BBA-303

COMPUTER APPLICATIONS IN BUSINESS MANAGEMENT

DIRECTORATE OF DISTANCE EDUCATION

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SUBHARTI UNIVERSITY

Meerut (National Capital Region Delhi)

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Syllabus

BBA 2nd Year Semester 3rd Semester

Computer Applications in Business Management

Course Code: BBA-303		
Course Credit: 04	Lecture: 04	Practical: 02
Course Type:	Core Course	
Lectures delivered:	40L +20P	

End Semester Examination System

Maximum Marks Allotted	Minimum Pass Marks	Time Allowed
70	28	3 Hours

Continuous Comprehensive Assessment (CCA) Pattern

Tests	Assignment/ Tutorial/ Presentation/class test	Attendance	Total
15	5	10	30

Course Objective: This is a basic paper for Business Administration students to familiarize with basic principles of computer system including computer arithmetic, hardware, operating system, software applications, internet and world-wide web and their applications in the relevant fields.

UNIT	Content	Hours
I	**Introduction to Computer:** Computer Characteristics, Evolution of computer and Generations of Computer. Types of Computer, Input Devices, Output Devices.	4
II	Personal Computers- PC and its main components, hardware configuration, Computer Memory – Concept, Internal and External Memory, Internal Memory Types-RAM, SRAM, DRAM, ROM, PROM, EPROM, EEPROM External Memory- Floppy Disk, Hard Disk, CD, DVD, ZIP drive. Factors influencing on PC performance.	10
III	Software – System and Application Software, Operating system- Functions and types. Computer Languages- Lower level language and Higher level language, compiler and interpreter, Characteristics of Good Language. Introduction to Windows, Basic commands in Windows.	10
IV	Modern Information Technology – Network Topology, Basic idea of Local Area Networks and Wide Area Networks, Intranet and Internet, Basic requirements for internet connection, Internet Access, E-mail, Discussion groups, Search tools, Web utilities	10
V	Computer Applications: Essential features of computer systems and structures required for office automation, communications, control systems, data acquisition, interactive multimedia, networking, parallel processing and neural networks.	6

Course Outcomes:

By the end of this course, students should be able to:

1. Understand the basic computer vocabulary;
2. Understand the basic roles and responsibilities of the software, hardware and operating system;
3. Make the use of the applications, and locate and use sufficient and appropriate resources to learn how to apply computer application software features specially using the software's help facility and online tutorials and reference.

Text Books:

1. Mano – Computer System Architecture; Pearson Education
2. Tanenbaum – Structured Computer Organization, Pearson Education
3. Sinha, P. K., & Sinha, P. Computer fundamentals. New Delhi: BPB Publications.
4. Norton, P. Introduction to computers. New Delhi: Tata McGraw Hill.

Reference Books:

1. Martin & Powell – Information Systems: A Management Perspective; McGraw-Hill
2. Laudon & Laudon – Management Information Systems: Pearson Education
3. Comer: Computer Networks and the Internet: Pearson Education
4. Graham Curtis – Business Information Systems: Addison Wesley.

Unit–1

Introduction to Computers

Notes

Structure

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

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 unit, 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

1.2. Computer

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

1.3. 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.

Notes

1.4. 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.

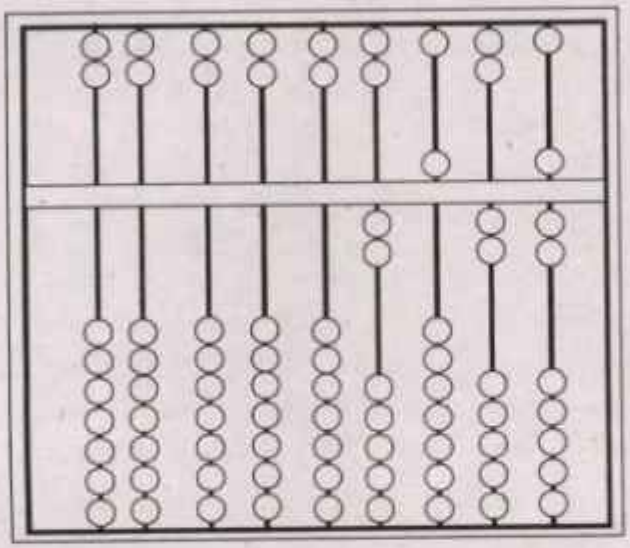

Fig. 1.1: The Abacus—First computing device

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*. These 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, made of stiff paper that stores data in columns containing patter of punched holes.

Notes

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, 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 as shown 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 unit as shown in Figure 1.4.

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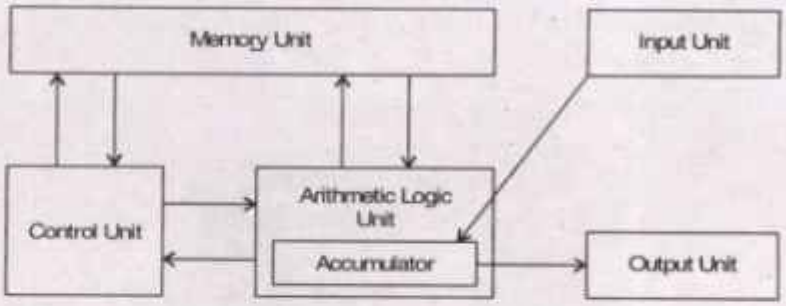

Fig. 1.4: The original von Neumann machine

(*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.

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 minicomputer 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 minicomputer 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.

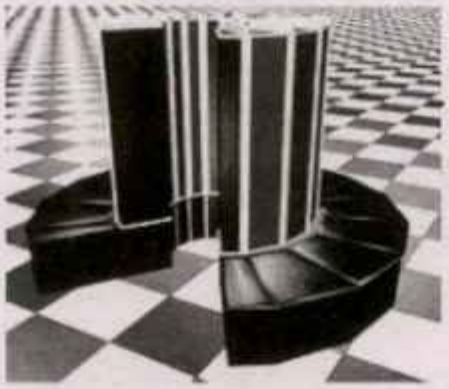

Fig. 1.8: CRAY-1

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.

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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 ULSI 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

1.5. 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.

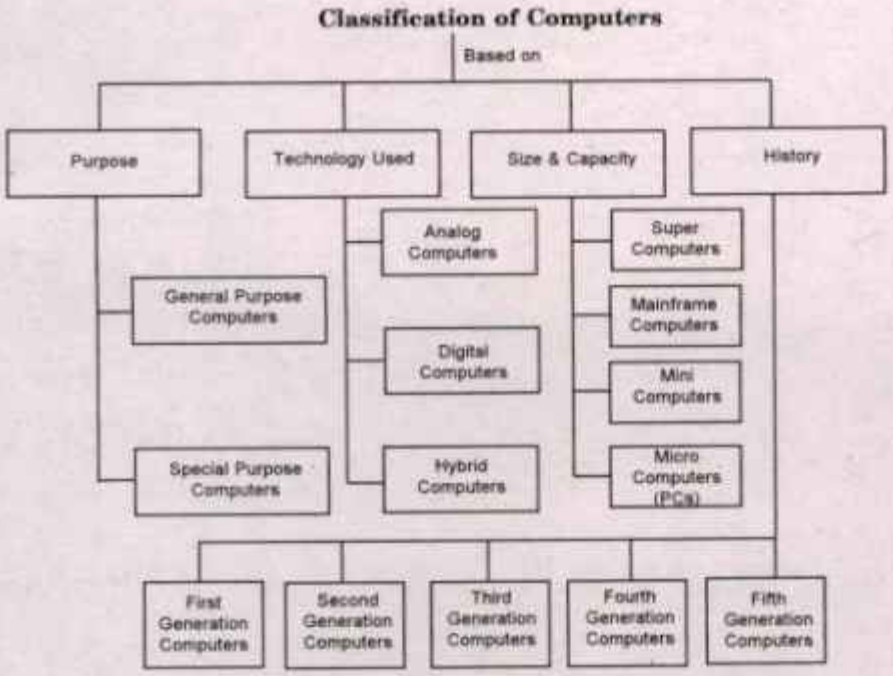

Fig. 1.9: Classification of computers based on different criteria

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:

Notes

(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 some 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.

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

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

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 co-processor enabled
80486 DX4	100	32	32	4 GB	More speed than 486 DX2

Notes

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*

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. The main 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 5¼" 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

1.6. 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 á 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

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(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.

IBM-compatible PCs are used as stand-alone machines or as workstations/ file servers in a local area network. 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. 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.

1.7. 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.

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.

1.8. 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.

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- 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.

1.9. 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.

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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 unit, 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

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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

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

Office Automation

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.

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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.

(*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 unit.

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
- Creating models and simulations
- Controlling various scientific devices

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- 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

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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 Unit 9–Modern Information Technology and Unit 10–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 to the receivers' teletext in single way and cannot be received back, while in viewdata, the users can send as well as receive messages.

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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.

Internet and Intranet. Internet and Intranet are the most recent telecommunication 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.

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

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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 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

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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 2.1 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 2.2 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, Communication 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.
- 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.

Notes

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 unit, we will discuss all these components in detail.

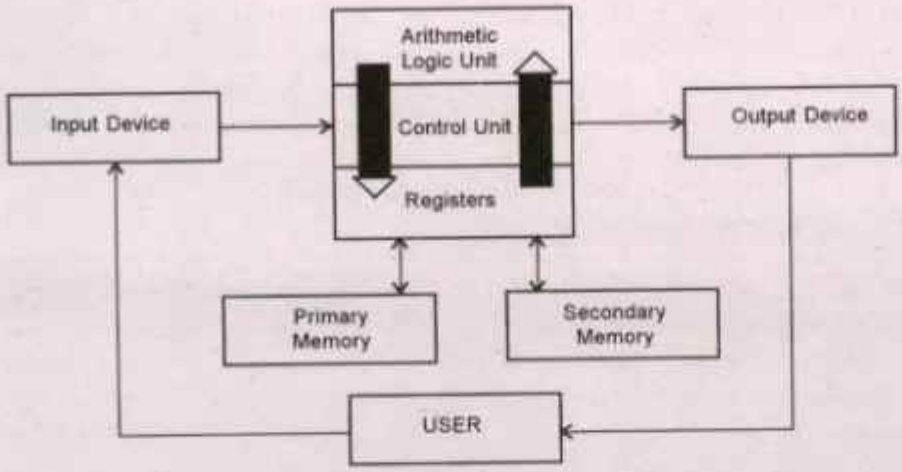


Fig. 3.1: Functional diagram of a generalised architecture of a computer system

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

Notes

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. 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 (ALU)
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) 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.

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.

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

Notes

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.

(*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.

Notes

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.

Notes

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.

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 every organization, most data are stored in computers. Primary memory (especially RAM) stores the data, instructions and information temporarily

Notes

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*.

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 and peripheral devices (keyboard, monitor, etc.).

3.8. Cards, Ports and Cords

Notes

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.

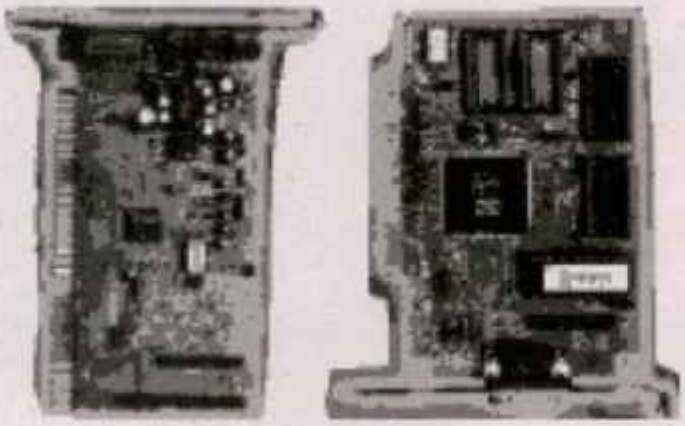


Fig. 3.3: Some cards

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.

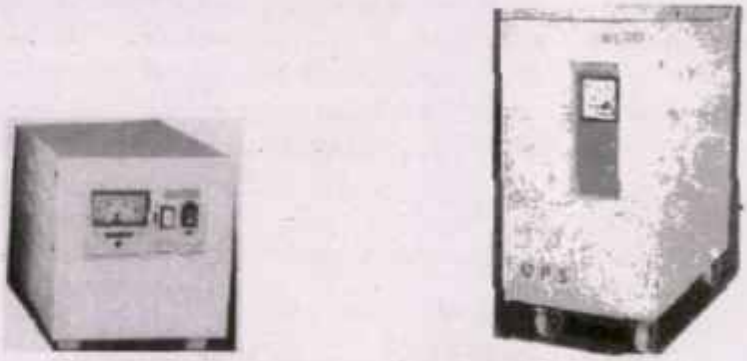
Cords are the cables used to plug into the ports. There are different types of cables for connecting different types of input, output and storage devices. The important cords used in a PC are keyboard cords, power cords, monitor cords and printer cords.

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

Notes

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 Transformer*). 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*.

