, magnetic tapes are still used on computers especially mainframes and minicomputers. Tapes are generally not used on personal computers due to their some disadvantages. Now, let us discuss the drawback of magnetic tapes.

Disadvantages of Magnetic Tapes. Magnetic tapes can not be used for all purposes due to their following negative features:

(*a*) No Random Access. This is the major disadvantage of magnetic tapes. You can retrieve data on tapes only sequentially i.e. the order by which data is recorded. So, you can not access the data randomly. For instance, if you have stored data of 5000 employees (Employee No. 1 to 5000) on a tape and you wish to retrieve data of an employee no. 2577, you can not access it randomly or directly without reading the data of first 2576 employees. Therefore, the tapes are only suitable for applications needing sequential retrieval of data.

(*b*) Non-standard Device for PCs. The tape drives require a tape controller that interprets special commands for operating many tape drives connected to it. Such devices are not available on all present day PCs with standard configurations due to their high cost. Therefore, magnetic tapes are suitable only for mini and mainframe computer and not for personal computer.

Applications of Magnetic Tapes. Magnetic tapes are useful for following types of applications:

- Batch mode applications (such as payroll) where all data is processed after a period of time (monthly).
- Applications where a large volume of data is needed to be stored and retrieved sequentially by a large organisation such as a university or an insurance company. For instance, a university can store the data of an examination on magnetic tapes in order to prepare the result.
- Applications of a large organisation having many distributed branches without any data communication facilities for transferring the data on tapes.

Numerical Problem on Magnetic Tape. A tape of length 2167 feet has a recording density of 200 bytes per inch. The speed of tape drive is 100 inches

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per second. The file on the tape has blocks of 1200 characters. Each IBG is 1 inch in length and the time spent on an IBG is 0.02 second. Calculate the net transfer rate of data from the tape and number of blocks in the tape.

Solution. The net transfer rate is calculated as follows:

$$\text{Nt Transfer Rate} = \frac{\text{No. of characters in a block}}{\text{Effective time to read a block}}$$

The effective time to read a block is calculated as follows:

Effective time to read a block = Time to read one block + Time spent at IBG

The time to read one block is calculated as follows:

$$\text{Time t read one block} = \frac{\text{No. of characters in a block}}{\text{Maximum transfer rate}}$$

The maximum transfer rate is calculated as follows:

$$\begin{aligned}\text{Maximum transfer rate} &= \text{Recording Density} \times \text{Tape Speed}\\ &= 200 \times 100\\ &= 20000 \text{ bytes per second.}\end{aligned}$$

Therefore,

$$\text{Time to read one block} = \frac{1,200}{20,000} = 0.06 \text{ second}$$

Given, Time spent at IBG = 0.02 second

So, Effective time = 0.06 + 0.02 = 0.08 second

$$\text{Hence, Ne Transfer Rate} = \frac{1,000}{0.08} = 15000 \text{ characters/sec.}$$

The total number of blocks in a tape is calculated as follows:

$$\text{Total umber of blocks} = \frac{\text{Length of tape}}{\text{Effective length of block}}$$

The length of one block is calculated as follows:

$$\text{Length of ne block} = \frac{\text{No. of characters in a block}}{\text{Recording density}}$$

$$= \frac{1200}{200} = 6 \text{ inches}$$

The effective length of one block is calculated as follows:

$$\begin{aligned}\text{Effective length of one block} &= \text{Length of one block} + \text{Length of IBG}\\ &= 6 + 1 = 7 \text{ inches}\end{aligned}$$

Therefore,

$$\text{Total no. of locks in a tape} = \frac{1400 \times 12}{7} = 2400$$

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Cartridge Tapes

Cartridge tapes are smaller than magnetic tapes, which resemble cassettes used in audio tape recorder as shown in Figure 5.4. They are used in microcomputers. Cartridge tapes are quarter inch wide and hence are also called QIC (*Quarter Inch Cartridge*) tapes. They are sealed in a cartridge just like an audiocassette tape. The size of the cassette is 5¼" similar to a 5¼" floppy.

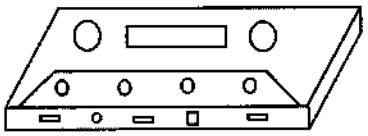

Fig. 5.4: Cartridge tape

Structure of Cartridge Tape. There are 9 to 30 tracks in a cartridge tape. The data is stored serially in a track with one head. After end of tape, the tape is rewound and data is recorded in subsequent track. One block of data consists of 6000 bytes and after one block, an error correction code is written. The capacity of the tape varies from 500 to 1000 MB. The data format used in cartridge tapes is called the *QIC standard*, which is standarised by the industry.

Uses of Cartridge Tapes. Cartridge Tapes are used for following purposes:

(*a*) *Backing up Data.* The data from the hard disk can be copied onto cartridge tapes in order to recover it back to hard disk in case the hard disk corrupts or data is lost. The cartridge tapes are also called streamer tapes as data is stored as a stream on a tape.

(*b*) *Archive.* The information can be recorded on cartridge tapes for future retrieval.

(*c*) *Data Distribution.* As cartridge tapes are portable, they can be used to transfer data from one computer to another within or outside the organisation.

Digital Audio Tapes (DAT). DAT is a form of cartridge tape consisting of 4 mm wide and 60 to 90 metres long tape, which is enclosed in a cartridge. It uses a Digital Data Storage (DDS) recording format, which provides 3 levels of error correcting code. It uses a special recording technique called *helical scan*. In helical scan, The data is read after recording in order to ensure the reliability of data recorded. It is interfaced to a computer using SCSI standard. DAT is the most preferred tape for backing up data due to its high capacity (4 GB) and fast data transfer speed (366 KB/Sec) as compared to QIC tape which has capacity of 1 MB and data transfer speed of 240 KB/Sec.

Winchester Disk (Hard Disk)

Winchester Disk is the most common storage device of present day microcomputers. It is popularly called as the *Hard Disk Drive* (HDD) or sometimes as *Fixed Disk Drive*. It is fixed inside the computer and is not easily-removable as shown in figure 5.5. It is used for storing the software

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and data inside the computer. It is also known as 'Winchester Disk', probably because this drive was first made by IBM at Hursley Laboratory, located nar Winchester in England.

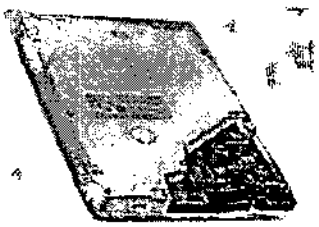

Fig. 5.5: Hard disk drive

Structure of Winchester Disk. The HDD consists of one or more disk platters, an access mechanism and read/write heads, which are sealed in a case as shown in figure 5.6. The read/write head is used to write data on the disk surface or to read it back.

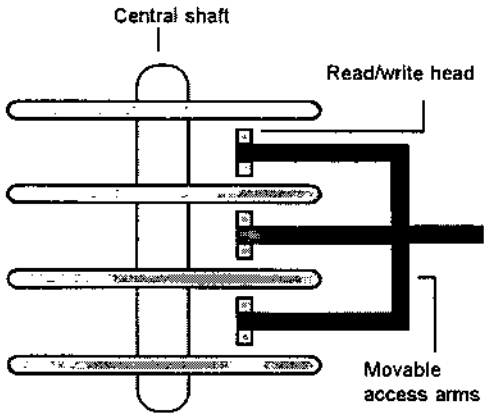

Fig. 5.6: Internal structure of a winchester disk

Size of Winchester Disk. Hard disk size depends upon the disk platter's diameter. There are many different platter sizes (such as 5½, 3½, 2½ inch etc.). The 3½ inch size platter is common with PCs and 2½ inch with laptop/ portable computers. The capacity of disk pack is calculated as follows :

Capacity of Disk Pack = Bytes per sector × Sectors per track
× No. of tracks per surface × No. of Surfaces

Types of Winchester Disks. There are different types of hard disks depending upon their storage capacities. Storage capacities of hard disks range from 10 GB to several GBs, but 40 GB to 100 GB are now-a-days a common part of Pentium computers.

Working of Hard Disk. A hard disk contains two or more vertically stacked disk plotters. Each disk plotter has its own read/write head, which moves across the surface of a disk coated with magnetically sensitive material. The disk revolves with a speed ranging from 7200 rpm (revolutions per minute) to 10,000 rpm. The read/write heads read from or write into the data on the revolving disk surface. Information is stored on the disk in concentric circles, called *tracks*. The performance of a hard disk depends on two criteria

first, the access time that is the time taken to randomly access a unit of data; and second, the *transfer rate* that is the number of bytes per second that can be read from or write to a disk.

Differences between Moving-head and Fixed-head Disk Systems. There are two types of hard disk systems depending upon the two methods of accessing the data— Moving-head and Fixed-head. The differences between these two types of disk systems are described in table 5.2.

Table 5.2: Differences between moving-head and fixed-head disk systems

Moving-head Disk System	Fixed-head Disk System
1. Moving head-disk system has one read/ write head for each disk surface, which is mounted on the access arm. (Refer figure 5.6)	1. A fixed-head disk system has as many read/write heads on each disk surface as the number of tracks, which are mounted on the access arm as shown in figure 5.7.
2. The head moves horizontally on the disk surface to read or write data.	2. The head does not move as each track has a separate head.
3. The access speed is less.	3. The access speed is more.
4. It has more disk capacity as less required for a single read/ write head placed on each surface.	4. It has less space is required for the read/write heads disk capacity as more space.

Transfer Rate of a Disk System. The rate at which information is read from the disk is called the transfer rate of a disk system. The transfer rate depends upon the following factors:

(*a*) *Access Time.* It is the time spent on reading a unit of data (record) from the disk. Access time is calculated by adding seek time and latency time. Seek time is the time taken by read/write head to reach the specified cylinder where the record has to be read or written. Seek time is zero when head is already positioned on the specified

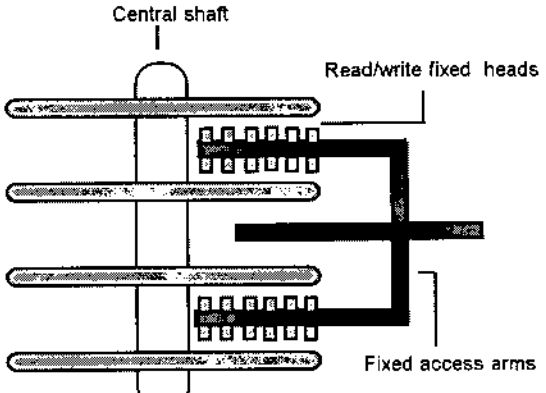

Fig. 5.7: Internal structure of a fixed-head disk system

cylinder. It is maximum when the head moves from the outermost cylinder to the innermost cylinder or vice-versa. Latency time is

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the time taken by disk in locating the specified sector when disk is rotated. It is zero when head is already position on the specified track. It is maximum when the disk rotates one complete cycle. As the latency time is the time spent on locating the specified sector, the average latency time is calculated as follows:

$$\text{Average Latency Time} = \frac{1}{2} \times \text{Maximum time taken in one revolution of the disk pack}$$

The average access time is calculated as follows:

Average Access Time = Average Latency Time + Average Seek Time

The Data transfer rate is calculated as follows:

Data Transfer Rate = Bytes per track / Average Access Time

(*b*) *Number and Size of Cylinder.* The transfer rate also depends upon the number of cylinders in a disk pack. The transfer rate is high when number of cylinders is more otherwise it is low. Similarly, when size of a cylinder is more, the transfer rate is high otherwise it is low.

(*c*) *Block of Data.* Transfer rate is high when the size of a block of data is large otherwise is low.

Numerical Problems on Winchester Disks. Let us now understand the methods of calculating total capacity and data transfer rate of hard disks by solving two numerical problems.

Problem 1: A magnetic disk has 32 sectors per track, 128 tracks per surface and 19 surfaces. Each sector store 512 bytes. Calculate the total capacity of the disk pack.

Solution. The total capacity of disk is calculated as follows:

Total Capacity of Disk Pack = Bytes per sector × Sectors per track × No. of tracks per surface × No. of Surfaces

= 512 × 32 × 128 × 19 = 39845888 bytes

= 38 MB

Problem 2: A magnetic disk has 64 tracks per surface, and there are total 12 storage surfaces out of which 10 are recordable. The capacity of the disk pack is 200 MB and the disk rotates at 7200 rpm. The average seek time is 50 millisecond. Calculate the data transfer rate for the disk pack.

Solution. The data transfer rate for the disk pack is calculated as follows:

Data Transfer Rate = Bytes per track / Average Access Time

The number of bytes per track are calculated as follows:

We know that,

Total Capacity of Disk Pack = Bytes per sector × Sectors per track × No. of tracks per surface × No of Surfaces

So,

$$\text{Bytes per track} = \frac{\text{Total capacity of Disk Pack}}{\text{No. of surface} \times \text{Track per surface} \times \text{Sectores per track}}$$

$$= \frac{200 \times 1024 \times 1024}{10 \times 64 \times 32} = \frac{29715200}{20480} = 10240 \text{ Bytes/track}$$

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The average access time is calculated as follows:

Average Access Time = Average Latency Time + Average Seek Time

The average seek time is given in the problem. So, we now calculate the average latency time as follows:

$$\text{Average Latency Time} = \frac{1}{2} \times \text{Maximum time taken in one revolution of the disk pack}$$

The maximum time taken in one revolution of the disk pack is calculated as follows:

As the disk rotates at 7200 rpm (revolutions per minute),

7200 revolutions take = 6 sec.

So, 1 revolution take $= \frac{60}{7200} = \frac{1}{120}$ = sec.

Therefore, Average Latency Time $= \frac{1}{2} \times \frac{1}{120} = \frac{1}{120}$ sec.

Given, Average Seek Time = 50 millisecond $= \frac{50}{1000} = \frac{1}{20}$ sec

So Average Access Time $= \frac{1}{240} + \frac{1}{20} = \frac{1+12}{240} = \frac{13}{240}$ sec.

Hence, Data Transfer Rate = Bytes per track / Average Access Time

$$= \frac{10240}{13/240} = \frac{10240}{1} \times \frac{240}{13}$$

$$= \frac{2457600}{13} = 189046.15 \text{ Bytes/sec}$$

$$= \frac{189046.15}{1024} = 184.61 \text{ KBytes/sec}$$

Floppy Disk

Floppy Disk (FD) is another common storage device, which is small, flexible and easily removable. It is made of a plastic disk coated with magnetic material, which is sealed inside a square plastic jacket as shown in figure 5.8. It is called as 'Floppy' because it is soft having flexible physical property. Data

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can be written on or read from this floppy by a drive, called *Floppy Disk Drive (FDD)*, which is fixed inside the computer as shown in figure 5.9.

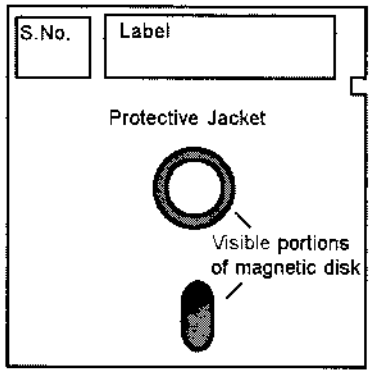

Fig. 5.8: Structure of a floppy disk

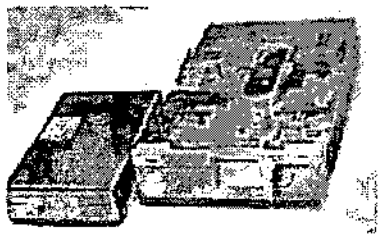

Fig. 5.9: Floppy disk drives (3.5" & 5.25")

Types of Floppies. There are many types of floppies depending upon their sizes and storage capacities as summarised in table 5.3. The original floppy, developed by IBM, is an 8 floppy, but the most popular sizes available for present day PCs are 5¼ and 3½. The storage capacity of floppies vary from 360 KB to 1.44 MB. The floppies can store data on both sides (Double-sided Floppies) or on single side (Single-sided Floppies) depending upon the floppy drive. Double-sided floppy drives are most frequently used in present day PCs. The floppy drive, that packs two high density floppy drives (5.25 & 3.5 inch) into a single package, is known as *Combo Drive.*

Table 5.3: Types of floppies

Type of Floppy	Size	Density	Sectors*	Tracks*	Storage Capacity
DSDD**	5.25 inch	Double	9	40	360 K
DSLD**	3.5 inch	Low	9	80	720 K
DSHD** Big	5.25 inch	High	15	80	1.2 MB
DSHD Small	3.5 inch	High	18	80	1.44 MB

* For definition of these terms, refer to glossary

** DS stands for Double Sided, LD for Low Density and HD for High Density.

5.5. Optical Storage Devices

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Optical storage devices use optical technology such as laser to store and retrieve data. They have the ability to store large quantities of data in a small space. They include CD ROM and DVD ROM/RAM disks.

Compact Disk Read Only Memory (CD ROM)

CD ROM is the latest storage device, used to store data, information and software, which can be read only and not be changed or erased. It is an optical read only memory made up of a resin as shown in figure 5.10. CD ROM drive as shown in figure 5.11 is used to read information only. You cannot write information on a CD ROM using CD ROM drive. The information is stored nDs by using a drive, called CD Writer.

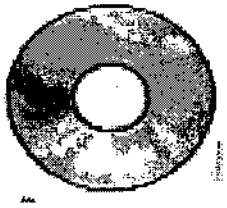

Fig. 5.10: A CD ROM disk

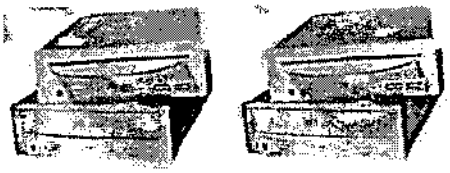

Fig. 5.11: CD ROM drive

Now-a-days compact disks are very popular storage devices for microcomputers because a large number of software including multimedia, audio and graphics software are available only on these disks. Compact Disks can store a large volume of data (upto 650 MB).

WORM (Write Once Read Many) is a type of compact disk, which can be recorded only once and not erased. It can store more data than a CD ROM, generally measured in Gigabytes.

Structure and Working of CD ROM. A CD ROM has a silver appearance on both sides. It is almost opaque and acts much like a mirror. It is not completely opaque as some light is refracted and hence a rainbow is produced when you tilt it in front of a bright light. The one side of a CD ROM has printing on it and the other side is used for storing data.

A CD ROM stores information using billion of microscopic pits that reside on its surface. You know that data is stored on a disk using a series of ones and zero (binary digits). The CD ROM places a pit on its surface to represent a one and no pit to represent a zero.

For reading the data of CD ROM the CD ROM drive spins the CD ROM by passing a small laser beam. The laser, in turn, reflects a light off the CD ROM's surface. If the surface area does not have a pit, the light will reflect faster.

The speed of a CD ROM drive is expressed as double-speeds (2x), quad-speed (4x), twelve-speed (12x) and so on. A single-speed drive transfers data at a rate of 150 Kbs (Kilobyte per second). A double-speed drive, therefore, transfers data at 300 Kbs. Similarly, a 36x drive transfers data at 5.4 Mbs.

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Recordable Compact Disk. We have discussed that you can not write on a traditional CD ROM disk. If you want to record information on a CD, you need special CDs called *Compact Disk Recordable (CD-R)* disks. The CD-R disk looks somehow like a traditional CD ROM disk, except that the front side has a golden appearance while the back has a blushes screen appearance. A CD ROM burner records information on a CD-R disc (which looks just like a traditional CD ROM disc) using a laser that burns the small bits into the disc's surface. A CD ROM burner looks very much like a CD ROM drive.

In the past time, there were certain limitations with CD writing. First, at one time, recording a CD was called *'burning'* a CD. It was a slow process, which took over an hour. Now-a-days, 32x CD recorders are widely available which could record 650 MB of data in less than 75 minutes. Another limitation of CD writing was that once you made a CD you could not add to it, even if it was not full. With latest multisession technology, today's CD Writers can keep adding to a blank CD until it is full. It is like the old fashioned WORM (*Write Once Read Many*) drives, except that it has a 650 MB removable cartridge that costs very little.

A limitation of CD-R is that you cannot rename, delete, or reorganise its files. This limitation has overcomed by CDRW (Compact Disk Re Writable) technology. With CDRW, it is possible to erase, rename and reorganise files much the same way as you do on a floppy or hard drive.

Audio and Photo CDs. An audio CD is a disk that can be played using a stereo or audio CD player. Audio CDs are also referred generally as music CDs. If you are using Windows and your PC has a CD ROM drive, sound card, and speakers, you can use you PC to play audio CDs. In most cases, to play an audio CD, you simply insert the audio CD into your CD ROM drive. Windows, in turn, will recognise the audio CD's format and will start playing the music tracks that the audio CD contains.

A photo CD is a CD that stores photographs in an electronic format. A photo CD provides several different resolutions of the same image. A high-resolution image requires more space while a low-resolution image might require less space.

DVD ROM/RAM (Digital Video Disk ROM/RAM)

DVD ROM and DVD RAM disks are optical disks having a storage capacity of 4.7 GB and 5.2 GB respectively. These disks are becoming the next generation's new standard for higher capacity removable media. They are ideal for storage of huge amount of information required for multimedia applications. One can put 133 minutes of high quality of video with digital sound on a DVD RAM Disk as shown in figure 5.12. Today, many PCs come with CD ROM drives that support Digital-Video Discs (DVDs). A DVD is a high-capacity disc, capable of storing up to 4.7GB. Because of their tremendous storage capacity, a DD can store an entire movie-much like a VHS tape.

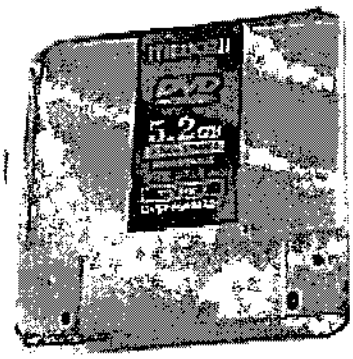

Fig. 5.12: A DVD RAM disk

5.6. Magneto-Optical Storage Devices

Magneto-optical storage devices use both magnetic and optical technologies to store and retrieve data. They include mainly MO disk.

Magneto Optical Drive

Magneto Optical (MO) drive, is the latest of all storage devices. This drive uses both a laser and an electromagnet to record data on a removable cartridge. The surface of the cartridge contains tiny embedded magnets. The unique feature of MO drive is that it has a very high storage capacity. Although MO drive is costlier and slower than HDD, it has a long life and is more reliable.

Structure and Working of MO Drive. A typical MO cartridge is slightly larger than a conventional 3.5-inch floppy disk but looks similar to it as shown in Figure 5.13. However, the floppy disk can store 1.44 Megabytes (MB) of data while an MO diskette can store many times that amount, ranging from 100 MB up to several gigabytes (GB).

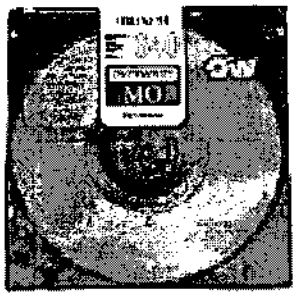

Fig. 5.13: A Magneto Optical (MO) disk.

An MO system achieves its high data density by using combination of a laser and a magnetic read/write head. Both the laser and the magnet are used to write data onto the diskette. The laser heats up the diskette surface so it can be easily magnetised, which helps in precisely locating the region of magnetisation. A less intense laser is used to read data from the diskette. In an MO, data can be erased and/or overwritten an unlimited number of times.

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5.7. Holography Storage: An Emerging Storage Technology

The terms holograms and holography were coined by Dennis Gabor (a Hungarian-born physicist and Nobel prize winner, also known as the *father of holography*) in 1947. Holography is the latest tecyhnology of data storage, where data is recorded in photo-refractive crystals as 3D holograms. "Holos" stands in Greek for "total, complete" and "gramma" means "letter, writing". In ancient Greece, the letter was used as a number or system for the measurement of distinguishable unities. So "gram" designates the unity and "holos", the total, the word "hologram" means the unity of the whole.

In simplest words, holography is three-dimensional recording with lasers. In other words, holography is the technology of recording wave front (light wave) information and producing reconstructed wave-fronts from those recordings. The record of the wave-front information is called a *hologram*. In order to understand technology of holography let us first distinguish between photography and holography.

Difference between Holography and Photography. Holography differs from photography in the following ways:

1. The hologram is not a picture and holography is not primarily a picture-making technique. A hologram does not bear an image at all. It only diffracts light in a particular way. Holograms are optical elements and not pictures. They perform optical functions rather than bear an image, and they are not extensions of photographs but a new way of recording, storing and retrieving optical information.
2. A photograph is basically the recording of the differing intensities of the light reflected by the object and imaged by a lens. The light is incoherent, therefore, there are many different wavelengths of light reflecting form the object and even the light of the same wavelength is out of phase. However, the holography uses a vastly different light source i.e. Laser light. Laser light differs drastically from all other light sources, man-made or natural, in one basic way that it is a coherent light meaning that the light being emitted by the laser is of the same wavelength and is in phase.
3. In traditional photography, light reflecting from the subject is focused by a lens onto a recording medium, mainly film. As a result a photograph presents only one perspective of the scene, the perspective from the lens. So, only the intensity of light is recorded, not the direction it came from. When recording a hologram, as no focusing lens is between the recording medium and the laser light reflected off the subject, so the light falls on the medium from all angles. So, the image is correct from all perspectives, just like real life.

Technique of Holography Storage. In holography, data is recorded in photo refractive crystals as 3D holograms. As all holograms provide the perception of 3D images, it is probably necessary to understand the meaning of 3D in data storage terms.

In two dimensional storage, binary data is written as dark or light dots on the surface of a recording medium. However, in three dimension storage, the data is stored throughout the whole volume of the recording medium by stacking pages one on top of the other within a photosensitive material. Strontium barium-niobate crystals are mostly used as recording media in 3D storage. In holography, this technique is used to create holograms. Multiple Holograms can also be stored in a single crystal.

Difference between Holographic Storage and Conventional Storage Techniques. Holographic storage differs from conventional storage in the following ways:

1. Holographic storage systems, in contrast to conventional magnetic and optical recording, require the unique integration of many different technologies as opposed to one dominant technology.
2. Information recorded using conventional technologies occupies a discrete location in or on the recording layer. In contrast. a bit recorded by holographic means is stored in the form of an interference pattern that spans the entire area or volume of the hologram.
3. In conventional storage, data is recorded and retrieved serially. Holographic storage, on the other hand, uses the information capacity of an optical wave-front so that data can be recorded and retrieved in parallel, one page at a time. Due to the page-oriented nature of holographic storage, holographic storage systems can have data rates approaching 1.0 Gbytes/sec.

Advantages of Holography Storage. Holography offers the following benefits over conventional storage techniques:

1. Holographic technology allows the storage of enormous amounts of information in a small area.
2. It provides more speed to retrieve stored information.
3. In holography, data can be recorded and retrieved in thousand streams at one time as oppose to conventional storage techniques where one bit stream of information is stored or retrieved.

5.8. Key Point Summary

- Storage of data on computer has its own advantages over manual storage.
- Various kinds of computer storage devices are Punch Card, Punch Tape, Magnetic Tape, Magnetic Drum, Hard Disk, Floppy Disk, CD ROM, Cartridge Disk, MD Disk and DVD ROM/RAM.
- Storage devices can be classified into three categories—(*a*) Magnetic Storage Devices, (*b*) Optical Storage Devices, and (*c*) Magnetic-optical Storage Devices.
- Magnetic storage devices include Magnetic Tape, Cartridge Tape, Hard Disk and Floppy Disk.