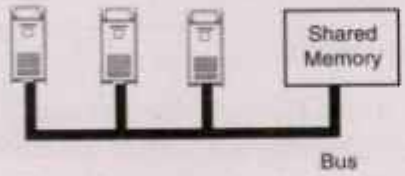
SIMD Machine

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

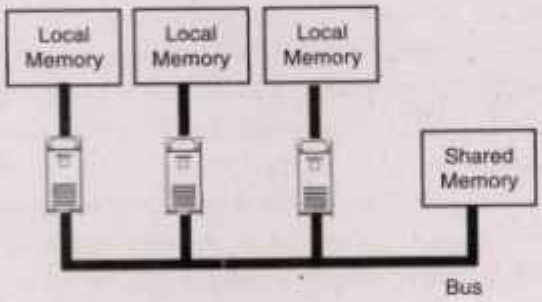
ALU is a vector ALU, which performs an operation on two input vectors and generate an output vector as result. This category of computers is called *Vector Machine*. In another approach, the machine consists of a square grid of processor and memory elements. Each unit of processor user its own data stored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

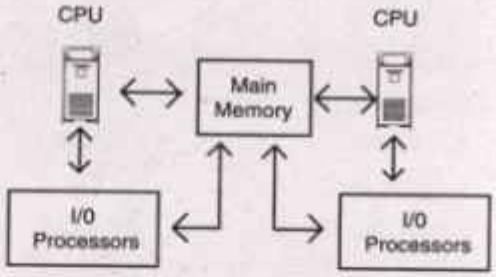

Fig. 3.6: An organisation of a multiprocessing system

3.11. Future of Processor

The processor is a collection of very large number of integrated circuits, which further consists 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.

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- 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 unit, 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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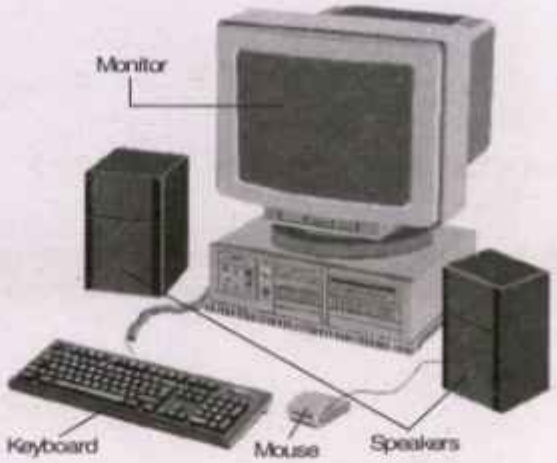

Fig. 4.1: A Personal computer having basic input devices

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 Y.

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.

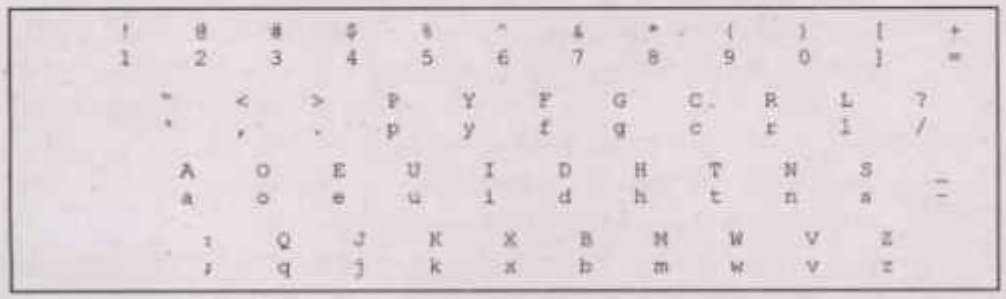

Fig. 4.3: Keys layout of the Dvorak keyboard

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

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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 Unit 6 – 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 buttons.

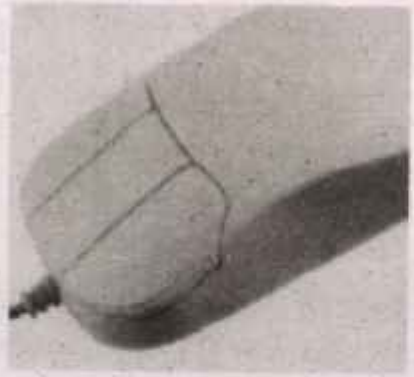
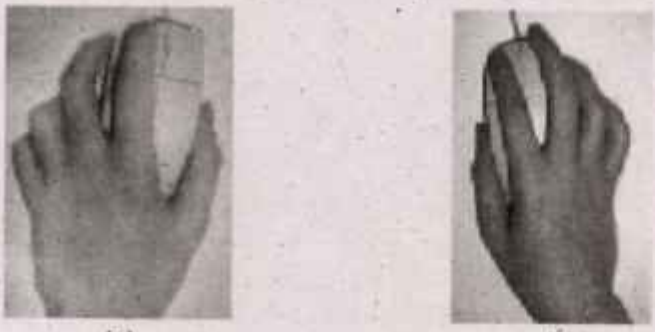


Fig. 4.4: A mouse

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 (b).



(a) (b)

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 use the scanner.

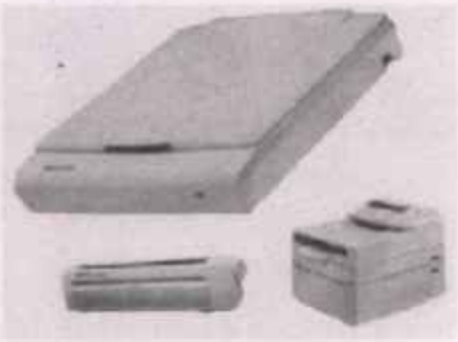


Fig. 4.7: Various types of scanners

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

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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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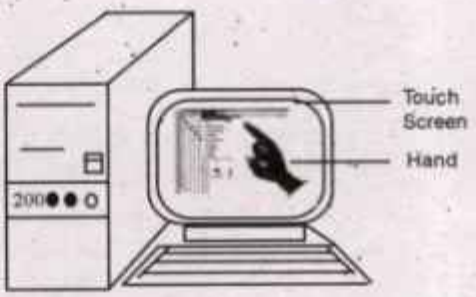

Fig. 4.8: Demonstration of touch screen

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.

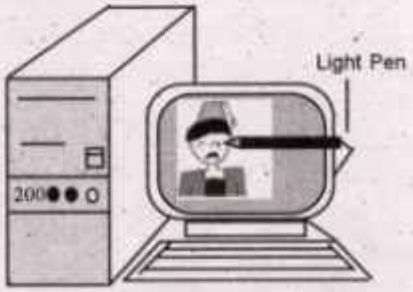

Fig. 4.9: Demonstration of a light pen

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.

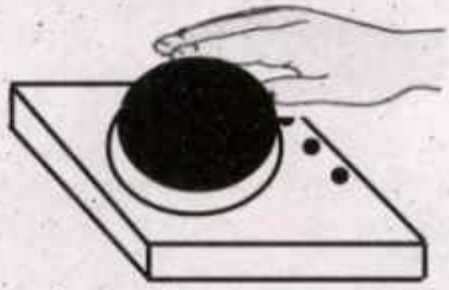

Fig. 4.10: A trackball

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.

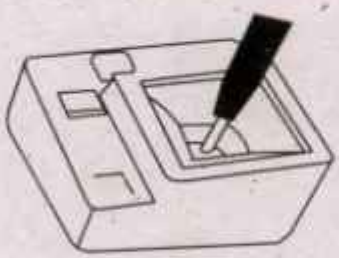

Fig. 4.11: A joystick

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.

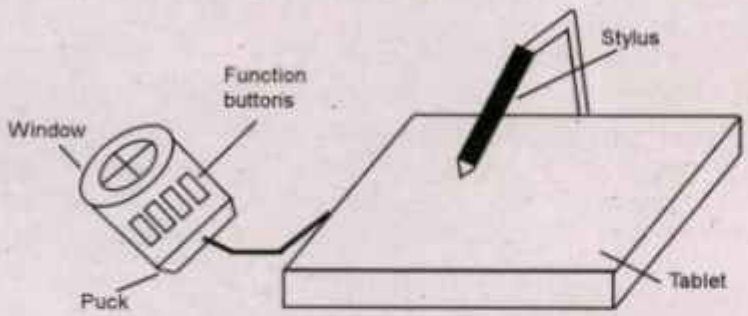

Fig. 4.12: A digitizer

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.

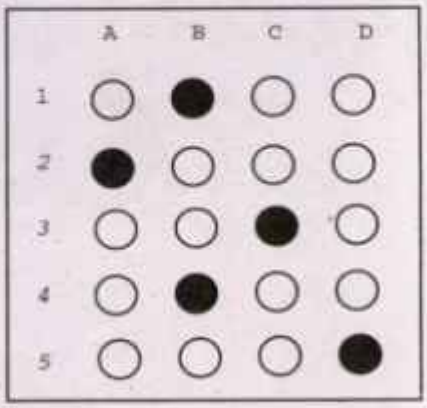


Fig. 4.13: A sample of answer sheet that is checked by Optical Mark Reader (OMR)

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

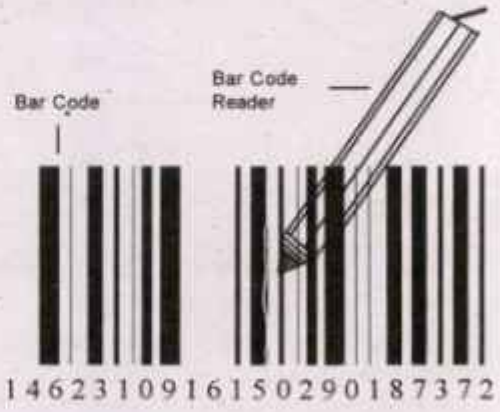


Fig. 4.14: A bar code reader

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 the 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.

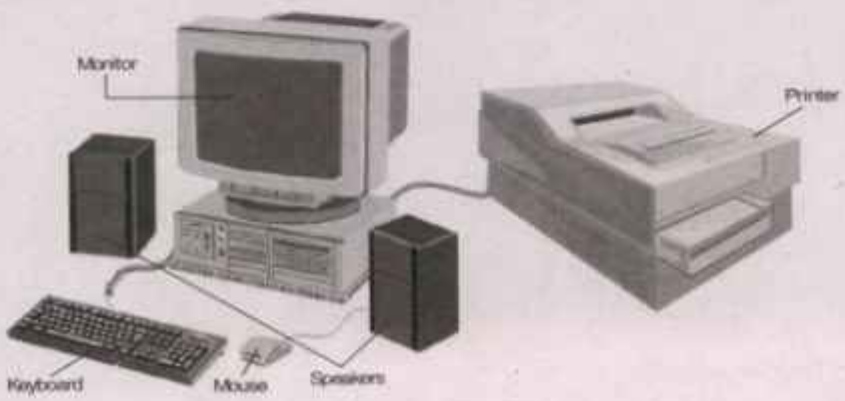


Fig. 4.16: A computer with basic output devices

Notes

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.

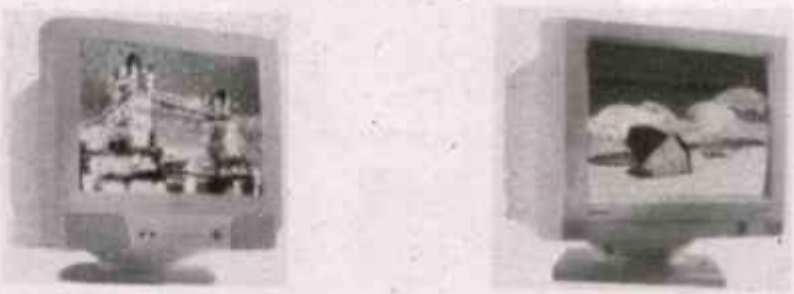
Types of Monitors. There are different kinds of monitors depending upon the number of pixels. Depending upon the resolution, monitors can be classified as follows:

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.

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



15" Multimedia Color Monitor 20" Color Monitor

Fig. 4.17: Two models of color monitors

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.

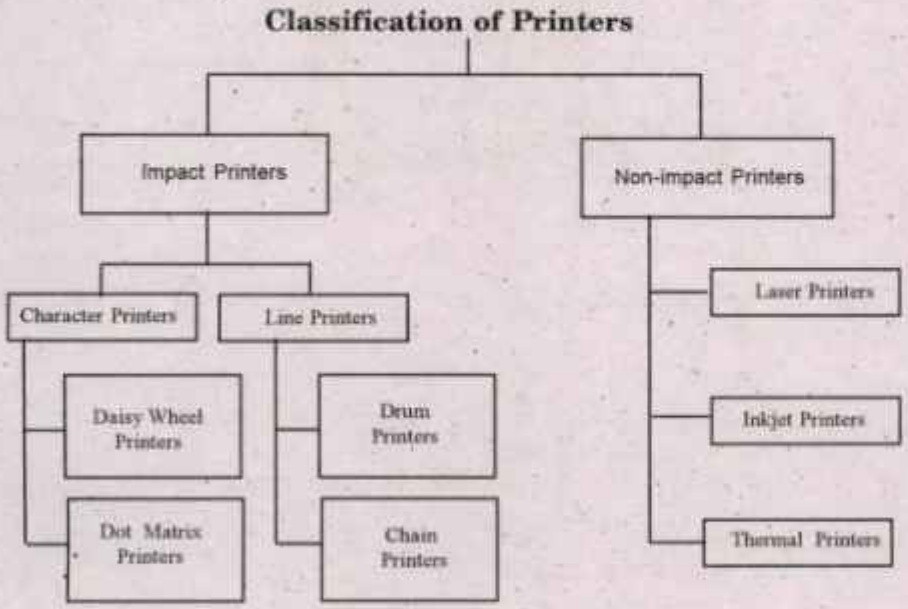


Fig. 4.18: Classification of printers

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 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.

Notes

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*) **Flatbed 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 flatbed plotters.