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- Magnetic tape is a sequential storage device and hence is suitable only for storing data for backups and batch mode applications.
- Magnetic tapes are long lasting, portable and provide high storage, but they cannot be used to access data randomly.
- Cartridge tapes are smaller than magnetic tapes and are used in microcomputers for backing up data and data distribution.
- Digital Audio Tape (DAT) is a form of cartridge tape that uses a Data Digital Storage (DDS) recording format.
- Winchester Disk (Hard Disk) is the most common storage device of PCs, which is fixed inside the computer.
- There are two types of hard disk systems—(*a*) Moving head, and (*b*) Fixed head.
- The transfer rate of a disk system depends upon the access time, number and size of cylinder and block of data.
- Floppy disk is a small, flexible and easily removable storage device.
- There are many types of floppies depending upon their sizes and storage capacities.
- Optical storage devices include CD ROM and DVD ROM/RAM disks.
- CD ROM is an optical read only memory storage device.
- A CD ROM stores information using billion of microscopic pits that reside on its surface.
- CD-R (Compact Disk Recordable) and CDRW (Compact Disk Re-Writable) are special types of recordable CDs.
- DVD ROM and DVD RAM are ideal for storage of high quality of video with digital sound.
- MO (Magnetic Optical) drive uses both magnetic and optical technologies to store and retrieve data.
- Holography storage is an emerging storage technology that uses a latest technology, where data is recorded in photo refractive crystals as 3D holograms.

5.9. Review Questions

1. What is the difference between manual and computer storage ? Explain.
2. Discuss briefly the evolution of computer storage devices.
3. Name the main storage devices of a computer. Which device :
   (*a*) has the highest storage capacity and is most commonly used.
   (*b*) has the lowest storage capacity but still is used most frequently.
   (*c*) is used to store data which cannot be erased or altered.
   (*d*) is the oldest of all storage devices and is used for backups.
4. Discuss the structure and working of—(*a*) Magnetic Tape Drives, (*b*) CD ROM.

5. Discuss the advantages and disadvantages of the following storage devices :
   (*a*) Magnetic tape
   (*b*) Floppy disks
6. Discuss the applications of the following storage devices :
   (*a*) Magnetic tape (*b*) Cartridge tapes
   (*c*) CD ROM (*d*) DVD ROM/RAM
7. Explain the following terms :
   (*a*) IBG
   (*b*) QIC Standard
   (*c*) Helical Scan
   (*d*) WORM
   (*e*) Hologram
8. Explain the differences between the following :
   (*a*) Moving-head and Fixed-head disk systems
   (*b*) Seek Time and Latency Time
   (*c*) CD-R and CDRW
   (*d*) Holography and Photography
9. A disk pack has 10 disk plates, each having 200 tracks. There are 40 sectors per track and each sector can store 256 bytes. Calculate the total storage capacity of the disk pack assuming that the top and bottom surfaces of the disk pack are not used.
10. With respect to a disk system, explain the following terms :
    (*a*) Surface (*b*) Cylinder
    (*c*) Track (*d*) Sector
    (*e*) Bits/Sector

    Calculate the capacity of the disk in terms of the above.
11. A magnetic disk has 64 sectors/track, 16 tracks/cylinders, 480 cylinders and 512 bytes/sector. The disk is rotated at 3000 rpm. Calculate :
    (*a*) The capacity of the disk in MB
    (*b*) The data transfer rate in MB/sec.
12. A magnetic disk drive has 32 sectors/track and 128 tracks/surface. The disk rotates at 3000 rpm and the read/write head assembly can move with a speed of 500 steps/minute. What is the worst time needed to read a complete sector ?
13. A fixed hard disk drive has block size of 1000 bytes with inter block gap of 250 bytes. A track can hold 10,000 bytes. The rotational speed is 600 rpm. Assume that an average rotational latency delay is one half revolution of every disk access. Compute the time needed to

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transfer 4000 bytes of information from the disk, assuming that they are stored in :

(*a*) Physically separate non-contiguous blocks

(*b*) Contiguous blocks.

14. A magnetic tape has the following parameters :

Bite density : 1600 bits/inch

Tape speed : 200 inches/second

Time spend on 1 RG : 3 milli seconds

Average record length : 1000 characters.

How many bytes can be stored on a tape reel of length 1200 feet ?

Unit–6

Software

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Structure

6.1. Introduction
6.2. Classification of Software
6.3. Operating Systems
6.4. Language Translators
6.5. Software Tools
6.6. System Software Utilities
6.7. Word Processors
6.8. Database Management Packages
6.9. Spreadsheet Packages
6.10. Office Automation Packages or Office Suits
6.11. Desk top Publishing Software
6.12. Graphics, Multimedia and Animation Software
6.13. Business Application Software
6.14. Key Point Summary
6.15. Review Questions

6.1. Introduction

In the Chapter 3 on Basic Computer Organisation, we have discussed that computer components can be broadly divided into two categories—Hardware and Software. A computer is hardware and it is useless unless it is provided with the necessary software. Therefore, all computer users must be aware of the basic software concepts besides hardware. Software is a program or set of instructions, which is required to use the computer. Many types of software are available for various applications. The software development field is so advanced that day by day existing software are becoming outdated and new software are coming in the market. So, we must get aware of the latest developments in the software industry.

In this chapter, we are discussing all the important software concepts and providing you the latest knowledge of all the system software available in the market. We will also discuss commonly used general and special purpose application software. Though we are also providing you the current information about the latest version of software, we are sure that it will be out-dated soon.

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6.2. Classification of Software

Software are broadly classified into the following two types:

(*a*) System Software

(*b*) Application Software

Let us discuss these.

System Software

Software that are required to control the working of hardware and aid in effective execution of a general user's applications are called System Software. These software perform a variety of functions like file editing, storage management, resource accounting, I/O management, database management, etc. Some of the examples of system software are DOS (Disk Operating System), Windows, BASIC, COBOL and PC TOOLS. These software are developed by System Programmers. System software can be further categorised into the following three types:

(*i*) **System Management Software.** These software are used to manage the computer hardware and are essential to use the computer. They include operating systems and operating environments such as DOS, Windows, UNIX, etc.

(*ii*) **System Development Software.** These software are used for development of both system and application software. They include Language Translators, Application Generators, CASE Tools, etc.

(*iii*) **System Software Utilities.** These software support the operation of the computer by providing file management capabilities, data compression, diagnostic routines, virus detection and removal, text editing, etc. We will discuss all these software in later part of the chapter.

Application Software

Software that are required for general and special purpose applications like database management, word processing, accounting, etc. are called Application Software. Some of the examples of application software are dBASE, Word Star, Tally, etc. Application software are developed using system software by Application Programmers. Application software can be further classified into the following two types:

(*i*) **General Purpose Application Software.** Whenever an organisation purchases computers, besides an operating system certain application software are also required to be purchased. These software are needed for general purposes like word processing, database management, spreadsheets etc. and are known as General Purposes Application Software. For example, Database Management Packages, Word Processors, Spreadsheets, etc. are general purpose application software.

(*ii*) **Special Purpose Application Software.** Although general purpose

application software are exclusively used by all users for general applications, there are certain software which are meant for some special applications and organisations. Besides general purpose application software, some organisations also need software for desktop publishing, graphics, multimedia, animations, financial accounting, sales and marketing, inventory, export documentation, etc. These software are collectively known as Special Purpose Application Software. For example, software required for Desk Top Publishing, Graphics, Multimedia, Accounting, Inventory, Production Management, etc. are special purpose application software.

We will also discuss about these software in detail in later part of the chapter.

6.3. Operating Systems

An operating system is the most essential system software that manages the operation of a computer. Without an operating system, it is not possible to use the computer. The computer is useless unless it is provided an essential software that makes it ready to use. An operating system is software, which makes the computer ready to use by a process called booting. Before discussing the types of operating systems, let us first see what exactly is meant by booting?

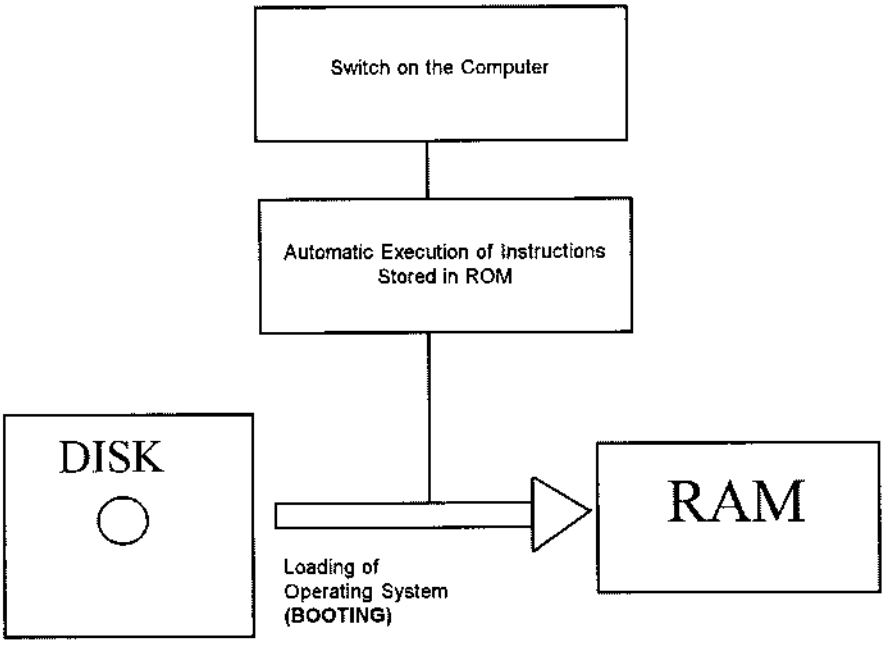

Fig. 6.1: Process of booting

Booting

The term 'booting' comes from the word—'bootstrap'. As bootstrap helps us to get our boots on, similarly booting helps the computer to get

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ready. When we switch on the computer, the instructions stored in ROM are automatically executed. These instructions help the computer to load the operating system from external storage device (disk) to internal storage (RAM) as shown in figure 6.1. This process of loading of operating system from disk to RAM is called booting.

Types of Operating Systems

Many operating systems are available for computers which can be divided into the two types : (*i*) Single-user operating systems, and (*ii*) Multi-user operating systems.

(*i*) **Single-user Operating Systems.** These operating systems are used for mainly computers having only one terminal (stand-alone PCs). MS DOS (Microsoft Disk Operating System) and PC DOS (Personal Computer Disk Operating System) are the two important single-user operating systems. Both systems are almost identical and are simply called DOS.

(*ii*) **Multi-user Operating Systems.** These operating systems are used for those computers (micro to mainframe) which have many terminals (multi-user systems). The popular operating systems used for multi-user systems are UNIX, NETWARE, MVS, OS/400, VMS and Linux. OS/2 and Windows NT are other popular multi-user, multi-tasking operating systems for microcomputers.

We will discuss these operating systems in the next chapter on Operating Systems.

6.4. Language Translators

We give instructions to computer using a language. A set of instructions is called a Program and the language using which we give the instructions is called the *Programming Language or Computer Language* or simply *Language*. There are many types of computer languages such as Machine Language, High Level Languages, etc. which we will discuss in detail in chapter 10 on Programming Concepts and Languages. Although we can give instructions to computer using any language, internally it understands only the machine language. The machine language consists of two numbers only i.e., 0s and 1s (which are generated by logic circuits as we have discussed in Chapter 7 on Computer Architecture). Regardless of the programming language used (except machine language), the symbolic instructions have to be translated into a form, that can be executed by computer. The software, which converts the codes of other languages into machine code, are collectively called Language Translators.

Language Translators are categorised into the following three types :

(*a*) Interpreters

(*b*) Compilers

(*c*) Assemblers

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Interpreters

Instructions of a high-level language are coded in many statements. At the time of their execution, they are converted statement by statement into machine code, by using system software, called Interpreters. For example, programs written in BASIC language are executed by using BASICA or GWBASIC interpreters. Programs written in some fourth generation languages, like dBASE III plus are also executed using dBASE interpreter. There are certain disadvantages of interpreters. As instructions are translated and executed simultaneously using interpreters, interpreters are very slow for executing large programs. Hence, they are not suitable for the most of applications development.

Compilers

As contrast to interpreters, compilers provide faster execution speed. Compilers do not translate and execute the instructions at the same time. They translate the entire program (source code) into machine code (object code). Using linker, the object code is converted into executable code. Compilers are widely used in translating codes of high level languages (e.g., COBOL, FORTRAN, Pascal, Turbo/Quick BASIC, Turbo/ Microsoft C etc.) and fourth generation languages (dBASE IV, Foxpro, etc.). As compared to interpreters or assemblers, compilers are preferred in development of application software.

Assemblers

Assemblers translate the assembly language code (source program) into machine language code (object program). After assembling, a linker program is used to convert the object program into an executable program. The Microsoft Assembler program (MASM) and Borland Turbo Assembler program (TASM) are two popular assemblers. Assemblers are used mainly in the development of system software.

6.5. Software Tools

To develop a large application, lots of effort, money and time are required for designing the systems and writing the program code. The overall goal of computerising an application is to make it more efficient than manual system with optimum utilisation of time, money and effort spent on its development. In order to save the valuable time spent by systems designers and programmers in designing the complete system and writing codes, certain programs are required, which are called software tools. The selection of software tools has become an important aspect of software development. Software tools assist the programmers/ analyst in the design, coding, editing, compiling, linking and debugging programs. They allow them to focus on the challenging aspects of a system. We are discussing below the important categories of software tools that are normally used.

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Application Generators

Application generators are software tools that help the programmer to quickly generate a complete or part program according to the specifications given. The programmer does not write the code but using an application generator, he defines the menus, screen, report formats, data elements and processing logic. The program code is generated quickly by the application generator. Now, the programmer can easily edit and execute the program.

Many application generators are available for different third and fourth generation languages like COBOL, dBASE, Foxpro, etc (we are discussing these languages in Chapter 10 on Programming Concepts and Languages). For example, Pacbase is an application generator for programs written in COBOL language. dBASE and FoxPro have built-in code generation capabilities for designing screen, menu and report formats. Genifer is a full-scale code generator that provides a pattern called a template, from which the code is generated. After defining screens, menus and reports, Genifer creates the data files, index files and programs.

Advantages of Application Generators. The major advantages of using application generators are:

- Saving a lot of development time
- Useful as a learning tool for writing programs
- Programs are easy to modify and maintain

Disadvantages of Application Generators. Application generators also have certain disadvantages such as:

- They cannot handle systems having complex processing logic
- They add complexity, if template language differs from native language

CASE Tools

Development of application software is very complex to plan, design, develop and manage. Software engineering is the systematic approach in design, development, operation and maintenance of such software. Its basic aim is to produce high quality software at low cost. *Computer Aided Software Engineering* (CASE) tool is a group of different software tools that are integrated and used in software engineering. For example, Designer/2000 is Oracle's suite of CASE tools that addresses the different stages of the application development.

CASE tools simplify all stages of project planning, analysis and design of an application. CASE tools include many important features like graphics library, data dictionary, design methodology, screen/report designing and systems documentation. CASE tools incorporate modeling techniques for representing the data and processes.

6.6. System Software Utilities

System software utilities support the operation of the computer. They provide many features including file management capabilities, data

compression, diagnostic routines, virus detection and removal, text editing, performance monitoring and spooling. There are many types of utilities for carrying different tasks. We must be aware that utilities are not operating systems, but certain utilities are in-built in operating systems. We are discussing below the important types of utilities that are commonly used in computers.

Text Editing Utilities

Text editing utilities are used to create, edit and print the non-document texts such as programs, data etc. Norton Editor (NE) which is one of the programs of Norton utilities, is the most common example of text editor. Most operating systems, including DOS, also has in—built text editor program. DOS Edlin and DOS Editor are two editors of DOS. DOS Edlin is a text editor that comes with every version of DOS. It allows only one line to be edited at a time. It was the most popular editor till 1990. In 1991, when DOS 5.0 was released, DOS offered a full screen editor, called DOS Editor with program name EDIT. DOS editor is very easy to use and is very popular among programmers.

Data Compression Utilities

Data compression utilities are popular among those computer users, who frequently need to transfer files from one computer to another. These utilities compress or decompress files that are stored on floppy and hard disks. As compressed files take up very less space in disks, data compression utilities are widely used during copying of data from hard disk to floppy disks. PKZIP/ PKUNZIP and WinZip programs are the commonly used examples of data compression utilities.

PKZIP and PKUNZIP are the popular PC shareware compression programs from PKWARE Inc. PC stands for Phil Katz, the author of these programs. PKZIP compresses one or more files into a single file having the secondary name ZIP while PKUNZIP decompresses the ZIP file to create uncompressed files. PKZIP and PKUNZIP programs are used in DOS environment. WinZip is the Windows version of these programs available as a utility with Windows operating systems.

Virus Detection and Removal Utilities

Virus detection and removal utilities have become essential now for all computer users due to danger of viruses, which is increasing day by day. These utilities are used to detect and eradicate the different types of viruses. Before discussing their importance, let us first discuss, what is a Virus?

Virus is an unauthorised software that is used to invade and disrupt the normal working of computer. As biological viruses spread from one person to another, computer virus spreads from one computer to another generally through floppy disks. There are many problems caused by viruses like damage of data, loss of user interface, unexpected screen messages, system crashes, etc. The potential problems caused by viruses in today's

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organisational computer systems are the worst. There are many types of viruses and their numbers is increasing day by day. The users and managers must take precautionary measures to control the spread of these viruses.

There are many utilities, such as Nashscan, SmartDog, Dr. Soloman's Anti-Virus Toolkit, McAfee, etc. that can detect and remove most of the viruses and are popularly called as Virus Scanners. These virus scanners must be upgraded from time to time for detection and removal of new viruses.

File Management Utilities

File management utilities provide capabilities for managing files like copying, comparing, searching, listing and sorting the files. Although these features are offered by many operating systems, utility programs provide better user-friendly environment along with some additional features. Norton Utilities (NU) and PC TOOLS are the most commonly used file management utilities. Norton utilities are widely used utility programs for DOS, Windows and Macintosh operating system developed by Symantec (originally called Central Point Software). They include programs to edit, undelete and search files besides to restore damaged files and to defragment the disk. Norton System Information (SI) is an early Norton utility that measures computer performance. *Peter Norton* is the most famous name for developing these utilities and hence the name Norton utilities is called. PC Tools is another popular comprehensive package of PC utilities from Symantec. It includes a DOS shell, file management, backup, data recovery, data compression and anti-virus utilities.

Diagnostic Utilities

Diagnostic utilities can detect bugs (errors in hardware/ software) in computers. For instance, the problems of floppy and hard disks can easily be detected by a popular utility program called *Norton Disk Doctor* (NDD) NDD is one of the programs of Norton utilities, developed by Peter Norton. QAPlus and Disk Manager (DM) are other examples of utilities that can detect and remove many bugs in storage devices, software and other components of computers. Disk Manager is a driver, developed by Ontrack Data International Inc., that allows older PCs to support hard disks greater than 528 MB as most of the PCs made before 1994 have BIOS which does not support the larger drives.

Performance Monitoring Utilities

These utilities provide information about the efficiency of computer working. For instance, QAPlus, PC Tools and Norton Utilities provide performance monitoring capabilities by providing information about speed, storage capacity and other features of the system.

Spooling Utilities

In multi-user/ networking environments, the input and output devices are generally slow. In such environment, the processing of computer is also

slowed down. To control the computer from being slowed down, the spooling programs are used. SPOOLing (*Simultaneous Peripheral Operations OnLine*) program is used to buffer data for the printer and remote batch terminals. This program sends the output to the disk and the printer does not interact with CPU during printing. Spooling utilities are used mainly in computer systems with multi-user/networking environment.

MIDI Software

MIDI (Musical Instrument Digital Interface) is a standard protocol for interchange of musical information between musical instruments, synthesisers and computers. It defines the codes for a musical event, which includes the state of a note, its length, pitch, volume and other attributes. With a MIDI interface, you can record a musical session on a computer. The computer stores the music as keystroke and control codes inserted of analog sound waves (a method used in tape recorder). Finale Lime, and Digital Orchestrator Plus are examples of MIDI software. They allows the user to compose music on screen, using standard musical notation, and to play this music back through the computer.

Speech Synthesis Software

Speech synthesis is the production of artificial speech by a computer. This technique involves storing pre-recorded words or sounds and then analysing and joining them using speech synthesis software. Kurzweil VoiceType and Dragon Dictate are examples of speech synthesis software. Using these software the user can issue voice commands to a computer or dictate messages that are automatically turned into type format.

Web Authoring Software

World Wide Web pages (See chapter 13 on Overview of Internet for details) can be created using special web authoring software such as Microsoft Front Page and Adobe SiteMill. Microsoft front page 2000 is a popular Wed authoring program from Microsoft for both Windows and Macintosh environments. FrontPage Explorer, one of the programs of Front Page is the management tool for developing and maintaining the entire Web site. Another program of front page is Front Page Editor, which is a graphical tool for designing the pages. Adobe SiteMill also provides tools for creating Web pages and for maintaining Web sites. Web authoring programs provide easy-to-use text and drawing tools for creating Web pages. They automatically translate these pages into the Hypertext Markup Language (HTML) code, which is used on the Web.

Childproof Desktop Software

Many times, people need to allow children to use a PC without getting into and disrupting files and programs used by adults. Childproof desktop software, provide alternative, simplified desktop environments for children and password protection which allow children to use PC without retrieving programs used by adults.

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6.7. Word Processors

Word processors are application software, which are used for word processing. Word processing is the most widely used technique for typing, editing, storing, formatting, manipulating and printing documents with the assistance of computer and printer. It is the most efficient means of generating documents electronically.

Features of Word Processors

Most of the word processing software provides the following useful features:

(*i*) **Editing of Documents.** Editing means modifying or making changes in your documents. It would involve:

- Inserting new text
- Copying text from one part of the document to another
- Moving text from once part of the document to another
- Deleting unwanted text.

(*ii*) **Formatting of Documents.** Each one of us has a hidden desire that the reader should feel interested in whatever we are trying to convey. The formatting features like fonts, bullets and numbering, font type, etc., can be used very intelligently to create the whole impact. A font is a set of letters that have a common or the same type faces. You can apply different font types and sizes in various texts of your document. You can make your text bold, italic and underlined as per your requirements. Your text can be left, right, center aligned or it can be justified within the margins. You can also align the paragraph by specifying left/and right indents along with the desired line spacing. Since adding bullets and numbering to the text makes it easy to read and understand, most word processors provides 'bullets and numbering' feature.

(*iii*) **Page Setting.** Page setting includes putting your text neatly between margins. You can provide different margins for left, right, top and bottom as per your requirements in the document.

(*iv*) **Tables.** Table is simply the arrangement of information in rows and tables. You can create tables in Windows-based word processors very easily.

(*v*) **Find and Replace Text.** In word processing, you can easily find a word of a phrase (group of words) in your documents. Once your word/ phrase is located, you can easily replace it with another word/phrase.

(*vi*) **Graphics.** Windows-based word processors (such as MS Word) provides enhanced graphic capabilities, called *clip gallery*. Using clip gallery, you can insert a picture/ diagrammed add multimedia effects such as sound and videos in your documents.

(*vii*) **Mail Merging.** One of the most useful features of a word processor is mail merging. It is efficient and faster way of preparing mass mailing to a list of addresses. It is a tool for producing repetitive documents. It gives the flexibility while sending better and then personalising each copy of it with different names and addresses.

Examples of Word Processors

There is a wide range of word processors available for both DOS and Windows environment. Word Star, Softword, Akshar, MS Word, Word Perfect and Amipro are some of the common examples of word processors.

Word Star, the most common and popular DOS-based word processor, is developed by the MicroPro International Corporation, Inc. U.S.A.. There are different versions of Word Star like 1.x, 2.x, 3.x, 4.0, 5.0, 6.0 and 7.0 but the releases 4.0 (also known as Word Star Professional) was most popular among users during few years back. But now-a-days, after popularity of Windows-based software, Word Star has become obsolete. Softword and Akshar are also DOS-based English and Hindi word processors respectively developed by an Indian Company, Softech.

Among the windows-based word processors, MS Word, Word Perfect and AmiPro are the leaders in the markets. MS Word, developed by Microsoft Inc. is a part of MS Office professional package. Word 97 and Word 2000 are the most popular versions of Word. The latest version of Word is MS Word 2002. Word Perfect (latest version 6.0), developed by Word Perfect Corporation, which provides almost same features as MS Word is also very popular among users. AmiPro (latest version 3.0)/ Word Pro, developed by Lotus Corporation, is another full-fledged, multi-featured word processor for windows. The important word processors are listed in table 6.1.

Table 6.1: Important word processors

Software	Feature
Word Star	Simplest DOS-based word processor, which is out-dated now.
MS Word	Popular Windows-based word processor from Microsoft.
Softword	Similar to Word Star, developed by an Indian company.
Akshar	Popular Hindi/English word processor developed by an Indian company.
Amipro	Full-fledged, multi-featured Windows-based word processor with DTP features.
Word Perfect	Windows-based word processor with DTP features.

Advantages of Word Processing

Word processing offers several advantages over typewriting. Using the word processing technique, the user can :

- Edit the text as and when required.

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- Move or copy any part of the text from one location/ file to another location/ file
- Insert or delete the spaces/ text
- Wrap words to the next line (*Word Wrapping*) and justify text to the right margin (*Justification*)
- Select different types of fonts and size of characters
- Adjust the margins and page lengths for the desired output
- Find the required word/ group of words and replace with another word/ group of words
- Check the spelling of any word of the document
- Store (save) the document on disk and print single or multiple copies
- Print letters with same text and different names and addresses (*mail-merging*)

Besides the above advantages, there are many more benefits of word processing depending upon the word processor used.

6.8. Database Management Packages

Business processes are always associated with a huge amount of data. To store, manipulate and process such data, some software packages are needed, which are collectively known as Database Management Packages/ Software/ Systems (DBMS). *Data Base Management System* is defined as a software that organises and maintains the data in a database for providing the information. Before discussing about these packages, let us discuss - what is meant by data, information, file and database.

Data , Information, File and Database

Data and information are the two basic components of any information system. Data is defined as a set of basic facts and entities, which itself has no meaning or value. For example, 5000, 4000, 4500, 4800, 8900.... is a data of employees salaries which itself has no meaning. On the other hand, information is defined as that data which has some meaning or value. For example, the personal data of employees names and their basic salaries represented as "Komal – 5000", "Rajesh – 4000", "Sarika – 4500", "Sapna – 4800", "Pawan – 8900", etc. is an information because it has some meaning.

File is a group of related records in a database. For example, a group of personal records of all the employees of a company is a file. However, database is a collection of related files that is created and managed by a database management system. We will discuss the basic concepts of database and database management system in Chapter 11 on Information, Database and Processing.

Examples of Database Management Packages

Many database management packages are available in the market. You must be aware of the benefits and limitations of these packages before purchasing and using them. dBASE, Foxbase, Foxpro, MS Access, Paradox,

Oracle, Ingres, Sybase, Informix, etc. are the major products of database management systems.

dBASE is the most popular and simplest to learn database management system which is developed by Ashton-Tale, U.S.A.. dBASE II was the first product developed for database applications and later on Ashton-Tale developed new versions viz. dBASE III plus, dBASE IV and dBASE V. dBASE III plus and dBASE IV are exclusively DOS based versions while dBASE V is Windows-based. FoxBASE+ is a dBASE III plus compatible DBMS, which is originally developed by Fox Software and later on by Microsoft. It is faster and multi-user as compared with dBASE III plus, which is slow and single-user. Although dBase and FoxBase were one time very popular among programmers, they have become obsolete now. Microsoft developed another dBASE IV compatible DBMS, called FoxPro which has now become very popular among users. FoxPro 1.0, 2.0, 2.5, 2.6 and Visual FoxPro 3.0/5.0 are the different versions of FoxPro. FoxPro offers several advantages over both dBASE and FoxBASE. The difference between dBASE, FoxBASE and FoxPro are given in table 6.2.

Table 6.2: Differences between dBASE, FoxBASE and FoxPro

Criteria	dBase	FoxBase	FoxPro
Operating Environment	DOS/Windows	DOS	DOS/Windows
Users	Single-user	Multi-user	Multi-user
Execution Speed	Slow	Medium	Fast
Disk Storage	Less	Average	More
Features	Less	Average	Many
Program Generators	Less	Less	Many
Compiler	Not available	Available	Available

MS Access, developed by Microsoft Inc., is also a part of MS Office professional package. It is a relational database management system (RDBMS), which is windows based and is quite similar to Visual FoxPro. Paradox, a part of Corel Office Pro software, is a network RDBMS and is known for its Querry By Example (QBE) method for asking questions. Oracle, Sybase, Ingres and Informix are the leaders among RDBMSs. Major DBMSs products are described in Table 6.3.