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

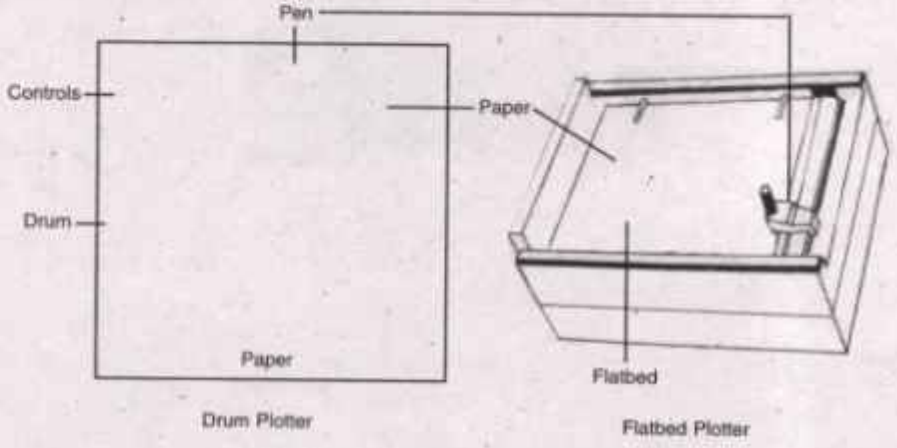


Fig. 4.23: Various types of plotters

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.

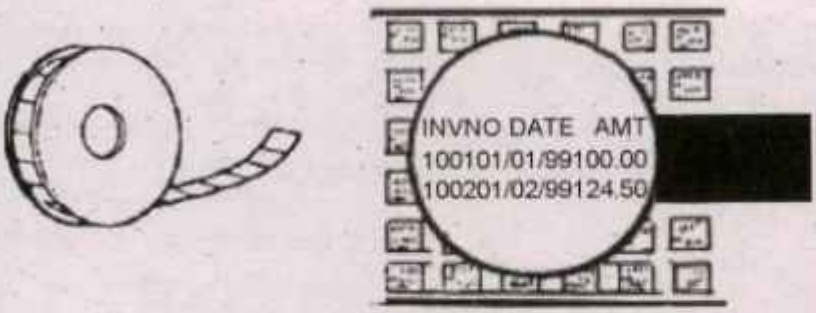


Fig. 4.24: Computer output microfilm

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.

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The emerging output devices are described below:

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

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- 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*) Flatbed 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
   (*b*) Light Pen
   (*c*) Plotter
   (*d*) Joystick
   (*e*) OMR
   (*f*) Monitor
   (*g*) Speaker
   (*h*) COM
   (*i*) OCR
   (*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 Unit–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 unit, 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 organisation, 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.

Notes

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, 5¼" and 3½" 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 3½ 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—3½" and 5¼".

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.

Notes

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.

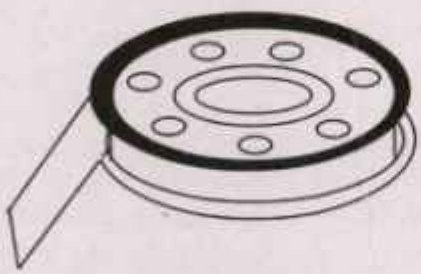

Fig. 5.1: A magnetic tape

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.

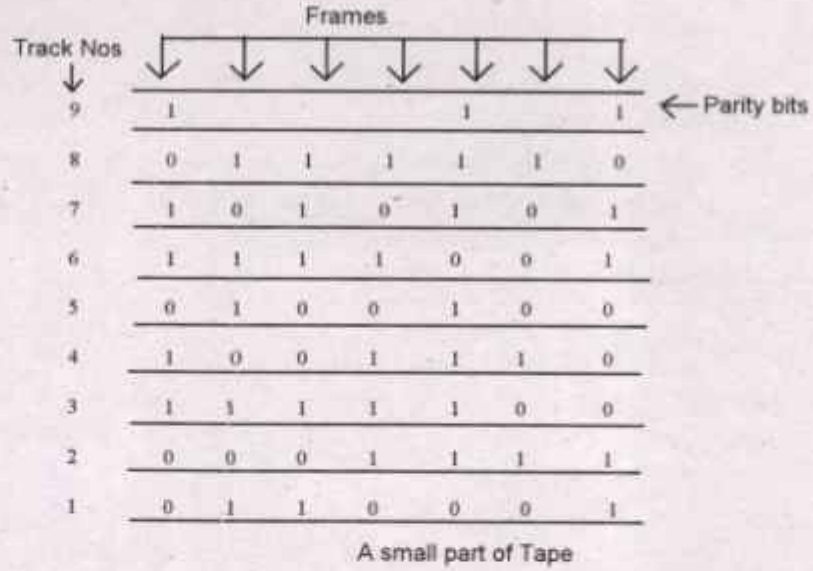

Fig. 5.2: Data recording on a 9 track magnetic tape using 8-bit EBCDIC/ASCII code

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.

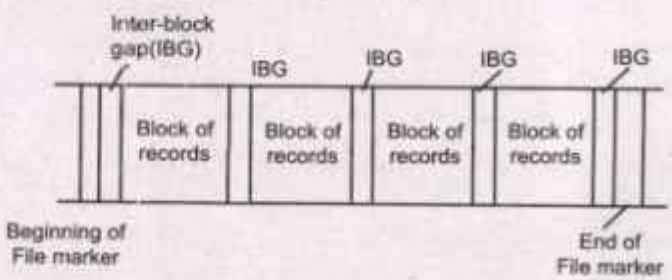

Fig. 5.3: Organisation of blocks and files on a tape

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:

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

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:

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

The maximum transfer rate is calculated as follows:

Maximum transfer rate = Recording Density × Tape Speed
= 200 × 100
= 20000 bytes per second.

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

Hence, $\text{Net Transfer Rate} = \frac{1,000}{0.08} = 15000$ 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:

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

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

The effective length of one block is calculated as follows:

Effective length of one block = Length of one block + Length of IBG
= 6 + 1 = 7 inches

Therefore,

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

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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.

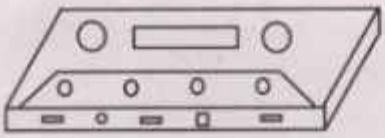

Fig. 5.4: Cartridge tape

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

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 near Winchester in England.

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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.

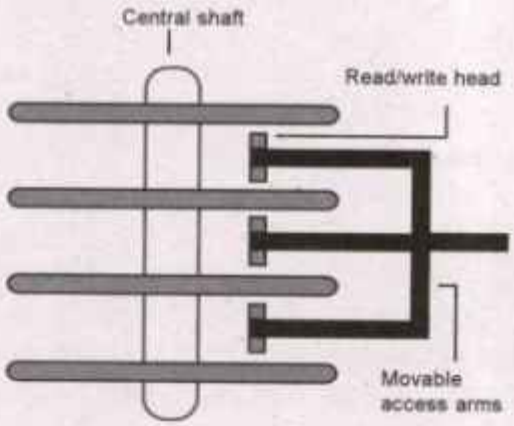

Fig. 5.6: Internal structure of a winchester disk

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

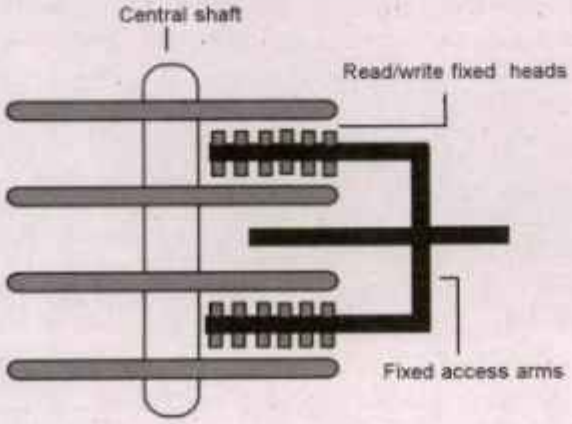

Fig. 5.7: Internal structure of a fixed-head disk system

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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,

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

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

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:

Average Latency Time = $\frac{1}{2}$ × 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 = 60 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.

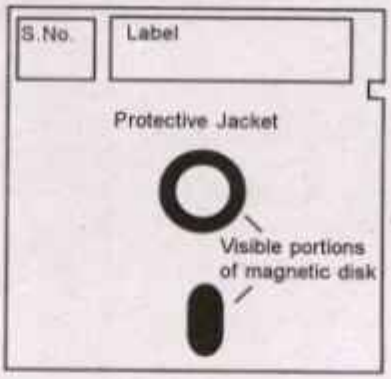

Fig. 5.8: Structure of a floppy disk

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

* 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 on CDs 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 DVD 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 H ngarian-born physicist and Nobel prize winner, also known as the *father of holography*) in 1947. Holography is the latest technology 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 from 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-dimensional 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.

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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 Unit 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 unit, 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.

Notes

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 unit.

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?

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 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.

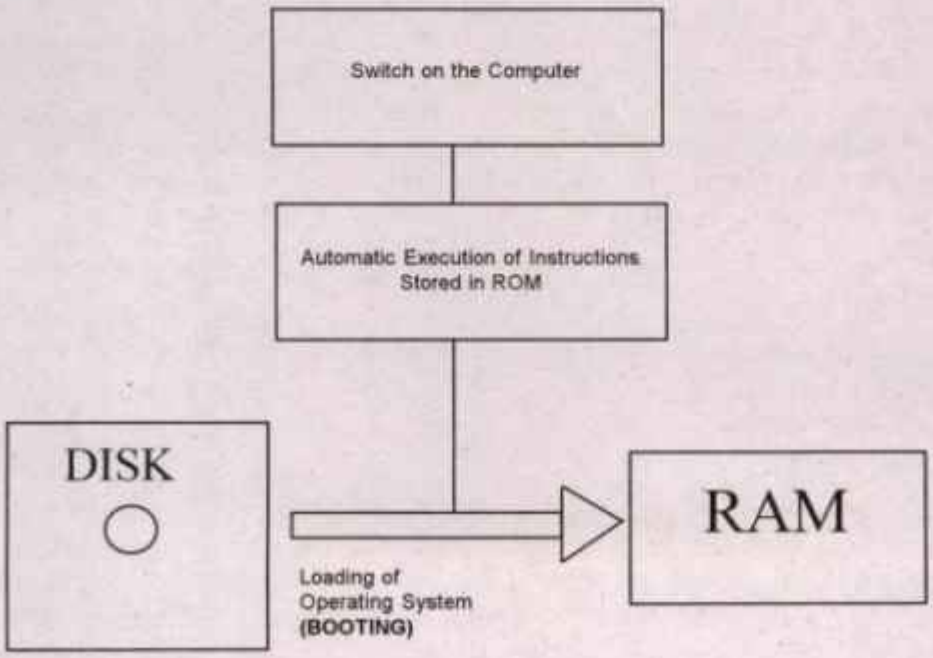

Fig. 6.1: Process of booting

Notes

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 unit 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 Unit 8 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). 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

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.

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.

Notes

Many application generators are available for different third and fourth generation languages like COBOL, dBASE, Foxpro, etc (we are discussing these languages in Unit 8 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.

Notes

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 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.

Notes

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.

Notes

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 Unit 10 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.

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

Notes

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.

Notes

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 2019. 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
- 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

Notes

- 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.

Notes

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
Paradox	Network 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.

Notes

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 2016, however the latest version is MS Excel 2019. Quattro Pro 2020, 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 Unit 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 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 2016 and PowerPoint 2019 are the currently used versions of PowerPoint. MS Office 2016 and MS Office 2019 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

Notes

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 unit. 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.

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 2021 (latest, equivalent to version 23.0), 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 unit. 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 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.

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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.

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.

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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.
- 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.

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- 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 unit, 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 unit, 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 unit.

7.3. Functions of an Operating System

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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 version of UNIX

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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.

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 different

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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

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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

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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.

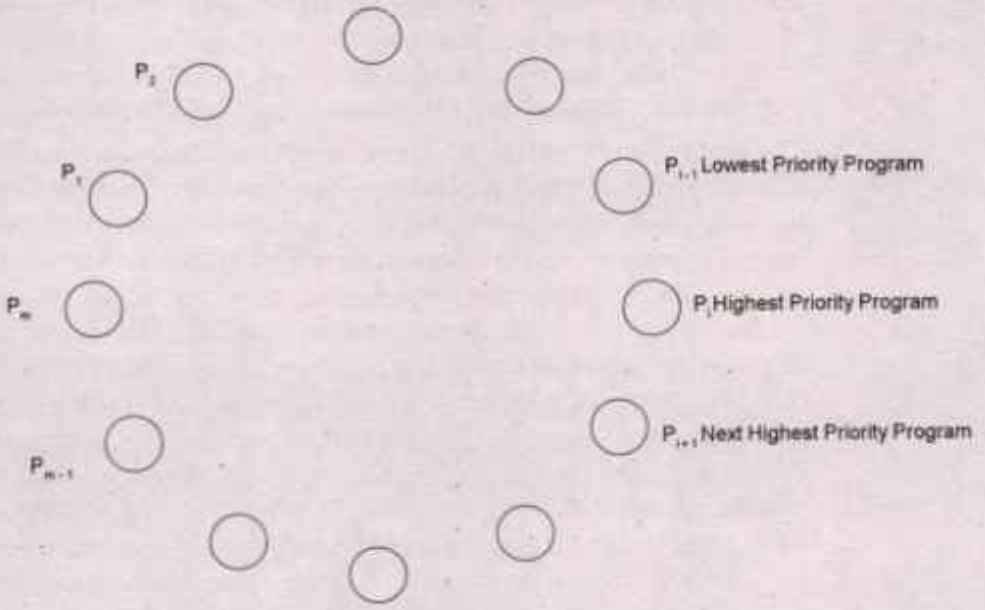

Fig. 7.1: The round-robin scheduling policy

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'

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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 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 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.

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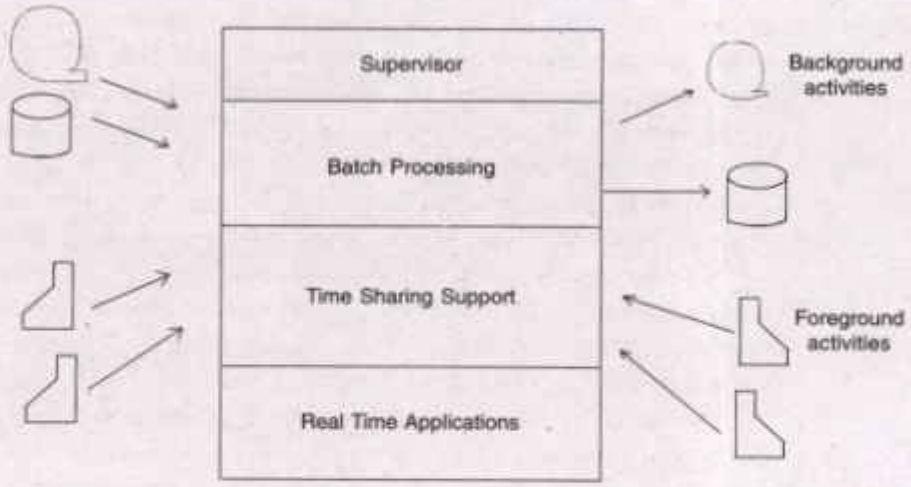

Fig. 7.2: An Operating System supporting a real time application

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 SoftWindows™ 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

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.
1985	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.

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

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

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

into a single system and gave it a name *UNIX System III*. Many new features and advancements were brought out by Bell Laboratories in this version. It was given the name *UNIX System V*. The people at University of California at Berkeley developed a variant to the UNIX System. Its recent version is called 4.3 BSD for VAX machines. It provided many new and interesting features.

By the beginning of 1984, UNIX system was installed at about 1,00,000 different computer sites. It ran on a wide range of computers ranging from a minicomputer to a mainframe. No other operating system can make such a claim. Many of the programs of the UNIX Operating System are written in C. However, the UNIX system can support many other languages also like FORTRAN, BASIC, Pascal, Ada, COBOL, Lisp and Prolog.

Features of UNIX

UNIX is such an operating system that can be run on a wide range of machines, from micro-computers to mainframes. There are a variety of reasons that have made UNIX an extremely popular operating system.

(*i*) **Portability.** As of today, there are innumerable computer manufacturers through out the world. Therefore, the hardware configurations also keep varying from one vendor to another. The positive and strong thing about UNIX is that it is running successfully on all these computers. The reason behind UNIX's portability is that it is written in a high-level language that has made it easier to read, understand and change. Its code can be changed and compiled on a new machine. PCs, Workstations, Minicomputers, Super Computers and Mainframes run the UNIX operating system.

(*ii*) **Machine Independent.** The UNIX system does not make the machine architecture transparent to the user. Thus, it becomes very easy to write applications that can run on micros, minis or mainframes.

(*iii*) **Multi-user Capability.** As discussed earlier, UNIX is a multi-user system. A multi-user system is a system in which the same computer resources like hard disk, memory, etc. can be used or accessed by many users simultaneously. Each user is given a terminal (a keyboard and a monitor). Each terminal is an input and an output device for the user. All the terminals are connected to the main computer. So, users sitting at any terminal can not only use the data or the software of the main computer but also the peripherals like printers attached to it. In UNIX terminology, the main computer is called the *server* or the *console*.

(*iv*) **Multitasking Capability.** UNIX has the facility to carry out more than one job at the same time. This feature of UNIX is called Multitasking. You can keep typing in a program in its editor while at the same time OS execute some other command given earlier like copying a file, displaying the directory structure, etc. The

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latter job is performed in the background and the earlier job in the foreground.

(v) **Software Development Tools.** UNIX offers an excellent environment for developing new software. It provides a variety of tools ranging from editing a program to maintenance of software.

(vi) **Built in Networking.** UNIX has got built in networking with a large number of programs and utilities. It also offers an excellent media for communication with other users. The users have the liberty of exchanging mail, data, programs, etc. You can send your data at any place irrespective of the distance.

(vii) **Security.** UNIX supports a very strong security system. It enforces security at three levels. Firstly, each user is assigned a login name and a password. So, only the valid users can have access to the files and directories. Secondly, each file is bound around permissions (read, write, execute). The file permissions decide who can read or modify or execute a particular file. The permissions once decided for a file can also be changed from time to time. Lastly, *file encryption* comes into picture. It encodes your file in a format that cannot be very easily read. So, if anybody happens to open your file, even then he will not be able to read the text of the file. However, you can decode the file for reading its contents. This is called *decryption*.

The following features make UNIX a unique operating system:

- UNIX is the only operating system that is written in a high-level language. This gives it the benefit of machine independence and portability. It becomes very easy to understand, change and move it to other machines.
- It was the first operating system to bring in the concept of hierarchical file structure. It becomes very easy to organise and search for different files.
- It uses a uniform format for files. This makes the application programs to be written easily. This file format is called the *byte stream*. UNIX treats every file as a stream of bytes. Therefore, the user can manipulate his file in the manner he wants.
- It provides primitives that allow the more complex and complicated programs to be built from simpler ones.
- It has a very simple user interface that has the power to provide all the services the users want.
- It hides the machine architecture from the user. This helps the programmer to write different programs that can be made to run on different hardware configurations.
- It provides a simple, uniform interface to peripheral devices.
- It is a multi-user, multiprocessing operating system.

System Structure of UNIX

The interaction between the user and the hardware happens through the operating system. The operating system interacts directly with the hardware.

It provides common services to programs and hides the hardware intricacies from them. The high level architecture of the UNIX system has been shown in Figure 7.3.

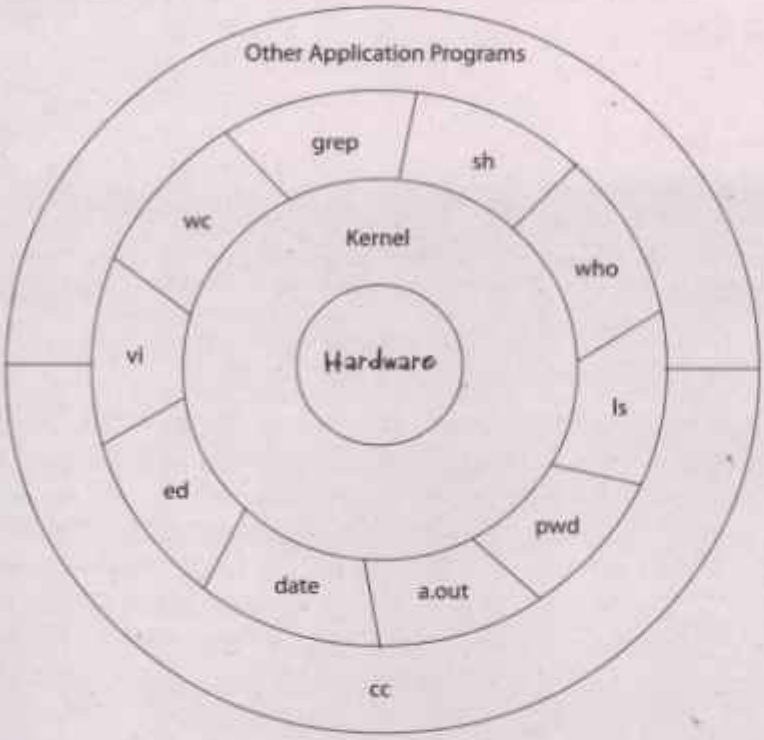

Fig. 7.3: System Architecture of UNIX

The hardware of a UNIX system is present in the centre of the diagram. It provides the basic services such as memory management, processor execution level, etc. to the operating system. The UNIX system seems to be organised as a set of layers. The system *Kernel* is actually the operating system. The user programs are independent of the hardware on which they are running. Therefore, it becomes very easy to run programs on UNIX system running on different hardware if the programs do make special assumptions. The programs such as the shell and editors like (ed and vi) interact with the Kernel by invoking a well-defined set of system calls. The system calls get various actions done from the Kernel for the calling program. They interchange data between the Kernel and the program. There are many other programs in this layer which form a part of the standard system configurations. These programs are known as *commands*. But there are several other user created programs present in the same layer. It is shown by the program whose name is *a.out*. *'a.out'* is the standard name for all the executable files produced by the C compiler. The outer most layer contains other application programs, which can be built on top of lower level programs. For instance, the C compiler, cc, appears in the outermost layer of the figure. It invokes a C preprocessor, compiler, assembler and link loader. These are all separate lower level programs. The programming style offered by the UNIX system helps us to fulfill a task by combining the existing programs.

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The UNIX System V offers somewhere around 64 system calls. However, only 32 system calls are frequently used. These system calls carry very simple options with them. So, it becomes easy to make use of these system calls. The body of the Kernel is formed by the set of system calls and the internal algorithms that implement them. Thus, the Kernel provides all the services to the application programs in the UNIX system. In the UNIX system, the programs don't have any knowledge of the internal format in which the Kernel stores file data.

Services Provided by Kernel. The services provided by the operating system are infact provided by the Kernel. The Kernel performs various operations and acts as a user interface. The services provided by the Kernel are given below:

1. It controls the running of various processes such as their creation, termination and suspension.
2. The Kernel allocates main memory for an executing process. The Kernel allows the processes to share portions of their address space. It keeps the private space of processes secure and doesn't allow tampering from other processes. However, if the free memory is low with the system, then the Kernel frees out some memory. It then writes a process temporarily to secondary memory. In a case, if the Kernel writes all the processes to the secondary memory, then it is called a *swapping system*. However, only if the pages of memory are written onto the secondary memory, then it is called the *paging system*.
3. The Kernel schedules processes for execution on the CPU. The time-sharing concept allows the processes to share the CPU. When the time of a process has finished, the Kernel suspends it. Therefore, the Kernel puts some other process for execution in the CPU. It is again the work of the CPU to reschedule the suspended process.
4. The Kernel permits different processes to make use of the peripheral devices such as terminals, tape drives, disk drives and network devices.
5. The Kernel allocates the secondary memory for efficient storage and retrieval of user data. The Kernel allocates secondary storage for user files, organises the file system in a well planned manner and provides security to user files from illegal access.

The services provided by the Kernel are absolutely transparent to the user. For instance, the Kernel formats the data present in a file for internal storage. However, it hides the internal format from user processes. Similarly, it makes a distinction between the regular file and a device but hides the distinction from user processes. Finally, the Kernel provides the services so that the user level processes can support the services they must provide. For instance, the Kernel provides the services that the shell requires to act as a command interpreter. Therefore, the Kernel allows the shell to read terminal input, to create pipes and to redirect I/O. The computer users can also create

private versions of the shell so that they can create an environment according to their own requirements without disturbing the other users.

User mode and Kernel Mode. Whenever the user on the UNIX system executes a process, then it is divided into two levels: User and Kernel. So, as and when a system call is executed by a process, then the execution mode of the process changes from the User mode to Kernel mode. The Kernel tries to process the requests made by the user. It returns an error message if the process fails. However, if no requests are given to the operating system to service, then also the operating system keeps itself busy with other operations such as handling interrupts, scheduling, processes, managing memory and so on. The main differences between the User mode and the Kernel mode are given below:

Notes

1. Process in a User mode can access their own instructions and data but they cannot access the instructions and data of the Kernel. But all the processes present in the Kernel can have the access to both the Kernel and the user addresses.
2. Some machine instructions give an error message when executed in User mode. For instance, a machine may contain an instruction that manipulates the processor status register; processes executing in User mode should not have this capability.

It is very true that the system runs in either the User mode or the Kernel mode. However, the Kernel runs on behalf of the user process. The Kernel is not a separate process running parallel to user processes. The Kernel forms a part of each user process.

Interrupts and Exceptions. The UNIX system allows devices such as I/O peripherals or the system clock to *interrupt* the CPU abruptly. Whenever the Kernel receives the interrupt, it saves the current work it is doing and services the interrupt. After the interrupt is processed, the Kernel resumes the interrupted work and proceeds as if nothing had happened. The hardware gives a priority number according to the order in which the interrupts should be handled. Thus, when the Kernel looks into an interrupt, it keeps the lower priority interrupt waiting and services the higher priority interrupt.

The term exception is different from the term interrupt. An *exception* is a condition in which a process causes an unexpected event. For instance, dividing a number by zero, address illegal memory, etc. Exceptions occur in the middle of the execution of an instruction. The system tries to start the instruction again after handling the exception. However, *interrupts* are considered to happen between the execution of two instructions. The system continues working on the next instruction after servicing the interrupt.

Program Execution Levels. Sometimes, the Kernel must stop the interrupt from occurring during critical activity. This could corrupt the data being handled. For instance, the Kernel might not want to handle an interrupt when it is working with linked lists because handling the interrupt at this point of time might lead to corruption of pointers. Therefore, a better technique has been worked out. The processor execution levels can be set

with the help of certain instructions. If you set the processor execution level to certain value, then it can keep away the interrupt from that level and lower levels. It will only allow the high level interrupts to disturb the process.

Notes

7.7. Overview of Windows

We have discussed the role of an operating system in managing the operations of a computer. Most microcomputers use DOS as an operating system. Although DOS is essential to operate a computer, but the user interface with DOS is not user-friendly. In order to operate the computer, one must learn DOS commands. The user is expected to memorise all DOS commands and understand their correct syntax (rules for writing statements of a language). Therefore, only DOS environment is not considered sufficient for running present day applications on PCs. Most of the present day applications related to management and other fields need a graphics-based user interface that is easy to operate. Such a graphics based user interface, that incorporates pull down menus and icons (small pictorial representations of files, programs, storage devices etc.) is known as *Graphical User Interface* (GUI). For example, as we have discussed earlier, the operating system of Mac PCs provide graphical user interface (GUI). In IBM-compatible PCs, GUI is provided by an operating environment/ system — 'Windows'.