Table 6.3: Major DBMSs products

DBMS package	Description
dBase	Most popular DOS/Windows based database management system
Foxbase	Faster, multi-user dBase-compatible DBMS
FoxPro/ Visual FoxPro	DOS/Windows-based DBMS with advanced features
Access	Windows-based DBMS similar to Visual FoxPro

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Paradox	Networld RDBMS with QBE (Query By Example) features
Oracle	Most popular RDBMS for microcomputers
Sybase	Distributed RDBMS that runs on most servers
Ingres	Popular RDBMS that runs on many operating systems
Informix	Popular RDBMS server mainly for UNIX operating system.

6.9. Spreadsheet Packages

Business applications require a lot of calculation work. In a manual system, it is done on a sheet of paper with rows and columns, which is called a spreadsheet. Spreadsheet packages use the concept of an electronic spreadsheet. An electronic spreadsheet (or *worksheet*) is a very big sheet consisting of thousands of rows and columns, which is used to store information in the memory of a computer. Like databases, electronic spreadsheets have now become an essential tool in developing a computerised management information system. Income statements, annual reports, balance sheet, cost analysis and budgets are some of the applications where worksheets are typically used.

Examples of Spreadsheet Packages

There are many products of spreadsheet packages– some of them are exclusively Windows based like MS Excel and others both as DOS and Windows based like Lotus 1-2-3. Lotus 1-2-3, developed by Lotus Development Corporation, is the most popular spreadsheet package among DOS users. The different versions of Lotus 1-2-3 are release 1.x, 2.x & 3.x (DOS based) and 4 & 5 (both DOS & Windows based). Lotus 1-2-3 is also available as a part of Lotus Smartsuite office automation package in the market. MS Excel, a part of MS Office, is the most popular Windows based spreadsheet package. The popular versions of Excel are Excel 97 and Excel 2000, however the latest version is MS Excel 2002. Quattro Pro (latest version 5.0), developed by Borland International is another spreadsheet package that provides advanced graphics and presentation features. Javelin Plus (from Information Resources, Inc.), Multiplan (Microsoft Corp.), Supercalc (Computer Associates International, Inc.) and PlanPerfect (Word Perfect Corp.) are some other examples of spreadsheet packages. Major spreadsheet packages are described in Table 6.4.

Table 6.4: Major spreadsheet packages

Spreadsheet Package	Description
Lotus 1-2-3	Most popular DOS/Windows based spreadsheet package
Excel	Most popular Windows based spreadsheet package
Quattro Pro	Spreadsheet package with advanced presentation features

Javeline Plus	Spreadsheet package that uses names to identify calls
Multiplan	Spreadsheet package from Microsoft Corp.
Supercalc	Spreadsheet package from Computer Associates
PlanPerfect	Spreadsheet package from Word Perfect Corp.

Advantages of Electronic Spreadsheets

The electronic worksheet offers several advantages over manual and other computer application software. These are described as follows :

- The user can perform any type of calculations involving mathematical, financial, statistical and other functions.
- All recalculations are performed automatically, if any figure is changed.
- As worksheet is very big in size, so a large volume of data can be stored on a single worksheet. For example, it is possible to store entire data of accounts of a big organisation on a single worksheet.
- The user can view/ print the data in any desired format.
- Most of the word processing features like spell checking and find/ replace words can also be performed on a worksheet.
- The data of worksheet can be viewed in many types of graphs/ charts.
- The worksheet can be saved, retrieved, combined to another worksheet and transferred to files of different database and word processing packages.

Besides the above main features, there are many more benefits of spreadsheets depending upon the spreadsheet package used.

6.10. Office Automation Packages or office suits

Office work includes many administrative and management activities. The preparation, distribution, processing and review of documents are the common activities of an organisation. Prior to the advent of computers, these office activities were either performed manually or with the help of mechanical and electrical machines. During the past few decades, the basic nature of office has changed remarkably. Office automation deals in application of latest technologies in improving the overall proficiency of the office. We have discussed about various office automation technologies in Chapter 2 on Applications of Computers.

Word processors, Spreadsheets and Database Management packages are also available as integrated packages generally called Office Automation Packages or Office Suites.

Examples of Office Automation Packages

MS Office and Lotus SmartSuite are two most popular examples of office automation packages. Microsoft Office (MS Office) Professional is a package that contains five powerful general purpose application packages. It includes

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Word, Excel, PowerPoint, Access and Mail. We have already discussed about Word, Excel and Access. PowerPoint is used to create professional presentations in the form of slides. The user can write text, draw figures and organisation charts on these slides. PowerPoint is the most popular and commonly used desktop presentation program for Macintosh and PCs. PowerPoint 2000 and PowerPoint 2002 are the currently used versions of PowerPoint. MS Office 2000 and MS Office 2002 are two currently used versions Microsoft office.

Lotus SmartSuite is another popular office automation package that contains five powerful general purpose application packages. It includes Word Pro, 1-2-3, Freelance Graphics, Approach and Organizer. We have already discussed about Word Pro and 1-2-3 in the earlier part of the chapter. Lotus SmartSuite 7.0 and Lotus SmartSuite 97 are Windows and Web Enabled versions of SmartSuite respectively.

Corel Office, an office suite, contains Word Perfect, Quattro Pro, Paradox, Corel Draw, Netscape Navigator, Presentations, Corel Flow, Sidekick and other general purpose application packages. SideKick is the first popup program (TSR—'Terminate and Stay Resident' in memory) used for editing programs and non-document files.

6.11. Desk top Publishing Software

Every office needs some kind of printed materials or documents in the form of letters, office forms, stationery, catalogues, manuals or even books. These documents or printed materials are always required to be designed properly with required type-settings and graphics. When a document is printed or published, it should be put into a form that looks attractive and readable to other people. Desk Top Publishing (DTP) is the technique that is used mainly by publishers and printers to design the documents required to be printed/published using a desktop computer (i.e., PC).

Desk Top Publishing (DTP) software are used to produce a high-quality document for commercial printing. Using DTP software, text and graphics are combined into a single document that is printed generally on a laser printer. Although these software are mainly useful for publishers but they are also used in general offices and educational institutes for the best presentation of management documents, project reports and thesis works. DTP software are used in combinations with word processors, graphics and CAD (Computer Aided Design) software. First, the document is written by using a word processor and the graphics/diagrams are made by using graphics/ CAD software. Then, all documents and graphics are merged into the DTP files for advanced page formatting.

DTP software are widely used by publishers and other organisations. These software require a special kind of hardware system, which include a high speed PC, laser printer and scanner/digitizer.

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Examples of DTP Software

Many desktop publishing software are available in the market with a wide variety of features. PageMaker, Ventura and CorelDRAW are the most common examples of DTP software. PageMaker (latest version 7.0), originally developed from Aldus Corp. and now from Adobe, is the most favourite among Indian users. Although PageMaker was originally introduced for Macnitosh but currenly it is available for both Mac and PC (mainly for Windows). Ventura Publisher developed by Ventura Software, Inc. (a Xerox company), provides full-scale pagination features for very large documents. It is available both for Mac and PCs (under DOS, Windows & OS/2).

CorelDRAW (latest version 11.0), developed by Corel Systems Corp., is the popular windows-based DTP and Graphics Software for PCs. It is designed to work with high quality graphics images and provides advanced autotracing features for building a vector-based image. As it does not provide word processing/DTP page layout features, it is used in combination with word processors and other DTP software like PageMaker.

6.12. Graphics, Multimedia and Animation Software

For last few years, Graphics, Multimedia and Animation Software are becoming very popular for high quality presentation of business and other applications. CorelDRAW, Adobe Photoshop, AutoCAD Map and Harvard Graphics are some of the commonly used graphic software. We have already discussed about CorelDRAW in the earlier part of the chapter. Adobe Photoshop is an image editing software with multiple layers, interactive GUI and powerful object-based editing tools. AutoCAD Map is a software for mapping and graphic applications. Harward Graphics, developed by Software Publishing Corp., is a business presentation software. It allows the user to create professional looking presentations in just few minutes.

Multimedia, a latest computer technology, displays information using a combination of full-motion video, text, graphics, animations and sound. A wide range of multimedia and animation software are available in the market. Macromedia Director, 3D Studio Max, AnimatorPro and Animator Studio are some of the commonly used multimedia/ animation software. Macromedia Director is a multimedia authoring software for creating tutorials and CBT (Computer Based Training) software. 3D Studio Max software allows the user to create 3D modelling and animations on a PC. AnimatorPro is an 8-bit, 256 colour, 2D Paint and animation software with in-built C based programming, 3D Studio and customised GUI. Animator Studio is a digital sound studio designer for animation with true colour features.

Multimedia refers to presentation of information in the form of images, sound and movement using a high speed PC (usually Pentium). Images represent the strongest component of multimedia. You cannot imagine multimedia without graphics, artworks and photographs. Sound, an another major component of multimedia, includes sound effects, music and

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narration. Movement is the essential part of video images. Images, sound and movements are created on a PC, generally called *Multimedia Computer*.

Macromedia Director (version 6 for Windows) is the most popular software for creating multimedia applications on your PC. You can call this software simply as *Director*. Using Director, you can integrate graphics, music, narration, sound effects and digital video into your multimedia application (such as an interactive movie). Animation is the major feature of Macromedia Director. Technically, *animation* is defined as the visual information changing in 1/30 of a second. Director's windows and commands will help you to design and handle full-featured animation.

Computer Aided Design

Computer Aided Design (CAD) is a technique to design products using computers. CAD softwares offer a simple and comfortable method to create general or specialised designs such as architectural, electrical and mechanical designs. CAD software are mainly used by draftspersons, engineers and architects.

A CAD software offers many advantages over hand-writing methods. Some of them are summarised below:

- Using CAD software, you can create drawings much faster than manual methods
- Modifications in the computerised drawings can be done very easily as compared to manual drawings
- You can change the plans of drawings that are drafted using computers much easily than a manual method
- A CAD software offers many features of easy duplication, editing and accuracy, which are not possible in manual methods
- Printed Circuit Boards (PCBs) and Integrated Circuits (ICs) are designed by using CAD software, which is not possible by using manual methods.

AutoCAD is the most popular CAD software for PCs. It is used as an engineering workstation for PCs. It can be run both on single-user (such as MS DOS) and multi-user (such as UNIX, XENIX, OS/2, etc.) operating systems. You can use AutoCAD for both 2-D and 3-D drawings. AutoCAD is widely used in applications involving architectural design and mechanical drafting. AutoCAD is a general purpose drafting software, which helps you to create your own:

- Screens and pulldown menus
- Icons, drafting tablet, pointer buttons and dialogue boxes
- Text fonts, hatch patterns (individual line entities), dot-dash linetypes
- Symbols and ports library
- Post-script fill patterns
- Prototype drawings with custom default settings.

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6.13. Business Application Software

Every business consists of many functions which are organised into different departments like Finance, Marketing, Inventory, Production, Research and Development (R & D) and Human Resources Development (HRD). For computerising these departments, special kind of application software are needed, which are collectively called as Business Application Software. These software are available either general requirements of the users (Standard Software) or can be developed as per the requirement of a specific organisation/user (Customised Software).

Accord, EX and and Tally are some of the examples of popular standard financial accounting software packages among Indian users. Accord developed by EDP Corporation, is the comprehensive accounting software for preparing MIS and other reports. EX developed by Tata Consultancy Services, provides business accounting capabilities along with inventory and invoicing features. Tally (latest version 5.0), developed by Peuronics Pvt. Ltd., is the accounting and book keeping software along with capabilities of invoicing/ inventory accounting.

6.14. Key Point Summary

- Software are programs, which are required to use the computer.
- Software are of two types—System and Application.
- System software are necessary to use the computer while application software are optional.
- System software are of three types—(*a*) System Management Software, (*b*) System Development Software and System Software Utilities.
- Application software are of two types—General Purpose and Special Purpose.
- An operating system makes the computer ready to use by the process of booting.
- Operating systems are of two types—Single-user and Multi-user.
- There are many types of computer languages, which are used to give instructions to computer.
- Language translators convert the codes of other computer languages into machine code.
- Language translators are of three types—(*a*) Interpreters, (*b*) Compilers, and (*c*) Assemblers.
- Software tools assist the programmers/analyst in design, coding, editing, compiling, linking and debugging programs.
- Application generators and CASE tools are the important categories of software tools.
- Some important types of system software utilities that support the operation of the computer are Text Editing Data Compression, Virus Detection and Removal, File Management, Diagnostic, Performance Monitoring and Spooling Utilities.

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- Word processing software are used for typing editing, storing, formatting, manipulating and printing documents with the assistance of computer and printer.
- Word Star, MS Word, Softward, Akshar, Amipro and Word Perfect are important word processors.
- Database Management (DBMS) Packages are used to organise and maintains the data to provide the information.
- dBASE, FoxBASE, FoxPro, Access, Paradox, Oracle, Sybase, Ingres and Informix are major DBMS packages.
- Spreadsheet packages are used for those business applications that require a lot of calculation work.
- Lotus 1-2-3, Excel, Quattro Pro, Javeline Plus, Multiplan, SuperCalc and PlanPerfect are major spreadsheet packages.
- Word processors, Spreadsheets, and DBMS packages are also available as integrated packages called Office Automation Packages.
- MS Office, Lotus SmartSuite and Corel Office are the popular Office Automation Packages.
- DTP Software such as PageMaker, Corel DRAW, etc. are used to produce a high-quality document for commercial printing.
- Graphics, Multimedia and Animation Software are used for high quality presentation.
- CAD software are used to create designs by drafts persons, engineers and architects.
- Accord, EX and Tally are popular business application software.

6.15. Review Questions

1. Differentiate between system and application software with examples.
2. What is an operating system ? Discuss briefly various types of operating system.
3. What is booting ? Explain it with suitable illustration.
4. Classify the following operating systems into single-user (S) or multi-user (M) :

(*i*) MS DOS	(*ii*) OS/2
(*iii*) UNIX	(*iv*) Windows NT
(*v*) OS/400	(*vi*) PC DOS
(*vii*) Linux	(*viii*) MVS

5. What is the difference between an interpreter and a compiler ? Give 2 examples of each.
6. What is an assembler ? Give two examples.
7. What are software tools ? Describe the major categories of software tools with examples.
8. What are application generators ? Describe their advantages and disadvantages.

9. What are CASE tools ? Describe their importance in development of a software.
10. What are system software utilities ? Discuss the role of commonly used utilities with suitable examples.
11. Discuss the importance of word processors in generating documents. Give some examples of DOS-based and Windows-based word processing packages.
12. Discuss the major features of commonly used DBMs packages.
13. What is an electronic spreadsheet ? Describe its major advantages. Name some commonly used spreadsheet packages.
14. What are office suites ? Why are they so popular among computer users ? Discuss with examples.
15. What is DTP ? Describe the importance of various DTP software currently available in the market.
16. What is multimedia ? Name any 4 multimedia software which are popular among users.
17. Discuss the various advantages of a CAD software over hand-writing methods.
18. Discuss the role of various business application software in computerising the different departments of an organisation.

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Unit–7

Notes

Operating Systems

Structure

7.1. Introduction
7.2. History and Evolution of Operating Systems
7.3. Functions of an Operating System
7.4. Operating System Techniques
7.5. Overview of DOS
7.6. Overview of UNIX
7.7. Overview of Windows
7.8. Key Point Summary
7.9. Review Questions

7.1. Introduction

In the previous chapter, we introduced the most essential system software— Operating System. An operating system manages the operation of a computer. Without an operating system, it is not possible to use the computer. We discussed the process of booting by the operating system, which makes the computer ready to use. We also discussed that there are two categories of operating systems— Single-user and Multi-user.

In this chapter we will discuss the features of commonly used both single and multi-user operating systems in detail. We will also discuss the techniques used in multi-user operating systems and general functions of an operating system. Before discussing all these topics, let us start our discussion with history and evolution of operating systems.

7.2. History and Evolution of Operating Systems

The evolution of operating systems has been driven by technological advances and by the demands and expectations of the users. In the earliest computers, switches and lights were the 'input' and 'output' devices. Each word (2 bytes) of the program was to go through a lengthy procedure before it was finally entered into the memory location as the whole process was carried out by using a number of sets of switches. This process was repeated for every word of the program. The program was used to get started by setting the program counter to the first word of instruction and then pressing a 'Start' button. This process of programming was very time consuming and

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it also involved a high risk of error involvement. But the computer users still used to feel satisfied with the results they got. To simplify this process, the basic need was to solve the problem of program loading. The basic idea was to make computer self-efficient in a respect that it automatically read a primitive loader program written on it on start up. This resulted in execution of more extensive loader programs with the help of the basic loader. Thus, this system could then load any user program. This arrangement got the name 'bootstrapping.' This technique is used these days also. The new name given to bootstrapping is 'booting'. Let us discuss the evolution of modern operating systems step by step.

1. **Introduction of Program Loaders.** The introduction of program loaders was the very first step to modern operating systems. Another advancement that took place was to improve the output. To display the textual results, output was improved by using a simple character terminal. Finding such terminals was no problem as they were mostly used in the field of communication at that time. These terminals later took the place of input devices using keyboards for low speed input. The keyboard could also be used as a control console helping the operator to communicate with the system. Thereafter, the keyboard was used as the main user interface device for future operating systems.
2. **Uses of Punched Card as an Input Medium.** The punched card was in use long before the arrival of computers or operating systems. The punched cards were used as an input medium in electro-mechanical calculating equipment. The punched cards also offered off time storage as they were also used as output media. The combined card-punch peripheral units could be commonly found out. They could read stacks of cards and produced a considerable amount of noise. These cards were very effectively used to keep track of stock kept in a warehouse for each item.

   Due to the improvement of the hardware, the execution time of programs also came down. But this resulted in slowing down of input output devices compared to processor's speed because the processor spent most of its time waiting for a card to be read or punched. Moreover, the setup time i.e., the time spent between jobs in order to load the next program and data became disproportionate to the run time of the job.
3. **Introduction of Input Output Control System.** The early programmers felt that a good part of each new program was the same as the previous one. This gave them the idea of writing a standard set of subroutines. It could be loaded into the memory at the time of start-up and kept there for use by the other jobs. This gave rise to the idea of Input Output Control System (IOCS).

   Later, magnetic recording was done to digital signals to give magnetic tape drives. They were used as data storage medium instead of using a card punch machine. Magnetic tapes were

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also used as an input medium. Ultimately, magnetic drums and disks arrived which lead to fast direct access to stored data. These developments complicated the IOCS routines.

4. **Shift from Machine Language to High-level Languages.** As you already know, binary machine code was used to write earlier programs. This method of writing programs was considered to be a very complicated and time-consuming affair. Thus, the programmers started using the assembly language. Writing larger and more complex programs became practically feasible for them. The assembly language was then followed by high-level languages like FORTRAN and ALGOL. This was again a step ahead development.
5. **Support of New Features.** In the year 1960, a new computer called Atlas was developed. This computer was first of its kind that incorporated the design of an operating system. Atlas supported many new features such as interrupts and a virtual memory system. This new idea of virtual memory took some time to make a broad impact. However, the idea of interrupts made quick impact. The reason behind was that it could easily handle many programs and peripheral devices simultaneously. It helped the operating system to look after several programs and I/O activities simultaneously. Around the year 1964, IBM produced the system 370 and then the 303X machines, which are used even today. These range of computers provided a wide range of computing facilities. Thereafter, much advancement was brought out in these machines.
6. **Use of term 'Operating System'.** The simple program loader concept helped in reducing the set up time between jobs. It allowed a series of jobs to be loaded automatically from an input device. This was an early form of operating system and was known by several names such as 'supervisor', 'executive' or 'monitor'. The term 'Operating System' was used later on. These systems performed the work of an operating system and hence, they have been granted this title. The term batch processing was given where the jobs were given to the computer in batches. Special control cards communicated with the operating system. They used to delimit the various jobs given to the computer and also specified what each job was supposed to do. These cards worked as an interface between the user and the operating system. As the complexity and sophistication with the computers grew, the complexity of these cards also grew. This resulted in the development of *Job Control Language (JCL).*
7. **Development of Multiprogramming System.** As the improvements were brought out in the hardware, it could cope with larger quantities of work. Now, the computer could run several programs at the same time. This is called *multiprogramming*. The concept of multiprogramming is being discussed in greater detail in the subsequent part of the chapter.

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7.3. Functions of an Operating System

An operating system concerns itself with every single and minute detail of your computer working. It manages everything that runs on your computer straight from running an application software, entering data, displaying information on monitor, printing a report, storing data on external storage device (disk), etc. Whatever you are working on your computer, an operating system is always in computer memory. It does many jobs on your behalf without showing you each and every step of processing. For example, if you give a command to open a document file in a word processor, the document is immediately displayed on the screen. But, how this file is opened from the disk (storage device) and how information is displayed on the monitor (output device), all these types of functions are performed by the operating system. In order to enable computer to effectively and efficiently utilise its resources to monitor the systems performance and to provide services to the users, an operating system is needed. So, an operating system performs basically the following three types of functions:

1. **Essential Functions.** The essential functions of an operating system are concerned with effective utilisation of computer resources. Storage management and processor management are two important essential functions of an operating system. Storage management is concerned with allocation and reclamation of storage when a program is initiated and terminated. *Processor management* is concerned with scheduling of programs in a time sharing system.
2. **Monitoring Functions.** These functions are concerned with collection of resource utilisation and system performance information. CPU and I/O devices form the resources whose utilisations are collected and monitored by device management functions of operating system.
3. **Service Functions.** These functions of operating system enhance facilities provided to the users. They mainly include automatic procedures for recovery due to hardware errors, file editing facilities and file organisation and access methods.

The role of an operating system can also be categorised under the following three headings:

1. A Resource Manager
2. A Processor Manager
3. An Information Manager

Let us discuss these functions in detail.

Operating System as Resource Manager

As we have already discussed, a computer cannot function without an operating system. All operating systems perform certain basic functions. The operating system manages programs, memory, input and output devices,

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interprets commands, etc. The operating system acts as a resource manager and performs the following functions:

(*a*) The single tasking operating systems are able to run only one application program at one time. Any user who is required to work with many applications at one time faces a great difficulty. Thus in order to switch programs in a single tasking operating system, the user has to quit one program and start working on the second program. The multitasking operating system offers a major advantage over the single tasking operating systems. With the help of a multitasking operating system, a user has the option of working with two or more programs at one time. In such a case, the CPU switches between different application programs as and when required.

(*b*) An operating system manages the computer's memory. It allocates the main memory and other storage areas to the system and user programs. The operating system's memory manager provides sufficient memory space so that several processes can be executed at the same time. It provides a satisfactory level of performance (i.e., process execution speed) for the system users. The operating system helps in the sharing of memory space among different processes.

(*c*) The operating system makes sure that each process running in a system does not interfere with the code or data of any other process either accidentally or deliberately. The operating system also takes care of data security and integrity. It prevents a process from deliberately invading the privacy of another process.

(*d*) An operating system has the ability to interpret commands and the instructions given to it.

(*e*) An operating system makes the men-machine interaction easier and more effective.

(*f*) Whenever an error is encountered by the computer, an error message is flashed on the screen by the operating system.

(*g*) It has the ability to manage and manipulate files present on various storage devices. It can transfer these files from one storage device to another.

(*h*) The text editors of an operating system allow us to modify files easily.

Operating System as Processor Manager

The processor management component of operating system organises the execution of user jobs on CPU of the computer. An operating system processes a user job at following three levels:

(*i*) **Job Scheduling.** Job Scheduling determines the time of processing of various jobs. The operating system uses special languages such

as Job Control Language (JCL) for executing these jobs sequentially i.e., one after the other. The typical scheduling criteria are:

- Job scheduling on the basis of First-Come-First-Served (FCFS) service
- Job scheduling on the basis of Shortest-Job-Next (SJN) criterion
- Job scheduling according to user specified priority
- Job scheduling according to the user specified deadline for finishing a job.

Types of Job Scheduling. There are following two types of job scheduling in processor management.

(1) Non-preemptive Scheduling. In this type of scheduling, a scheduled job always completes before another scheduling decision is made. FCFS and SJN scheduling are non-preemptive scheduling.

(2) Preemptive Scheduling. In this type of scheduling, a scheduling decision is made even while the job is under execution.

(*ii*) **Program Initiation.** Program initiation determines the time and method to initiate processing of next job step.

(*iii*) **Process Scheduling.** Process scheduling organises the execution of all processes of each job step. The typical process scheduling criteria are:

- Selecting the process to be scheduled next and allocating the processes to the selected process
- Deleting an existing process and creating a new one
- Monitor the state of each process
- Deallocating the processor from a process
- Supporting a method for communicating between processes.

Operating System as Information Manager

An operating system ensures the efficiency of input/output operations by the information management. The information management component of operating system provides procedures for storing and accessing the information from external storage devices.

Sub-components of Information Management Component. The information management component of operating system comprises the following three sub-components.

(*a*) **Physical Input/Output Control Systems (IOCS).** The physical IOCS provides the following functions :

(*i*) Capability of programs to perform their own Input/Output operations

(*ii*) Handling of device error conditions

(*iii*) Ensuring of Input/Output efficiency

(*iv*) Providing basic device independence.

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(*b*) **Logical Input/Output Control System (IOCS).** The logical IOCS provides the following functions:

(*i*) Efficient organisation and access of data on storage devices

(*ii*) Basic capabilities for file definition

(*iii*) Selection of data organisation for a file.

(*c*) File System. File system provides the following functions:

(*i*) Protection of existing files

(*ii*) Controlled sharing of existing files

(*iii*) Viewing files as objects for manipulation, modification and access.

7.4. Operating System Techniques

There are several techniques used in multi-user operating systems for enabling many users to concurrently share the single or multiple CPU (e.g., multiprogramming and multiprocessing). Some techniques are used in single user operating system to handle multiple tasks (multitasking). We will now discuss these common techniques used in different operating systems.

Multiprogramming

Multiprogramming is a process by which single CPU works on two or more programs simultaneously. Using this technique, the operating system keeps the CPU busy. Multiprogramming allows the processor to handle either multiple batch jobs at a time (*Batch Multiprogramming*) or multiple interactive jobs shared among multiple users (*Time Sharing Multiprogramming*). Time-sharing is a technique that allows a CPU to simultaneously support the activities of several users by allocating fixed time slots (in milliseconds). Examples of operating systems that support multiprogramming are OS/2, UNIX and Macintosh System 7.

Multiprocessing

Multiprocessing refers to the use of two or more CPUs to perform a coordinated task simultaneously. For example, MVS, VMS and Windows NT support multiprocessing.

Multitasking

Multitasking refers to the ability of an operating system to execute two or more tasks concurrently. In a multitasking environment, the user opens new applications without closing the previous ones and the information can be easily moved among a number of applications. For example, Windows NT and OS/2 operating systems use this technique.

Types of Operating Systems

The variations and differences in the nature of different operating systems may give the impression that all operating systems are absolutely different

from each other. But this is not true. All operating systems contain the same components whose functionalities are almost the same. For instance, all the operating systems perform the functions of storage management, process management, protection of users from one another, etc. The procedures and methods that are used to perform these functions might be different but the fundamental concepts behind these techniques are just the same. The operating systems are categorised according to number of terminals, nature of work performed by them and use on a particular platform. Now let us quickly look at the different types of operating systems.

Single-User and Multi-User Operating Systems

Many types of operating systems are available for computers, which are discussed below:

(*i*) **Single-user Operating Systems.** These operating systems are mainly used for computers having only one terminal (stand-alone PCs). MS DOS (Microsoft Disk Operating System) and PC DOS (Personal Computer Disk Operating System) are the two important single-user operating systems. Both systems are almost identical and are simply called DOS.

(*a*) *MS DOS.* MS DOS, developed by 'Microsoft Inc.' in 1981, is the most widely used operating system of IBM-compatible microcomputers. The latest version of MS DOS is 7.