Windows is the most popular system software, that provides graphical user interface. Windows provides an interface, which is similar to the Macintosh user interface. In such interface, each active application is displayed in a window on the screen as shown in Figure 7.4. The application window can be closed, opened, hided, displayed, moved, resized, minimised

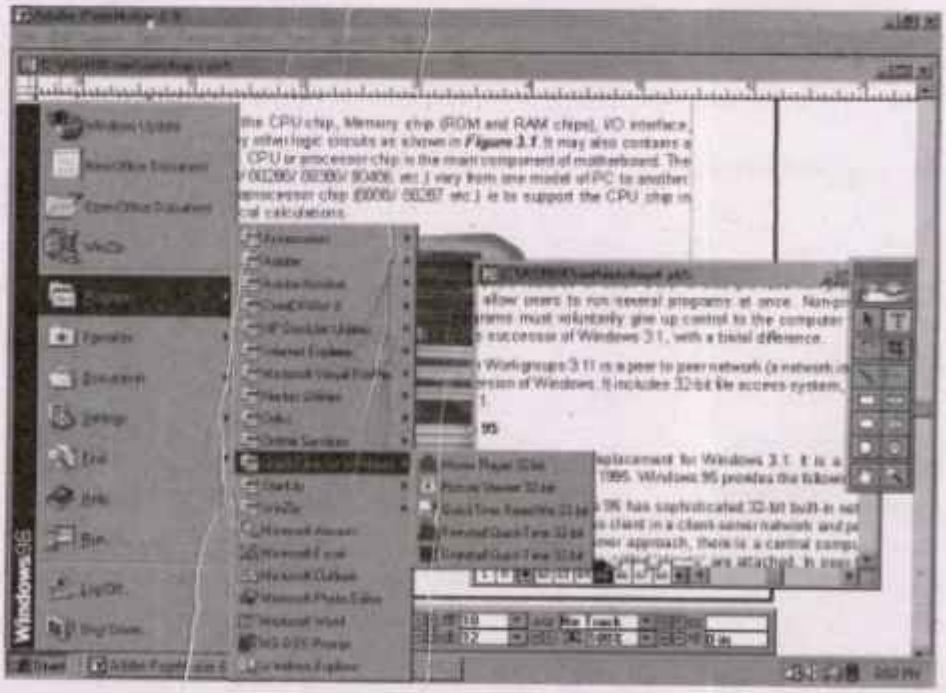

Fig. 7.4: A window screen showing many active applications

or maximised. The user can run several applications simultaneously, each in its own window. Windows allow the user to share data among different applications. Windows provides an interactive environment, where the user is engaged in continuous dialog with the computer. In Windows, although both keyboard and mouse are used as input device, the mouse is the primary tool for selecting and running window applications.

The different versions of Windows are Windows 1.x, Windows 2.x, Windows 3.0, Windows 3.1, Windows 3.11, Windows for Workgroups 3.11, Windows 95, Windows 98, Windows 2000, Windows XP and Windows NT. Windows 1.x, 2.x and 3.0 were the earlier attempts from Microsoft, Inc. for creating graphical user interface but were not very successful. Windows 3.1 and higher versions provide powerful and multifeatured GUI capabilities. Windows NT may appear to you user same as Windows 3.1, but it is based on entirely a different concept.

Windows 3.1/3.11 & Windows for Workgroups 3.11

Windows 3.1 is generally misunderstood as an operating system, but actually it is not an operating system. Windows 3.1 is a graphics-based operating environment that replaces the DOS interface. In order to run Windows 3.1, DOS must be installed on the computer. Windows 3.1 has all the basic features of other GUIs. It also provides non-preemptive multitasking features, which allow users to run several programs at once. Non-preemptive multitasking means the programs must voluntarily give up control to the computer for getting their turn. Windows 3.11 is the successor of Windows 3.1, with a trivial difference.

Windows for Workgroups 3.11 is a peer to peer network (a network in which any computer can be server) version of Windows. It includes 32-bit file access system, which is not provided by Windows 3.11. Various versions of window 3.x series have become obsolete now and have been replaced by Windows 95 & higher versions.

Windows 95

Windows 95 is a much-awaited replacement for Windows 3.1. It is a 32-bit operating system from Microsoft, released in 1995. Windows 95 provides the following important features:

(*i*) **Built-in Networking.** Windows 95 has sophisticated 32-bit built-in network components, that allows it to operate both as client in a client-server network and peer-to-peer network operating system. In client-server approach, there is a central computer acting as a file server, with which workstations called '*clients*' are attached. In peer-to-peer networking, every computer connected with network can work as a file server and therefore can share files and printers with other computers.

(*ii*) **Multimedia functions.** Windows 95 provides all multimedia controls and functions. Multimedia is the way of disseminating information in form of text, audio, graphics/animated graphics and full-motion video.

(iii) **Preemtive Multitasking.** Windows 95 provides preemtive multitasking features, which are found in operating systems like OS/2 and Windows NT. In preemtive multitasking, operating systems dictate the time slice for each program, resulting in smoother control and fewer crashes.

(iv) **Memory Protection.** Memory protection feature of Windows 95 ensures that one application do not crash other applications in memory.

(v) **'Plug and Play'.** Windows 95 automates the hardware configuration process, by knowing the kind of printer, mouse and other peripherals. This feature is known as 'Plug and Play'.

(vi) **OLE (Object Linking and Embedding).** OLE is the key technology for Windows 95. Object Linking and Embedding is the Microsoft's standard for creating compound documents (compound document is a document made from different programs) in Windows. OLE permits seamless integration of applications in Windows.

Windows 98

Windows 98 is the next upgrade of Microsoft Windows operating system. It makes our computer easier to use by providing new and enhanced features. The major features of Windows 98 are:

(i) **Faster than Windows 95.** Windows 98 is a faster operating system. Without adding new hardware, the computer runs faster in Windows 98 as compared to Windows 95. The maintenance wizard of Windows 98 checks the hard disk for problems and frees its space so that the programs run faster.

(ii) **Web Integration.** It provides improved web features by combining the power of the computer with the interactive content of the Internet.

(iii) **Improved Reliability.** It improves computer reliability by introducing new utilities, wizards and resources which help in running the computer smoothly and efficiently. The new web-based resource site automates driver and system file updates, and provides up-to-date technical support. The system file checker of Windows 98 restores the critical files if they are changed. In Windows 98, scandisk runs automatically if the computer is shut down improperly.

(iv) **Multiple Display.** In Windows 98, we can use several monitors simultaneously to run different programs on separate monitors.

(v) **Power Management.** Windows 98 improves the startup time of the computer. In Windows 98, we can start the computer in just a few seconds. Windows 98 restore all the programs in their last saved positions.

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(*vi*) **More Entertaining.** Windows 98 provides new features such as enhanced television, video playback and Web TV for Windows that makes our computer more entertaining. Using Web TV for Windows, we can receive and view searchable television program listings provided we have an Internet connection and a TV tuner card installed on our PC.

Window NT

NT stands for New Technology. Windows NT is a 32-bit version of the Windows operating system that supports preemptive multitasking. It is a network operating system that offers networking capabilities. It is divided into 2 parts—Windows NT Server and Windows NT workstation. Windows NT Server operates as a network server and domain controller. *Windows NT workstation* serves as a network client and desktop OS. The major features of Windows NT are:

(*i*) **Client/Server Architecture.** Entire OS is designed as divided into smaller units, which can communicate with each other by passing well defined messages to each other. The unit that need services is called *client* while the one that provide services is called *server*. Each small portion of OS run in its own protected memory space.

(*ii*) **Portability Windows NT.** Windows NT can be parted on a new processor architecture. Portability of Windows NT is implemented using a software that interface between hardware and rest of OS, which is called *Hardware Abstraction Layer* (HAL).

(*iii*) **Compatibility.** Windows NT can interacts with other OS such as DOS, Windows, etc.

(*iv*) **32-bit Memory Model.** Windows NT offers 32-bit memory model and hence has addressing limitation of 4 GB.

(*v*) **Protected Memory Model.** Every process running in Windows NT processes its own memory space which minimises system crashes and provides higher security to the system.

(*vi*) **Kernel and User Modes.** Windows NT has two modes—Kernel and User. Critical pieces of system viz. I/O Managers, Process Manager etc, run in Kernel mode while any program not running in Kernel mode runs in User mode. Windows NT has micro-kernel which means that kernel has been designed with basic features only to perform necessary function.

(*vii*) **Pre-emptive Multitasking.** Micro-Kernel of Windows NT provides time-slicing for the CPU for each process. Once allotted time is over, the running process is pre-empted and control is passed to next process.

(*viii*) **Scalability.** It is the characteristic of a network that make it possible for network administrator to add many additional modes without the need to redesign the basic system. Scalability in Windows NT is implemented using SMP (*Symmetric Multi-processing*). In SMP, processors are exactly control operations.

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Windows 2000

Windows 2000 is a line of desktop and NetWare operating systems, which was designed to replace Windows NT. It is built upon the NT Kernel and Provides an interface that closely resembles Windows NT and Windows 98. Windows 2000 line of OS includes the following parts:

(*i*) **Windows 2000 Professional.** It was designed to replace Windows NT workstation 4.0. It provides improved security, special features for mobile users, and better performance.

(*ii*) **Windows 2000 Server.** It was designed to replace Windows NT server 4.0. It provides improved functional and up to two-way symmetric multi-processing (SMP).

(*iii*) **Windows 2000 Advanced Server.** It was designed to replace Windows NT 4.0 Enterprise Edition. It provides large physical memories and up to four-way symmetric Multi-processing (SMP).

(*iv*) **Windows 2000 Data Center Server.** It is most powerful server operating system ever offered by Microsoft. It provides up to 64 GB of physical memory and up to 16-way SMP.

7.8. Key Point Summary

- An operating system manages the operation of a computer.
- The evolution of modern operating systems begin with the introduction of program loaders and punched cards, followed by Input/Output Control System (IOCS). After this, there was a shift from machine language to high-level languages and support of new features. Later on, the Job Control Language and the modern operating systems with multiprogramming concept were developed.
- The basic three types of functions performed by an operating system are—(*a*) Essential Functions, (*b*) Monitoring Functions, and (*c*) Service Functions.
- The role of an operating system can also be categorised into as a Resource Manager, a Processor Manager and an Information Manager.
- As a resource manager, the operating system manages programs, memory, input/output devices and interprets commands.
- As a processor manager, the operating system processor a user job at three levels—(*a*) Job Scheduling, (*b*) Program Initiation, and (*c*) Process Scheduling.
- As an information manager, the operating system functions as Physical IOCS (Input/Output Control System), Logical IOCS and File System.
- The common techniques used in different operating system are Multiprogramming, Multiprocessing and Multitasking.
- Operating systems can be classified into single-user and multi-user operating systems.
- Operating systems can also be classified into Batch Processing, Multiprogramming, Time-sharing and Real-time operating systems.

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- The major functions of a multiprogramming operating system are Processor Management, Storage Management and I/O Management.
- The major functions of a time-sharing operating system are Processor Management and Storage Management.
- Operating systems can also be classified into native and non-native operating systems.
- MS DOS is the most popular, single-user operating system for PCs.
- MS DOS is partitioned into three layers—(*a*) BIOS, (*b*) Kernel, and (*c*) Shell.
- Unix is the most popular, multi-user operating system for all types of computer.
- Unix offers many useful features such as Portability, Machine Independent, Multi-user Capability, Multi-tasking Capability, Software Development Tools, Built-in-Networking and Security.
- The system architecture of Unix is organised as a set of four layers—(*a*) Hardware, (*b*) Kernel, (*c*) Commands, and (*d*) Other application programs.
- The kernel is actually the operating system that provides all the services.
- Whenever the user on the Unix system executes a process, it is divided into two levels—User and Kernel.
- Windows is the most popular multi-user operating system for PCs that provide Graphical User Interface (GUI).
- Various versions of Windows are Windows 3.1/3.11, Windows 95, Windows 98, Windows 2000 and Windows XP.

7.9. Review Questions

1. What is an operating system ? What are the functions of an operating system?
2. Explain the following terms:
   (a) Batch monitor
   (b) Turn-around time
   (c) Throughput
   (d) Job control language
   (e) Storage fragmentation
3. Differentiate:
   (a) Preemptive and non-preemptive scheduling
   (b) FCFS and SJN scheduling techniques
   (c) Batch Process and Real-time Processing
   (d) Single-user and Multi-user operating systems
   (e) Multiprogramming and Time-sharing operating systems
4. Describe the advantages and disadvantages of time-sharing operating system.
5. (*a*) Why is password essential in a UNIX system while it is optional in a system running under DOS?

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(b) What are the 'Kernel' and 'User' modes of operation in UNIX?

6. Is multiprogramming and multitasking mutually exclusive? Explain your answer briefly.
7. What are the functions of an Information Manager?
8. What are GUIs and what are their functions?
9. (*a*) Explain the features of Windows in general.
   (*b*) How Windows operating system is different from DOS and UNIX? Discuss.
10. How does an operating system:
    (*a*) run several programs concurrently on a single CPU?
    (*b*) allow several programs to use a single printer simultaneously?
11. Describe briefly the history and evolution of operating systems.
12. Discuss the role of an operating system as a resource manager.
13. How does an operating system process a user job? Explain briefly.
14. Explain the following concepts:
    (*a*) Time-slicing
    (*b*) Swapping
15. Differentiate between Native and Non-native operating systems.
16. Discuss briefly the structure of:
    (*a*) MS DOS
    (*b*) UNIX
17. Write a short note on history of UNIX.
18. Compare the following versions of Windows:
    (*a*) Windows 3.1/3.11 and Windows 95
    (*b*) Windows 98 and Windows 2000.