(*b*) *PC DOS.* PC DOS is essentially the same operating system as MS DOS, but developed and supplied by IBM for its personal computers.

(*ii*) *Multi-user Operating Systems.* These operating systems are used for those computers (micro to mainframe) which have many terminals (multi-user systems). The popular operating systems used for multi-user systems are OS/2, Windows NT, UNIX, NetWare, MVS, OS/400, VMS and Linux.

(*a*) OS/2. OS/2 is a single-user, multi-tasking operating system, developed jointly by IBM and Microsoft. This provides a unique feature of multitasking, where several programs can be run simultaneously. OS/2 was the first operating system that provided users with a Graphical User Interface (GUI).

(*b*) Windows NT. Windows NT (New Technology) is the single user 32-bit multi-tasking operating system for 386s and above, developed by Microsoft Inc. Windows NT was driven by a need to exploit the tremendous power of 32-bit microprocessors and runs applications, which are developed for DOS and Windows.

(*c*) UNIX. UNIX was initially developed by AT&T at Bell Laboratories in 1969. UNIX is a highly successful operating system for multi-user systems. Actually, it is more popular among scientific and engineering users rather than business users. In 1980, Microsoft developed its own

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version of UNIX for 286s and higher PCs which is called XENIX. UNIX System V Release 4 is the latest version of UNIX.

(*d*) NetWare. NetWare is a group of network operating system developed by Novell, Inc., that provides multi-user capabilities.

(*e*) MVS (Multiple Virtual Storage). MVS is one of the most complex multi-user operating systems ever developed for IBM mainframes. In MVS, each job (time-sharing user or batch program) is assigned its own virtual storage space.

(*f*) OS/400. OS/400 is the IBM's operating system for its AS/400 computer.

(*g*) VMS (Virtual Memory Storage). VMS operating system is used on DEC's VAX series of minicomputers.

(*h*) Linux. Linux is a 32-bit UNIX like operating system that has been developed recently for microcomputers. It is the world's first free operating system developed and maintained by thousands of people worldwide. Debian is a free operating system (OS) that uses the Linux kernel (the core of an operating system). As most of the basic OS tools of Debian come from the GNU project; hence it is also called GNU/Linux. Debian GNU/Linux provides more features than a pure OS. It comes with more than 3950 packages, which are bundled up in a nice format for easy installation on the computer.

The applications of different single and multi-user operating systems are summarised in table 7.1.

Table 7.1: The applications of different single and multi-user operating systems

Operating System	Type	Applications
MS DOS	Single-user	Mostly used for running/developing stand-alone applications/ programs on microcomputers.
PC DOS	Single-user	Mostly used for running/ developing stand-alone applications/ programs on microcomputers.
OS/2	Multi-user	Used for GUI applications and running several applications simultaneously on microcomputer.
Windows NT	Multi-user	Used for GUI applications and running several applications simultaneously on microcomputer.
UNIX	Multi-user	Most widely used for multi-user applications on all computers.
NetWare	Multi-user	Most widely used for LAN (Local Area Network) applications on Microcomputer.
MVS	Multi-user	Used widely for large applications needing virtual storage space.

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OS/400	Multi-user	Used for large multi-user applications on AS/400 computer.
VMS	Multi-user	Used for large multi-user applications on VAX computer.

Batch Processing, Multiprogramming, Time-sharing and Real-time Operating Systems

Many types of operating systems are available for computers, which are categorised according to the work performed by them. Let us briefly discuss these types of operating systems :

(i) **Batch Processing Operating System.** The main function of a batch processing system is to automatically keep executing one job to the next job in the batch. The main idea behind a batch processing system is to reduce the interference of the operator during the processing or execution of jobs by the computer. All functions of a batch processing system are carried out by the batch monitor. The batch monitor permanently resides in the low end of the main store. The current jobs out of the whole batch are executed in the remaining storage area. In other words, a batch monitor is responsible for controlling all the environment of the system operation. The batch monitor accepts batch initiation commands from the operator, processes a job, performs the job of job termination and batch termination. In a batch processing system, we generally make use of the term turn around time. It is defined as the time from which a user job is given to the time when its output is given back to the user. This time includes the batch formation time, time taken to execute a batch, time taken to print results and the time required to physically sort the printed outputs that belong to different jobs. As the printing and sorting of the results is done for all the jobs of batch together, the turn around time for a job becomes the function of the execution time requirement of all jobs in the batch. You can reduce the turn around time for different jobs by recording the jobs or faster input output media like magnetic tape or disk surfaces. It takes very less time to read a record from these media. For instance, it takes round about five milliseconds for a magnetic tape and about one millisecond for a fast fixed head disk in comparison to a card reader or printer that takes around 50–100 milliseconds. Thus, if you use a disk or tape, it reduces the amount of time the central processor has to wait for an input output operation to finish before resuming processing. This would reduce the time taken to process a job which indirectly would bring down the turn around times for all the jobs in the batch.

Another term that is commonly used in a batch processing system is Job Scheduling. Job Scheduling is the process of sequencing jobs so that they can be executed on the processor. It recognises

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different jobs on the basis of First Come First Served (FCFS) basis. It is because of the sequential nature of the batch. The batch monitor always starts the next job in the batch. However, in exceptional cases, you could also arrange the different jobs in the batch depending upon the priority of each batch. Sequencing of jobs according to some criteria require scheduling the jobs at the time of creating or executing a batch. On the basis of relative importance of jobs, certain 'priorities' could be set for each batch of jobs. Several batches could be formed on the same criteria of priorities. So, the batch having the highest priority could be made to run earlier than other batches. This would give a better turn around service to the selected jobs.

Batch processing systems use the concept of storage management. At any point of time, the main store of the computer is shared by the batch monitor program and the current user job of a batch. The big question that comes in our mind is how much storage has to be kept for the monitor program and how much has to be provided for the user jobs of a batch. However, if too much main storage is provided to the monitor, then the user programs will not get enough storage. Therefore, an overlay structure has to be devised so that the unwanted sections of monitor code do not occupy storage simultaneously.

Batch processing systems also use the concept of sharing and protection. The efficiency of utilisation of a computer system is recognised by its ability of sharing the system's hardware and software resources amongst its users. Whenever, the idea of sharing the system resources comes in your mind certain doubts also arise about the fairness and security of the system. Every user wants that all his reasonable requests should be taken care of and no intentional and unintentional acts of other users should fiddle with his data. A batch processing system guarantees the fulfillment of these user requirements. All the user jobs are performed one after the other. There is no simultaneous execution of more than one job at a time. So, all the system resources like storage, I/O (Input/ Output) devices, central processing unit, etc. are shared sequentially or serially. This is how sharing of resources is enforced on a batch processing system. Now, arises the question of protection. Though all the jobs are processed simultaneously, this too can lead to loss of security or protection. Let us suppose that there are two users A and B. User A creates a file of his own. User B deletes the file created by User A. There are so many other similar instances that can occur in our day-to-day life. So, the files and other data of all the users should be protected against unauthorised usage. In order to avoid such loss of protection, each user is bound around certain rules and regulations. This takes the form of a set of control statements which every user is required to follow.

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(*ii*) **Multiprogramming Operating System.** The objective of a multi programming operating system is to increase the efficiency of system utilisation. The batch processing system tries to reduce the CPU idle time through operator interaction. However, it cannot reduce the idle time due to I/O operations. So, when some I/O is being performed by the currently executing job of a batch, the CPU sits idle without any work to do. Thus, the multiprogramming operating system tries to eliminate such idle times by providing multiple computational tasks for the CPU to perform. This is achieved by keeping multiple jobs in the main store. So, when the job that is being currently executed on the CPU needs some I/O, the CPU passes its requirement over to the I/O processor. Till the time the I/O operation is being carried out, the CPU is free to carry out some other job. The presence of independent jobs guarantees that the CPU and I/O activities are totally independent of each other. However, if it was not so, then some times, it could lead to some erroneous situations leading to dependent errors.

A multiprogramming supervisor has a very difficult job of managing all the activities that take place simultaneously in the system. It has to monitor many different activities and react to a large number of different situations in the course of working. The multiprogramming supervisor has to look through the following control functions:

(*a*) *Processor Management.* The supervisor has to decide as to which program should be made to run at the central processor at any given point of time. An important measure to determine the system performance in multiprogramming is throughput. Throughput can be defined as follows :

$$\text{Throughput} = \frac{\text{The number of jobs completed}}{\text{The total time required to complete the job}}$$

Hence, when two heavily computational jobs are being multiprogrammed, the throughput becomes low because of the idling of I/O channels. So, when the degree of multiprogramming is two, then one job be made as computationally oriented and the other one could be made as I/O oriented. The computational job is also known as a CPU bound job. It keeps the processor busy. However, the I/O bound job keeps the I/O channels busy. Both the jobs work independently from each other. Therefore, the throughput becomes high. When one or more jobs are ready to use the processor, then the supervisor allots the processor to the highest priority job amongst them.

(*b*) *Storage Management.* The supervisor is vested with the important decision of finding out how different storage areas are to be allocated to different jobs present in the system. The storage management function of the supervisor concerns with the allocating of storage to a program when its processing has been started. The supervisor

should avoid the situation of storage idling. The storage can be idle in a situation where the total storage requirement of all jobs in the system is less than the storage capacity of the system. Hence, it becomes the duty of the supervisor to start a new job in the unused area of storage. There is one more possibility to storage idling. It arises in a case when there is enough free storage available and the supervisor also does not have any restrictions on starting a new job but is unable to do so because the free storage is not in a state that can start a program. For instance, small areas of full storage may arise between programs that exist on the system. This situation is known as storage fragmentation.

(*c*) *I/O Management.* The supervisor again has to decide as to how and when to start the I/O operations at various I/O devices in the system. An operating system can carry out a variety of I/O facilities. The supervisor has to manage I/O operation because a user program has to be protected from interference by other programs. Any program that wants some I/O operation to be done has to first pass on its I/O requirement to the supervisor through a trap. This trap is known as the supervisor call trap. The supervisor needs to look into the I/O requirements sent by any program because certain I/O devices such as disks are sharable among different programs. Thus, the supervisor creates a queue to send all these requests one by one and process them. This can depend on program priority or in an order that optimises the performance of the device. These strategies are called the I/O strategy and device strategy, respectively.

Sometimes, errors in different devices also occur which are again managed by the supervisor. In order to rectify the error, a transient routine is loaded. It tries to recover from the error by retrying an I/O operation. When it has recovered from the error, then it hands over the control to the resident supervisor, which performs the standard I/O completion actions and then returns to the user program. The supervisor initiates automatic error recovery, therefore, the program in which the problem has occurred will not be aware of I/O failure.

(*iii*) Time-sharing Operating Systems. The time sharing systems were developed with a main aim to provide fast response to the requests made by the user. The computing environment which best illustrates the advantages of time-sharing systems over multiprogramming or batch processing systems is one in which a number of interactive terminals are simultaneously used for program development and computational purposes. The response given by the system is shown visually on the screen. The user expects a very fast response from the system if the request made by him requires very less processing by the CPU. For instance, on giving a program statement by the user, the compiler should display the error message quickly. If this interaction takes little time, then

the compilation of the user program will proceed rapidly. Both the interactive as well as non-interactive programs can participate in time-sharing. The time sharing systems provide a good rate of program activity for all programs in the system. In order to provide good program activities, certain basic changes are required in the structure of the operation system. These changes mainly involve the processor management and storage management components of the operating system. Let us discuss them in detail.

(*a*) *Processor Management.* A time-sharing system provides a good program activity for all programs. In order to provide good service to all the programs, all of them should achieve the highest processing priority. This means that the required CPU attention should be given to each program. Thus, the highest priority would shift from one program to another. It can be achieved practically by using the round-robin scheduling policy. The round-robin scheduling policy is shown in figure 7.1.

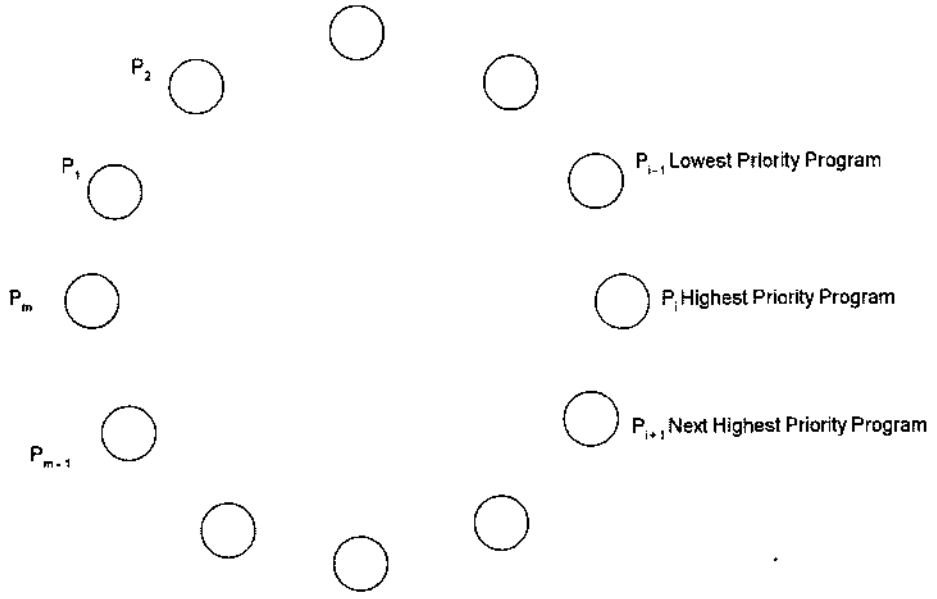

Fig. 7.1: The round-robin scheduling policy

Under this policy, all 'm' programs in the system form a circular queue. The processor scheduler scans through this queue again and again. It tries to look for the program which is in the 'ready to execute' state. When such a program is found out, then it is scheduled to be executed on the processor. Once the current processing requirements of this program (here Pi) are met with, the scheduler tries to find out the status of the other programs P_{i+1}, P_{i+2} ...P_m, P_2...P_i in a round fashion. The processor then schedules the first 'ready to execute' program it finds. Now Pi will become the lowest priority program and P_{i+1} becomes the highest priority program. This gives the program P_{i+1} an

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opportunity to receive full CPU attention. This is how all programs receive equal CPU attention. If a program is not in a ready to execute state when it is assigned the highest priority, then it will have to wait till its turn comes again.

The advantages of round-robin scheduling are huge over fixed priority scheduling but still it cannot provide good service to all the programs of the system. For instance, think of a situation in which a program P_j were to be a CPU bound program. So, as and when P_j becomes the program of highest priority, the processor would start executing it. Thus, it will not spare CPU for a considerable amount of time. Thus, the service to all programs will be denied till the time the program P_j finishes its task with the CPU. Therefore, the concept of time slicing comes up. It tries to safeguard the system when one or more programs try to eat up a considerable amount of CPU time. The time slice 'd' is the largest amount of CPU time that a program can take up in one turn. Thus, a program can make use of the CPU time till the time it comes across an I/O operation or till the time slice 'd' has finished up, whichever is earlier. Under the time slicing concept, the program cannot monopolise CPU indefinitely.

The concept of time slicing can be carried out through the use of a hardware interval timer. So, when a program is allocated the CPU time, the supervisor has to load the time slice into the interval timer. However, if the program frees the CPU before its time slice expires, then some other program is scheduled by the supervisor and the time slice is loaded once again in the interval timer. At times, the program is not able to release the CPU in the scheduled time, then the interval timer gives rise to a timer interrupt. The supervisor again gets control of the program in order to process the interrupt. He suspends the program that was being executed by the CPU. He performs CPU scheduling once again and executes some other program on the CPU. However, if no other program is ready, then the suspended program is selected and made to run again.

Now, how much time slice should be chosen is a very critical design decision. In order to get a good response, time slice should be as small as possible. However, if 'd' is made very very small, then it can increase the system overheads to a greater extent. Any program that consumes n seconds of CPU should be scheduled to a minimum of (n/d) times. The supervisor also takes away some time of the CPU for scheduling.

(*b*) *Storage Management.* In any time sharing system, the problem of program fragmentation exists because more than one program remains in the main store. The value of the number of programs being executed in the time-shared system is found

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out irrespective of the program or storage size. It is generally determined by system specification. The time-sharing system should be able to support 32 interactive terminals. All the programs that are being carried out should reside in the main storage. This would help the CPU to change from one program to the other easily. Sometimes all the programs do not reside simultaneously in the memory. In such a situation, the programs reside on secondary storage and are loaded into the computer's main memory before execution. After a program is processed, it is copied onto the secondary storage and new program is put in the main storage. This process is called program swapping.

(*iv*) *Real-time Operating Systems*. Since the earliest days of computing, the range and complexity of applications into which computers were drawn has risen to a greater extent. A specific class among these is the real time systems. A real time system is said to be one that responds back fastly so that it is able to make an impact on the environment in which it is working. A real time system is actually very fragile because any system interacts with its working environment. The real time system is mostly applied in those systems where the response or the feedback is immediately required such as process control systems in factories or missile tracking system for defence. Another important area of real time system application is in the airline seat reservation system in whose case the availability of a seat is checked, reserved and booked while the operator is interacting with the customer.

Thus, the interaction between the computer and the application environment has to be very quick in case of a real time system. Therefore, the operating system has to be designed in such a manner so that it is able to meet the need of quick response. However, the response requirements of an application are found out by the nature and type of the application. Since the response time requirements of a real time system are critical, a general time-sharing system may not be able to satisfy them. When a real time application is to be supported by a computer system along with general time-sharing series, then the real time application is given the higher processing priority. This helps in giving out a quick response for the application. A practical operating system which supports any real time application has been shown in figure 7.2. The real time application and the time-sharing support are the activities that are carried out in the foreground and they enjoy a high processing priority. Among these two also, the real time application enjoys a higher processing priority than the time-sharing system. The batch processing activities run in the background. Thus, when no higher priority programs are active, then this provides work for the processor.

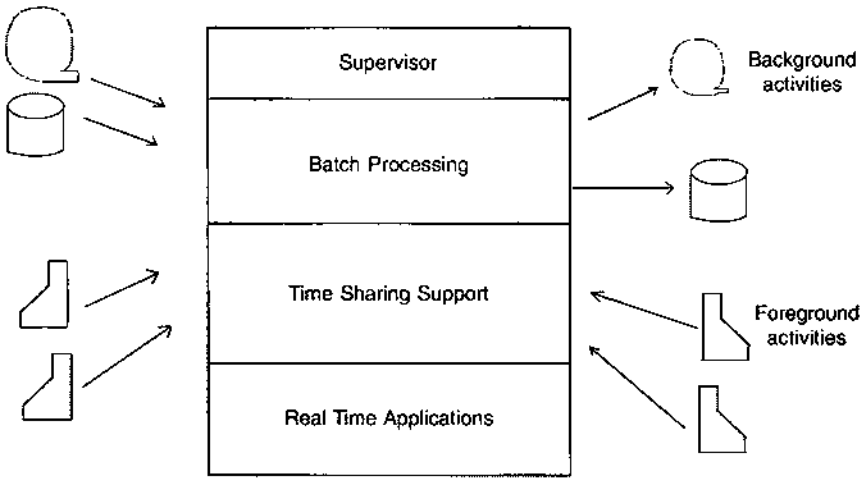

Fig. 7.2: An Operating System supporting a real time application

Native and Non-native Operating Systems

Operating systems that run on a particular personal computer platform are referred to as Native Operating System. Most processors found on desktop computers are capable of running only a specific type of OS. For example, Motorola Power PC processors are capable of running the Mac OS and not Windows 95. This is because Mac OS is native to power PC processor and non-native to the Intel PC processor. So, you cannot run the Mac OS using Intel PC processor or Windows 95 using Motorola PowerPC processors. However, you can expand a computer system's capabilities by using emulation software to run a non-native OS. You can for example, create a partition, a portion of the computer hard drive on which you store the non-native OS, special OS emulation software, and applications and files that run under the non-native OS. An emulation software such as SoftWindowsTM allows Macintosh owners to run Windows and Windows programs in emulation mode without installing special hardware. Although emulation software is useful, it does not provide the same level of performance as a standard OS running on its native platform.

Some operating system, are hardware independent and can run on various platforms. NeXT Step OS can be installed on both PCs and UNIX machines.

7.5. Overview of DOS

MS DOS is a product of Microsoft Corporation of USA. It is the most popular operating system for PCs. Another operating system available in the market is the PC DOS. It is a product of IBM and is very much similar to MS DOS. However, the basic commands of both these operating systems remain the same.

DOS is the most commonly used operating system. The full form of DOS is Disk Operating System. It is a single user operating system, which means that only one application can be made to run at one time. DOS provides

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a 'Platform' or an 'Environment' which lets the application program to interact with CPU and I/O devices. Many application software require DOS for running. The common among these are word processors like WordStar, Professional Write; spreadsheet programs like Lotus 123, VP Planner Plus; accounting software like Tally, EX, etc. Each software package has a specific command to get itself running on DOS. For example, in order to run the spreadsheet program, Lotus 123, just type 123 at the DOS prompt. DOS will run Lotus 123 for you. Once any application software shuts down, the control comes back to DOS and the DOS prompt is seen on the screen. Now, DOS is ready to accept more commands from you.

Different Versions of DOS

From the first day, when DOS was written, it has evolved from a simple program loader into a very complex, stable and successful operating system. Let us briefly look at the different faces of DOS from the time it took birth in the year 1981 as shown in table 7.2.

Table 7.2: Different versions of DOS

Year	DOS version	Feature
1981	MS DOS 1.0	Marked the first operating system on IBM PC. It supported single sided diskette drive which could hold data up to 160 KB only.
1982	MS DOS 1.1	It included double sided disk support.
1983	MS DOS 2.0	It had hard disk and the commands available with it were almost the double of its earlier version. It was introduced with IBM PC-XT and had a hierarchical file structure.
1984	MS DOS 3.0	It was introduced with PC/AT. The PC/ATs performed at a speed of 6 MHz. Soon they were able to perform at 8 and 10 MHz. The speed of PC/AT was 67% faster than PC/XTs. The PC/AT had a 1.2 MB floppy disk. A hard disk of larger capacity was also added to it.
1984	MS DOS 3.1	It included a support for Microsoft Networks. Now, PCs could be connected to one another and were able to share data and other resources. This marked the beginning of networking.
1986	MS DOS 3.2	The smaller 3.5 inch diskettes could store twice as much data as a standard 5¼" diskettes.
1987	DOS 3.3	IBM introduced PS/2 series. It could support higher capacity (1.44 MB) 3½" drives of PS/2 compatibility. It supported generalised code-page font.
1988	DOS 4.0	It was designed to look and function very similarly to OS/2. The shell allows you to use DOS without entering commands at the DOS prompt. By this time, you could also use mouse with the shell.

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1991	DOS 5.0	The memory management was improved. The shell and other extended commands were also improved. Now the 2.88 MB floppy diskettes were used.
1993	DOS 6.0	It had advanced features like disk space compression, memory space organiser and disk re-organiser.
1993	DOS 6.2	A few other small changes were brought in.

The Structure of MS DOS

MS DOS is partitioned into many layers. These layers segregate the kernel logic of the operating system (the user's idea of the system) from the hardware on which it is being run. These layers are:

(*i*) The BIOS (Basic Input/Output System)

(*ii*) The DOS Kernel

(*iii*) The Command Processor (Shell)

Now, let us quickly look at the functions of these layers.

(*i*) **The BIOS.** Every computer system comes with its own copy of BIOS, which is provided by the manufacturer of the computer system. The BIOS holds the default resident hardware dependent drivers for the following devices:

- Console display and keyboard (CON)
- Date and time (CLOCK $)
- Line Printer (PRN)
- Boot disk device (Block device)
- Auxiliary device (Aux)

The interaction between the MS DOS kernel and the device drives happens through I/O request packets. The device drivers translate all these requests into appropriate commands that are given for the different hardware controllers. In many MS DOS systems, most of the parts of hardware drivers are found in Read-Only Memory (ROM). The main idea is that they can be used by many stand-alone applications, diagnostics and the system startup program. When the system is switched on, at that point of time, BIOS is read into Random Access Memory (RAM). BIOS is a part of a file named I/O. SYS. This file has special file attributes like it is marked as hidden and system.

(*ii*) **The DOS Kernel.** The DOS kernel is mostly used by application programs. It is provided by Microsoft Corporation itself and contains a large number of hardware-independent services. These services are called system functions. The DOS kernel performs the following functions:

- File management
- Record management

- Memory management
- Character-device input/output
- Access to the real-time clock.

The DOS kernel is read into the memory at the time of system initialization. The DOS kernel forms a part of the file named MSDOS.SYS. This file again has special attributes like hidden and system.

(*iii*) The Command Processor. The command processor is also called the Shell. It is the shell that provides an interface between the user and the hardware. It helps in carrying out all the commands given at the DOS prompt. It also helps is loading and executing the programs from the storage device. The default shell that carries out all these functions is present in a file called command.com. Command.com is a special file that runs under the complete supervision of DOS. A programmer can replace the command.com file by simply adding a SHELL directive to the system configuration file (CONFIG.SYS) on the system startup disk. The file command.com is partitioned into three sections.

(*a*) *The Resident Portion*. It is loaded above the DOS kernel and its buffers and tables. It contains the routines that process the critical errors, Ctrl-C, Ctrl-Break and termination of other programs. This part of the command.com is also responsible for giving error messages.

(*b*) *An Initialisation Section*. When the system is geared up, at that point of time the initialisation section is loaded exactly above the resident portion. It runs the AUTOEXEC.BAT file created by the user.

(*c*) *A Transient Module*. The transient portion of the COMMAND. COM file is loaded in the high end of memory. Many application programs can very safely use this memory. The transient module helps in displaying the user prompt. It can also read commands from the keyboard. The transient module again executes all these commands.

7.6. Overview of UNIX

UNIX is the most popular operating system. UNIX is a multi-user system, which means that more than one person can work at the same computer system at the same time. UNIX also supports multitasking. Multitasking means that more than one program can be made to run at the same time. For example, you can initiate a program and leave it by itself to go on and in the meantime you can work on some other program.

Versions of UNIX

The original version of UNIX actually came from AT&T. Because of the great deal of flexibility offered by UNIX, many new companies emerged and

brought out their own variations. Some of the popular versions of UNIX are given in table 7.3.

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Table 7.3: Different versions of UNIX

Version	Developed by
UNIX	AT & T
AIX	IBM
XENIX	SCO (Santa Cruz Operation)
ULTRIX	DEC (Digital Equipment Corporation)
UNICOS	Cray Research
Sun OS	Sun Microsystems
BSD	University of California at Berkeley
Dynix	Sequent
HP/UX	Hewlett–Packard

Brief History of UNIX

The original version of UNIX came in the late 1960's. It was designed by Ken Thompson at AT&T Bell Laboratories. At that point of time, Bell Labs were busy in designing a very big operating system called *Multics*. Their objective was to provide a very sophisticated and complex multiuser system, which had a support for many advanced features. However, Multics failed because the state of art provided by it at that time was too complex. Therefore, Bell Labs had to withdraw themselves from the Multics project. Ken Thompson then started working on a simpler project and he named it UNIX. This version of UNIX was rewritten in the year 1973. The source code of UNIX operating system was rewritten in C language by Dennis Ritchie, the inventer of C. In order to make UNIX popular among users, AT&T came up with a unique marketing strategy. They started distributing source copies of UNIX to different universities at a very nominal price. This resulted in the widespread popularity of UNIX. In 1974, Thompson and Ritchie described the UNIX System and got it published in a newspaper named Communications of the ACM. This helped in increasing the acceptance level of the UNIX system.

By the year 1977, the UNIX system was installed at around 500 different sites. UNIX system found its major contribution in the operating telephone companies, providing a good environment for program development, network transaction operations services and real time services. A large number of institutions and universities were provided licenses of UNIX system. In the year 1977, the UNIX system was first ported from a PDP to a non-PDP machine.

So, as the popularity of UNIX grew, many other companies came out with their own versions of UNIX and ported it onto other new machines. From the year 1977 to 1982, Bell Laboratories combined many AT&T variants