Unit–8

Programming Concepts and Languages

Notes

Structure

8.1. Introduction
8.2. Procedure Oriented Programming
8.3. Object Oriented Programming
8.4. Role of Systems Analyst and Programmers
8.5. Programming Process
8.6. Program Tools
8.7. Types of Computer Languages
8.8. Object Oriented Languages
8.9. Key Point Summary
8.10. Review Questions

8.1. Introduction

In the very first unit, we discussed that computer has no intelligence of its own and each and every instruction should be given to it for performing any task. The set of instructions given to computer to process the data or perform certain task is called a *Program*. Programming is the technique for writing the programs. The programming process is a set of activities that are carried out to develop and implement a program. You must understand this process in order to become a programmer. Programming is required at all levels from manufacturing of the computer to its operation by the user. Programming, which is done at systems level for developing systems software, is known as *Systems Programming* (Systems Software Development). Systems Programs are written in low level languages like Machine/Assembly Language and some high level languages like C, C++, etc. Programming, which is done at the user level, for development of application software, is known as *Applications Programming* (Applications Software Development) or simply *Programming*. Application Software are generally developed using high level languages, DBMSs or Front End Tools.

There are two approaches used in programming—a traditional approach, Procedure Oriented Programming and a latest approach, Object Oriented Programming. You must be aware of the advantages and disadvantages of both approaches of programming. In this unit, you will study these approaches of programming, steps in programming and various types of computer languages.

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8.2. Procedure Oriented Programming

Procedure oriented programming is the traditional way of programming, where an application problem is viewed as a sequence of steps (algorithms). As per the algorithm, the problem is broken down into many modules (functions) such as data entry, reporting, querying modules etc. as shown in Figure 8.1. There are two types of data, which are associated with these modules—one is global and another is local data. *Global data items* are defined in main program, whereas *local data* is defined within associated functions. Many of the functions share global data, as this kind of data is available to all functions. Procedure oriented programming is the conventional approach of programming for developing application software. High level languages like COBOL, Pascal, BASIC, Fortran, C etc. are based on procedure oriented approach, and hence are also called *Procedural Languages*.

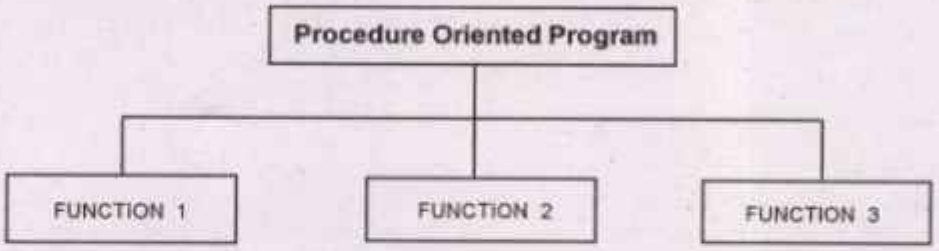

Fig. 8.1: Generalised structure of a procedure oriented program

Benefits of Procedure Oriented Programming

The main benefits of procedure oriented programming are –

- It is easy to port programs as compilers for procedural languages are easily available.
- It is easier to learn procedure oriented programming than new ways of programming.

Drawbacks of Procedure Oriented Programming

Although procedural oriented programming is the conventional approach of programming, it has certain drawbacks. The main disadvantages of this approach are:

- As most of the functions share global data, this data is freely available to all functions. Although this freely available data is easily accessed by any function, it can create certain problems. When a new function is written for analysing this data in different way it is possible that data may be changed accidentally or deliberately. Therefore, there is no security of data in procedure oriented programs.
- Another problem is that whenever data structure is required to be changed, all the functions using that data must also be changed. So, procedure oriented programs (especially for complex applications) are extremely difficult to modify and maintain.
- Procedure oriented programming does not model the real world problem.

8.3. Object Oriented Programming

Object oriented programming is the latest approach of programming. It attempts to eliminate most of the drawbacks of procedure oriented programming by incorporating new concepts. It is a new way of organising programs, which is not dependent upon any particular language. In object oriented programming, a problem is viewed not as a sequence of steps to be done, but as a collection of different units (called objects) that models the real world things. The structure of an object-oriented program is shown in Figure 8.2.

The 'Object oriented' concept can be better understood by discussing about the definitions of an object and its related terms. So, let us discuss the basic terminology used in Object Oriented Programming (OOP).

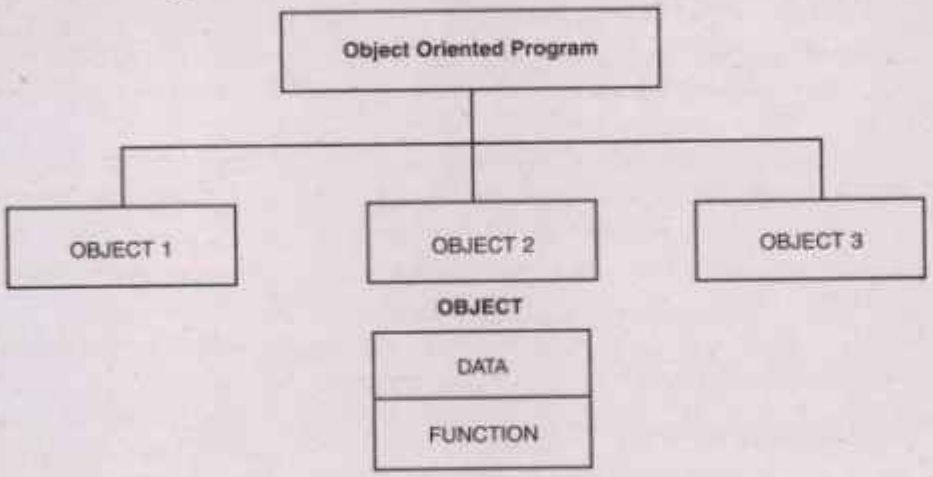

Fig. 8.2: Generalised structure of an object oriented program

Basic Terminology Used in OOP

Object. The fundamental idea behind OOP is to store the data and functions operating on that data into a single unit, called an object. An object may represent a person, a student, an employee, an account, an examination or any item that closely resembles the objects of real world.

Class. A class is a collection of similar objects. For example, if 'Car', 'Bus' etc. are different objects then 'Vehicle' is a class.

Encapsulation. The wrapping of data and functions in an object or class is known as encapsulation.

Data Hiding. Data hiding is the important feature of objects, by which data is not accessible by other functions outside the objects.

Data Abstraction. The act of representing essential features of the objects without giving details is known as data abstraction. Classes use this concept and represent essential properties of the objects.

Inheritance. An object of one class (base class) can inherit the properties of another class (derived class) by a process, called inheritance. For example,

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'Petrol Vehicle', is one class that inherits the properties of another class 'Vehicle'.

Polymorphism. The ability of objects to exhibit different behaviours in different instances is known as polymorphism. For example, an additional function of an object generates a sum if the data is in numeric form or it concatenates the strings if the data is in character form.

Benefits of Object Oriented Programming

Object oriented programming offers several benefits over the procedure oriented approach. The main advantages of using object oriented approach in software development are described as follows:

- Reusability of the code is the major benefit of object oriented programming. Redundant code can be eliminated through inheritance feature of OOP. The generation of windows, menus, dialog boxes etc. are few examples of programming codes that can be reused. So, a lot of time of programmers is saved during development of application software.
- In object oriented programming, as the emphasis is on data rather than algorithms, a program can easily be broken down into objects, which model truly the real world objects.
- The programs and data are more secure due to data hiding feature of OOP.
- New data types can be easily created through data abstraction feature of OOP.
- Object oriented programming is very useful in application areas like real-time, artificial intelligence, expert systems, computer aided manufacturing/designing, office automation and decision support systems.

Drawbacks of Object Oriented Programming

Although the object oriented approach is the latest and most widely accepted programming approach, it has certain drawbacks as described below:

- Although object oriented software are easier to upgrade and maintain, first time development process is more difficult than procedure oriented software. This drawback can be solved by using latest programming tools.
- All languages cannot easily implement object oriented approach. So, object oriented programming is limited to few languages (object oriented languages).

8.4. Role of Systems Analyst and Programmers

Software development project is not managed by a single person, but it is a teamwork. Software project is managed by a person called, *project leader*. The project leader is generally a system analyst, who analyses and designs the complete software. Programs are developed by software professionals,

called *Programmers*. System Programmers develop system software while application programmers are involved in development of application software.

System analyst and programmers play a vital role in development of an application or a system software. The analyst plays the role of a specialist in computer-based applications. Programmers are responsible for coding, editing, testing and debugging the programs. System analyst and programmers work together as a team.

Role of System Analyst

A system analyst is a person who is overall responsible for development of software He is the computer professional charged with analysing, designing and implementing computer-based information system. He is the crucial interface among users, programmers and MIS managers. He performs the following roles for the organisations:

(*i*) **Investigation of Problem.** The analyst studies the problems and needs of an organisation during development of a system. He visits the various departments of the organisation and interviews the users. He analyses the problems of the current system and collects their requirement.

(*ii*) **Solving the Problem.** The analyst solves the problems of the current system faced by the users. He determines how people, method and technology can improve the current system. He presents the system proposal to the management and after acceptance of proposal develop the system along with his team consisting of analysts, programmers and users.

(*iii*) **Managing the Project.** The analyst monitors the development and implementation of software in relation to quality, cast and time. He works with the project team for managing the project properly.

(*iv*) **Motivation.** The analyst motivates users to participate in development and implementation of the proposed system.

Role of Programmers

Programmers are the members of a project team. They perform the following roles during development of a system:

(*i*) **Development of System.** As per the design prepared by analyst, the programmers design the data structures and write the programs. During database design, the programmers create, organise and maintain data files depending upon the requirement specification, hardware configurations and the features of programming language and DBMS used. During program design, the programmers write programs (called coding of programs) as per the logic developed by analyst. Programmers also enter/edit programs using a text editor, compile execute and debut programs.

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(*ii*) **Testing of System.** The programmers play a vital role during testing of complete system. They prepare the test data with the help of users and test programs using various techniques.

(*iii*) **Implementation and Maintenance of System.** The tested software is implemented at the user's place by the analyst along with the help of programmers. The programmers with the help of technical writers prepare the manuals, conduct training programmers and convert data files from old to new system during implementation. Maintenance of system is also undertaken by programmers as per guidance of analyst.

8.5. Programming Process

Having understood the importance of programming in developing a system, we are now in a position to discuss the steps of the programming process carried out by each programmer. A program is developed in the following steps:

1. **Understanding the Problem.** As the analyst assigns the programs to different programmers module-wise, the programmers understand the problem to be solved by studying the structure charts of the system especially the assigned modules. The programmers define the problem of each program on a document and proceed for the next step.
2. **Understanding the Requirements.** After understanding the problem definition, the programmers study the input, output and processing requirements of the program, Software Requirements Specification (SRS) document and various tools of structured analysis, which forms the basis for program requirements analysis. The programmers study the SRS document and obtain the input, output and processing requirements for the programs to be written. They also study the data flow diagrams, data dictionary and process descriptions (structured English statements, decision tools and decision tables) for obtaining the program requirements. The programmers also review the database design before proceeding for the next step.
3. **Developing the Algorithm.** After defining the problem and understanding the requirements, the next step of a programming process is to develop algorithm. This is the most time consuming and crucial part of a programming process. An algorithm is a step-by-step procedure for solving a programming problem. The algorithm develops and designs the logic of a program. The common tools for developing an algorithm are:
   (*i*) *Flowcharts.* Graphical representation of the program are called Flow Charts.
   (*ii*) *Pseudocodes.* Descriptive representations of the program are called Pseudocodes.

These tools are generally called *Program Tools*. We will discuss these tools with few examples in the subsequent part of this Unit.

4. **Checking the Algorithm.** The algorithm must be complete and correct in order to ensure the efficient execution of the program. Therefore, it becomes mandatory to check the algorithm before coding it. There are many methods to check the algorithm. Some of them are –
   (*i*) *Dry Run*. Manual way of checking algorithm by finding the values of each variable after every step of algorithm is called Dry Run.
   (*ii*) *Review*. Studying the logic and comparing it with specifications is called Review.
   (*iii*) *Structured Walk Through*. Presentation of algorithm to the team members is called Structured Walk Through.
5. **Coding the Program.** After checking the algorithm and its final approval, the programs start coding. Coding involves writing of program as per the algorithm using a programming language and database environment specified in the SRS document. The programmers may do the coding manually or by using application generators and CASE tools. Screen generators, menu generators and report generators are widely used application and CASE tools for generating program codes. Although, code generators may generate many lines of program statements, they cannot generate the whole code. The programmers still require to modify the generated code and write new code manually.
6. **Entering the Code.** After writing of the program, it is entered into the computer using a text editor. Text editors are used to create, edit and print the programs. The interpreters and compilers of most programming languages (such as Turbo C, C++, Pascal, Foxpro, etc.) have inbuilt text editors.
7. **Translating Program.** After entering the program into the computer, it is required to be translated to a machine code using language translators such as interpreters and compilers.
8. **Executing and Testing the Program.** After translating, the program is executed and tested with a test data. The test data is prepared as per the requirement specifications of the program. The test data is feeded into the computer and outputs are compared with the required reports. The program is tested for the following aspects:
   - The data entry should be user-friendly with all possible errors messages.
   - Online help should be provided throughout the time of execution.
   - The execution speed should be as per the requirements.

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- The output should be as per required formats.
- The modifications and deletions should be easy and correct.
- The database must be maintained as per the requirements.

Besides the above guidelines, there may be many more aspects for testing. However, the basic aim of testing is that the program should run efficiently, correctly and according to the specifications given in SRS document and guidelines of the analyst.

9. **Debugging the Program.** During the testing, the program may have some bugs (errors), which must be connected. The bugs of a program are removed by a programming technique called debugging. During debugging the program code and algorithm is reviewed and corrected. The debugging program is entered into computer again, translated, executed and tested unless it is found cent percent error-free.
10. **Document the Program.** After the final approval of the program testing, the program algorithm and code is properly documented. A program code is documented as per the documentation techniques of programming. A project report is prepared by the programmer and submitted to the analyst or project leader. The documentation of program is a major part of systems documentation.

8.6. Program Tools

The tools that are used by programmers for developing the logic of a program are called program tools. There are two major types of program tools—Program Flowcharts and Pseudocodes. Programmers use both of these tools to design the program logic.

Program Flowcharts

A program flowchart, simply called a *flowchart*. A program flowchart is the graphical representation of the steps followed for solving any programming problem or for accomplishing a task. It is the best tool to develop the program logic. It includes all necessary steps of a program. It is called flowchart, because it charts the flow of a program. It is a symbolic representation of each input, output and processing step. Besides being a good method of writing down the algorithm, it is also a part of program documentation and helps in understanding, debugging and maintaining programs.

Before coding a program in any programming language, the programmers are always advised to draw the flowcharts first. In the flowcharting technique, operations are represented by drawing appropriate symbols for the actions. The important symbols used in a flowchart are shown in Figure 8.3. These flowchart symbols are connected by arrows to illustrate the sequence of operations. Let us briefly discuss the significance of these symbols.

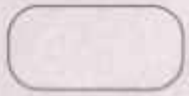
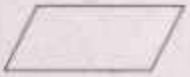
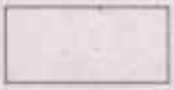
Symbol	Explanation
	**Terminator** – Used in start and end of a flowchart.
	**Input/output** – Used to accept the data or display/print the output.
	**Process** – Used to show the activity or processing to be performed on data.
	Flow lines – Used to connect other symbols in a flowchart for showing the sequence of their execution. The default direction of execution is from top to bottom and from left to right for reverse directions the arrow must be used.
	**Decision Box** – Used to check a condition whether it is true or false. Depending upon the condition, the program branches in two directions.
	**Connector** – Use to connect two parts of a flowchart.
	**Predefined Process** – Used to represent a module of a program.

Fig. 8.3: Symbols used in a flowchart

(*i*) **The Input/Output Symbol.** This symbol is used to represent the input/output operations (I/O operations) such as read and write. This is illustrated in Figure 8.4.

Fig. 8.4: The input/output symbol

(*ii*) **The Process Symbol.** This symbol is used to represent process like assigning a value to a variable or adding a number. It has one arrow going inside to denote the input data to the process and another arrow leaving it to denote the processed data leaving this process. In other words, it has one entry and one exit. Figure 8.5 illustrates this.

Notes

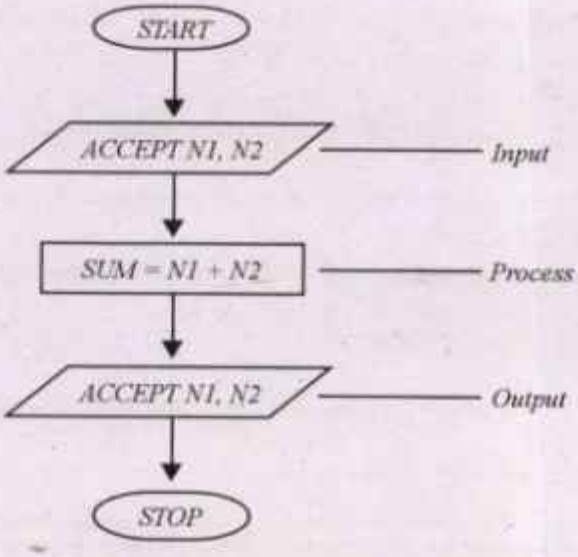


Fig. 8.5: Flowchart to add two numbers

In Figure 8.5, "Sum = N1 + N2" is a process, which adds the two numbers and stores the result in Sum. For this process, the input is numbers flowing in (represented by in-going arrow from the process).

(*iii*) **The Terminal Symbol.** This symbol indicates the beginning or the end of a flowchart as shown in Figure 8.6.

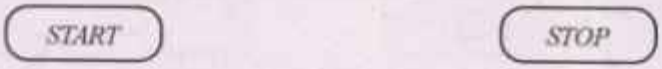


Fig. 8.6: The terminal symbol

(*iv*) **The Connector Symbol.** The connector symbol is used to maintain links between two or more flowcharts when the flowchart runs

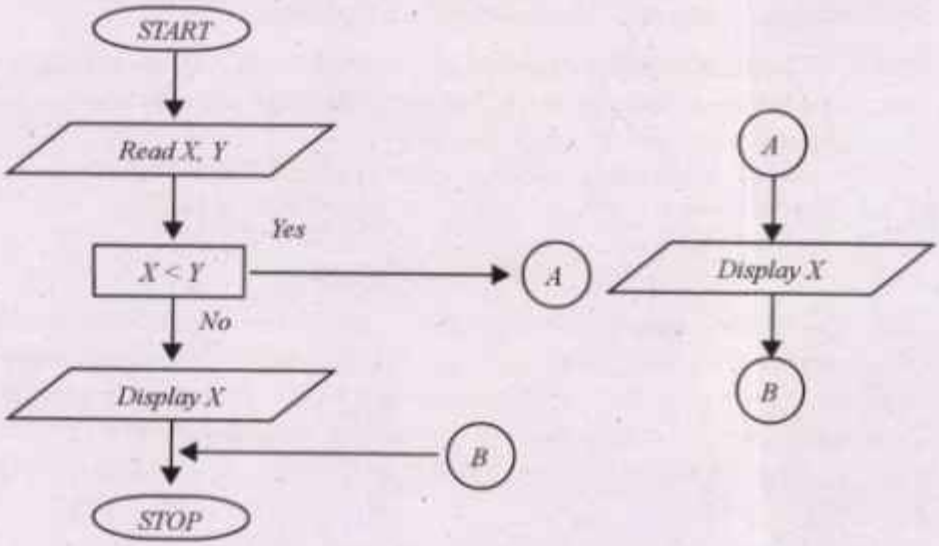


Fig. 8.7: Flowchart showing the connector symbol

longer than one page or when the same diagram is continued at different locations of the same page. If the same flowchart is continuing on the next page, then at the end of the first page this symbol is used with a marker, which can be an alphabet or a number. The same symbol is used, with the same marker as was used in the first page, at the beginning of the second page. Figure 8.7 illustrates this.

(v) **The Flowline Symbol.** This symbol represents the direction of the flow of data in a flowchart. These are straight lines with arrow heads. They are normally drawn from top to bottom and left to right.

Problem:

A student appears for a test in 3 subjects. Each test is out of 100 marks. The percentage of each student has to be calculated and depending on the percentage calculated, grades are given as under:

Percentage	Grade
⇒ 90	E+
80-90	E
70-79	A+
60-69	A
50-59	B+
<50	FAIL

Draw a flowchart for the stated problem.

Solution: Flowchart for the same is given in Figure 8.8.

Pseudocode

Pseudocode is the another way for developing the logic of a program. In contrast to a flowchart, the pseudocode uses simple English statements to represent the program logic. Some programmers prefer to write pseudocode than to draw flowcharts. The reason for this is that writing the logic of program sometimes become easier than drawing the diagrams. Some programmers use both tools, first they draw flowcharts and then write pseudocodes. Although, using both tools is time-consuming, it is the best way to develop a best program logic design.

Some of the conventions, which are used while writing pseudocodes are as follows:

- All statements in a loop should be indented.
- All alphanumeric values should be enclosed in single or double quotes.
- The beginning and end of a pseudocode is marked with keywords like 'start' and 'end' respectively.

Notes

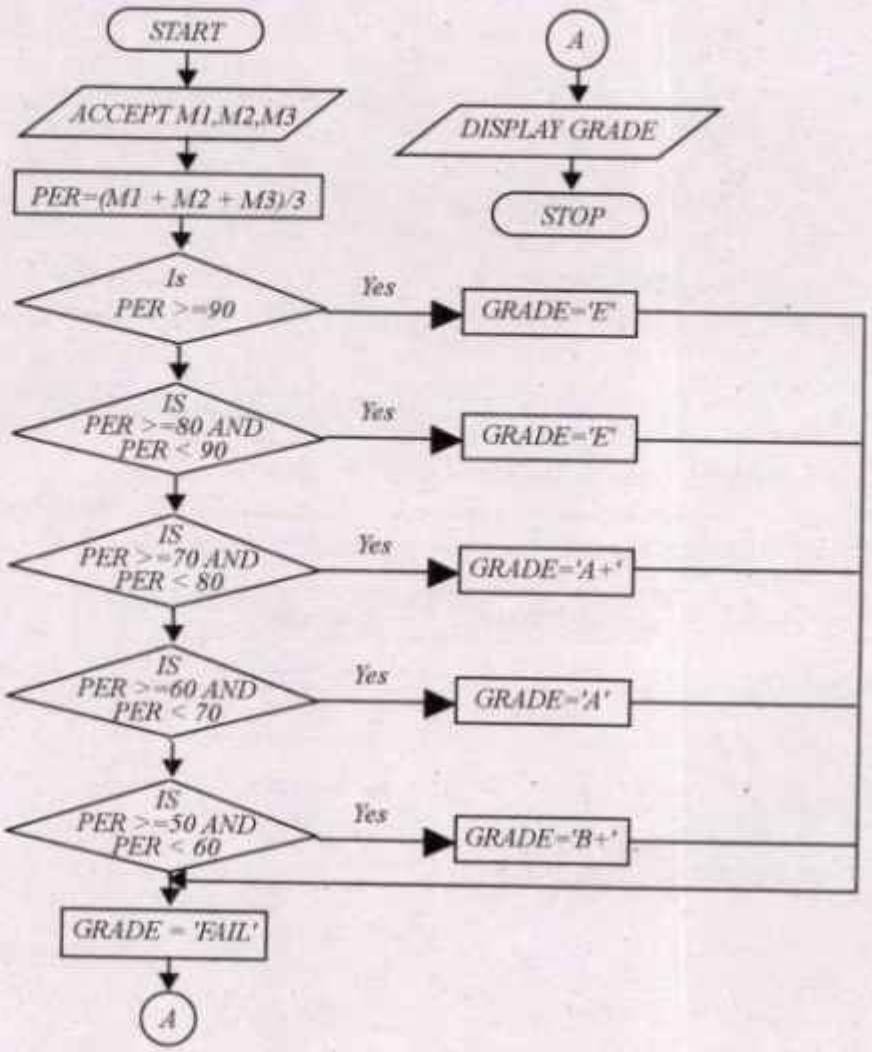


Fig. 8.8: Flowchart showing the calculation of percentages and grade

- All statements must include certain keywords, which denote an operation.

Some books follow the convention of ending each statement with a semicolon. Let us briefly discuss some of these conventions:

(*i*) **The Input Statement.** The following verbs can be used to accept or input data from the keyboard or from an existing form like a file:

Accept or Read

Example:

Accept Name

Read Name

(*ii*) **The Output Statement.** The following verbs can be used to output data:

Write or Display

Example:

```
Write Grosspay
Display Grosspay
```

Problem:

Notes

A student appears for a test in 3 subjects. Each test is out of 100 marks. The percentage of each student has to be calculated and depending on the percentage calculated, grades are given as under:

Percentage	Grade
⇒ 90	E+
80-90	E
70-79	A+
60-69	A
50-59	B+
<50	FAIL

Solution:

```
START
ACCEPT M1, M2, M3
PR = (M1 + M2 + M3) /3
IF   PER > = 90
    GRAD = 'E+'
ELSE
    IF      PER >= 80 AND PER < 90
            GRADE = 'E'
    ELSE
            IF   PER > = 60 AND PER < 70
            GRADE = 'A'
            ELSE
                IF   PER > = 50 AND PER < 50
                        GRADE = 'B+'
                ELSE
                        GRADE = 'FAIL'
                ENDIF
            ENDIF
    ENDIF
ENDIF
ENDIF
DISLAY GRADE
END
```

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8.7. Types of Computer Languages

One man communicates with another in a language, which another man can understand. Similarly, man communicates with computer in a language which machine can understand. This language, which consists of a set of commands, understandable by computer directly or after translating, is known as *Computer Programming Language*. There are many types of computer languages, which can be categorised into following four types:

(*a*) Low-level Languages (First & Second Generation Languages)

(*b*) High-level Languages (Third Generation Languages)

(*c*) User-Friendly Languages (Fourth Generation Languages)

(*d*) Object Oriented Languages (Fifth Generation Languages)

Let us discuss these in detail with examples.

Low-level Languages

In early days of computers, only those languages were used for programming, which could be directly executed on computer. Languages, which computer can understand directly and are machine dependent, are called Low-level Languages. For example, Machine Language and Assembly Language are two important low-level languages. *Machine language* is the oldest and most difficult of all the languages. It is also known as *First Generation Language*. In *Machine Language*, all the instructions are given to computer in binary digits, and hence are directly understood by the computer. On the other hand, Assembly Language is easier than machine language, and is known as *Second Generation Language*. In *Assembly Language*, instructions are given using mnemonic operation codes (such as ADD, MUL etc.) instead of binary digits as shown in Figure 8.9. Low-level languages are mainly used for development of systems software.

Reasons for learning Assembly Language. We learn Assembly language due to the following reasons:

- Although programmers prefer high level languages (such as C or Pascal) to Assembly language for developing application software, they use Assembly language combined with a high level language to speed up certain time dependent routines.
- Assembly language helps us to understand the computer architecture. The intimate knowledge of computer helps us to write very efficient programs both in assembly and high level languages.
- Assembly language does not impose many rules and restrictions for writing a program. On the other hand, high level language imposes many rules. Therefore, Assembly language is mostly used to write system programs, which are difficult to develop using HLL. For example, we can easily write a program to change hardware setting (such as Monitor Display Mode, Keyboard Characters Set, etc.) in assembly language, which is difficult to write in high level language particularly COBOL, BASIC, Fortran, etc.

```
; Program to add 2 numbers which are 16 bit each
; The number are stored in memory locations N1 and N2
; The result is stored in TOT
STACK SG SEGMENT STACK
        DW 32 DUP (O); DW (Define Word)
;The above statement defines 32 words initialized to zero
STACKSG ENDS
DATA  SG SEGMENT
        N1 DW 16h; First no stored in N1
        N2 DW 39; Second no stored in N2
        TOT DW? Result is stored in TOT
DATA SG SEGMENT
        ASSUME CS:CODESG, DS:DATASG, SS:STACKSG
START:
        MOV AX, DATASG; Initialize data Segment
        MOV DS, AX; Initialize DS Register
        MOV AX, N1; AX=N1
ADD AX, N2; AX=AX+N2
MOV TOT, AX; TOT=AX
MOV AX, 4Cooh; Requests  normal exit
2Ih; Return to DOS
CODESG ENDS
END START
```

Fig. 8.9: An example of assembly language program showing use of mnemonic operation codes

- In assembly language, the code of programs is much smaller than that of HLL programs. This is due to the fact that many lines of instructions written in a high level language can be written using simple one-line instructions of assembly language.
- As assembly language is a low-level language, each line of the source program corresponds to one machine instruction. So, the program code is smaller and hence program runs faster.

High-level Languages

Development of applications using low level languages requires a deep understanding of the hardware. In order to facilitate the programmers to write programs without knowing the internal details of computer components, many languages were developed. These languages use common English

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words and are translated into low-level languages before processing by the computer. These languages, which computer cannot understand directly and are not machine dependent, are called High-level Languages (HLL). These languages are also known as *Third Generation Languages*. Various high-level languages are described below:

(*i*) **BASIC (Beginners All Purpose Symbolic Instruction Code).** BASIC is the first programming language to be made standard with personal computers. It was first developed by John Kemessy and Thomas Kurtz, two professors from Dartmouth College, U.S.A in 1964. It was primarily developed to teach programming to students of Dart- mouth college, but later, it became so popular that today it is being taught in primary classes of most of the schools for learning programming. This is because that BASIC is very easy to learn and use as it uses common English words as shown in Figure 8.10.

```
PROGRAM TO CALCULATE PERCENTAGE OF MARKS OBTINED
10 REM
20 INPUT "Enter your Name", N$
30 INPUT "Enter you Marks obtained:, MO
40 INPUT "Enter your Maximum Marks", MM
50 LET P=(MO * 100)/MM
60 PRINT "YOUR PERCENTAGE IS", P
70 END
```

Fig. 8.10: An example of a basic program showing use of common English words

Features of BASIC. The BASIC programming language offers the following features:

- The programming is in easy language *i.e.*, in everyday English.
- Program if contains any error, can be edited easily.
- This language can be used for both mathematical and commercial problems.
- It can be used on both small (microcomputers-PCs) and large computers.
- The BASIC programs can be run on different computers with little or no modifications.
- Using BASIC, you can easily make graphics and computer games.

Versions of BASIC. BASIC is available in interpreter and compiler versions, the former being more popular for beginners. The different versions of BASIC language are:

1. ANSI BASIC. It is an interpreter-based version of BASIC, standardised in 1978 by the American National Standards Institute.
2. BASICA (Advanced BASIC). The interpreter-based version of BASIC, which was developed by Microsoft corporation for the IBM PC Compatible computers.

3. GW-BASIC (Gee Whiz BASIC). It is the BASIC Interpreter that accompanied with MS-DOS in versions prior to 5.0.
4. QBasic. It is the BASIC interpreter that accompanied with MS-DOS and PC-DOS version 5.0. It supersedes GW-BASIC and includes a program REMLINE.BAS that can convert GW-BASIC programs to QBASIC code.
5. Quick BASIC. It is the popular BASIC compiler from Microsoft that adds advanced features to the BASIC language.
6. Visual BASIC. It is the most popular version of *QUICK BASIC* for developing of Windows-based applications. It is considered a new programming language and environment (developed in 1990), which is based on BASIC language.

(*ii*) **COBOL (Common Business Oriented Language).** COBOL has been the most popular high-level language for developing business applications mainly a mainframes and minis. It was developed in around 1960 and is still being used for developing business applications that typically run on mainframes. One time, COBOL was also popular on PCs but now it has become obsolete on microcomputer's environment. There are different versions of COBOL-COBOL ANSI'74, COBOL 85 and Microsoft COBOL. The ANSI'74 version of COBOL was standardised in 1974 by American National Standards Institute. COBOL 85 and Microsoft COBOL has been the most popular versions of COBOL.

COBOL is the most structured programming language because its instructions can be read and understood easily by the programmers who have not written them as shown in Figure 8.11. All COBOL programs are divided into four parts, called *divisions*. The first division, called *IDENTIFICATION DIVISION*, documents the program's name, author, date-written, etc. The second division, called *ENVIRONMENT DIVISION* specifies the hardware and software environment of the program. The third division, called *DATA DIVISION*, defines the names and formats of the files and variables used in the programs. The last division is the *PROCEDURE DIVISION*, which describes the step-wise instructions and statements of the program.

Although COBOL programs are lengthy in coding, they follow the rules of structured programming techniques. So, if you can learn COBOL, you can learn any programming language very easily.

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```
* PROGRAM TO COPY A DATA FILE
  IDENTIFICATION DIVISION.
  PROGRAM-ID. COPY-A-FILE.
  AUTHOR. ASHOK ARORA.
  INSTALATION. EXAM CENTRE.
  DATE-WRITTEN. JULY 6, 2001
  DATE-COMPILED. JULY 6,2001.
  SECURITY. FOR DEMO ONLY.
  ENVIRONMENT DIVISION.
  CONFIGURATION SECTION.
  SOURCE-COMPUTER. PENTIUM-III.
  OBJECT-COMPUTER. PENTIUM-III.
  INPUT-OUTPUT SECTION.
  FILE-CONTROL.
          SELECT INPUT-FILE ASSIGN DISK
          ORGANIZATION IS LINE SEQUENTIAL.
          SELECT OUTPUT-FILE ASSIGN DISK
          ORGANIZATION IS LINE SEQUENTIAL.
  DATA DIVISION.
  FILE SECTION.
  FD INPUT-FILE
          LABEL RECORDS ARE STANDARD
          VALUE OF FILE-ID IS "EXAM.DAT".
  01 INREC PICTURE X (80).
  FD OUTPUT-FILE
          LABEL RECORDS STANDARD
          VALUE OF FILE-1D IS "EXAM1.DAT".
  01 OUTREC PICTURE X(80).
  WORKING-STORAGE SECTION.
  01 EOF PIC X VALUE 'N'.
  PROCEDURE DIVISION.
  MAIN-PARA.
          OPEN INPUT INPUT-FILE OUTPUT OUTPUT-FILE.
          READ INPUT FILE AT END MOVE 'Y' TO EOF.
          PERORM FILECOPY-PARA UNTIL EOF ='Y'
          CLOSE INPUT-FILE OUT-FILE.
          STOP RUN.
  FILECOPY-PARA.
          MOVE INREC TO OUTREC
          WRITE OUTREC.
          READ INPUT-FILE AT END MOVE 'Y' 60 EOF.
```

Fig. 8.11: An example of a COBOL program for copying a data file

(*iii*) **FORTRAN (Formula Translator).** FORTRAN is the first high-level programming language, developed by John Backus of IBM during 1956-57. Although it was originally designed to express mathematical formulas and is used occasionally for business applications, it is still the most popular language for developing scientific and engineering applications to solve mathematical problems as shown in Figure 8.12.

```
C ** PROGRAM TO CONVERT CENTIGRADE TO FAHRENHEIT
C ** CT STANDS FOR CENTIGRADE TEMPERATURE
C ** FT STANDS FOR FAHRENHEIT TEMPERATURE
      READ * , CT
      FT = 1.8 * CT + 32.0
      PRINT * , CT, FT
      STOP
      END
```

Fig. 8.12: An example of a FORTRAN program converting Centigrade to Fahrenheit

Version of Fortran: The popular versions of FORTRAN are FORTRAN II, FORTRAN IV, FORTRAN 77 and FORTRAN V. FORTRAN II was the first version of FORTRAN used during 1950-60. FORTRAN IV was standardised, by ANSI in 1966. In 1977, an updated version of FORTRAN IV was announced which is called FORTRAN 77 and was standardised in 1978 by ANSI. FORTRAN V is the latest version of FORTRAN.

(*iv*) **ALGOL (ALGOrithmic Language).** ALGOL is a high level programming language that was developed as an international language for the expression of algorithms between people and machines in 1960. Algol-60 was a turning point in language development since it was designed to reflect mathematical algorithms.

(*v*) **Pascal.** Pascal is a high-level programming language developed by a Swiss Professor Niklaus Wirth in the early 1970s. It was named after Blaise Pascal, a French mathematician who built the first desk-calculator type adding machine in the seventeenth century. Pascal is a structured programming language like COBOL, but it is not only used for developing business applications but also for scientific applications. In fact, you can write program for any application in Pascal as shown in Figure 8.13. Pascal is a compiler-based language, built upon ALGOL by simplifying syntax and adding data types and structures such as files, records and sets.

```
{Program to calculate perimeter of a circle}
PROGRAM calperi (OUTPUT);
{The following statements declare constant}
CONST
        pi = 3.14159;
{The following statements declare variables}
VAR
        rad, peri :REAL;
{Beginning of program block}
BEGIN
        WRITE ('Enter radius');
        READLN(rad);
        peri := a* pi * rad;
        WRITELN ('Perimeter=', peri)
END.
{END of program block}
```

Fig. 8.13: An example of a Pascal program for calculating perimeter of a circle

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Turbo Pascal: There are many versions of Pascal programming language, but Turbo Pascal, developed by Borland International in 1983 is the most popular one. There are also different versions of Turbo Pascal viz. 1.0, 2.0, 3.0, 4.0, 5.0, 5.5 and 6.0. Turbo Pascal 6.0, developed in 1990, is the latest version of Turbo Pascal.

(*vi*) C. C is the most powerful high-level language, developed by Dennis Ritchie at AT&T's Bell Laboratories of USA in 1972. It was developed to replace the popular language of that time like ALGOL, PL/I, PL/M etc. The statements of C are very similar to those of Pascal as shown in Figure 8.14.

```
/* Program to calculate perimeter of a circle */
#include <stdio.h>
main ()
{
        float pi = 3.14159
        float rad, peri;
        printf ( "Enter radius");
        scanf ( "%f", &rad);
        peri = 2* pi * rad;
        printf ( "perimeter = %f", peri);
}
```

Fig. 8.14: An example of a C program for calculating perimeter of a circle

Historical Development of C. The history of developing C started in 1960, when ALGOL language was developed by an international committee for searching a language, which can program all types of application. ALGOL 60 did not become popular, as it was very abstract and general. Later on, in 1963, a new language called *CPL* (Combined Programming Language) was developed at Cambridge University. As CPL was hard to learn and more difficult to implement, in 1967, Martin Richards at Cambridge University modified CPL and developed a new language called *BCPL* (Basic Combined Programming Language). But BCPL could deal with only specific problems and was not accepted. In 1970, Ken Thompson at AT & T'S Bul Laboratories developed language called *B*. But again B language could deal with only specific problems. Finally, in 1972, Dennis Ritchie developed the C language.

Feature of C. C language offers features of both low-level (2nd generation) and High-level (3rd Generation) languages as discussed below:

1. Pointers. In C, we can refer the memory locations by its internal address, called pointers. Pointers is one of the features of Low-level languages.
2. Dynamic Allocation of Memory. In C, the programs during execution can request operation system to release memory for its use, which is called Dynamic Allocation of Memory. This is again one of the features of Low-level language.

3. Bit Manipulation. In C, data can be manipulated in its lowest form of storage *i.e.*, BITS, which is again one of the features of Low-level language.
4. Recursion. In C, one function may call itself again and again, which is called Recursion. Recursion is a feature of high-level language.

Uses of C. As C provides features of both low and high level languages, it can be used to develop both system and application software. C can be used to develop operating systems, compilers, interpreters and other system software. You can also use C to develop both commercial and business application software.

Versions of C: There are many versions of C viz. ANSI C, Microsoft C and Turbo C. Turbo C is the most popular one among them.

(vii) LOGO. LOGO is a high-level programming language, created by Seymour Papert in the mid 1960s for teaching programming to young children for making drawing. LOGO is so simple to learn that children studying in First class can use it. Using Logo, children can create simple to complex patterns on screen very easily. Logo is also called *Turtle graphics* as you can create patterns consisting of lines rectangles, squares, circles etc. by moving turtle (a triangular shaped cursor) with simple commands as shown in Figure 8.15.

```
FD 50
RT 90
FD 25
RT 90
FD 20
RT 90
FD 25
```

Fig. 8.15: Logo Program to draw a flag

(viii) Ada. Ada is a high-level language, based on concepts developed in Pascal language. It was designed for embedded application, where a computer forms part of a speicalized system such as a cruise missile. It was developed as a result of search for a new programming language organised by the US Department of Defense in the late 1970s. Ada was named after August Ada Byron (1815-1852), counters of Lovelance and daughter of Lord Byron. Lady Ada was a mathematician and colleague of Charles Babbage (Father of computers), who built a digital computer, called *Analytical engine*. As the software for the Analytical Engine was developed by lady Ada, therefore she is known as the *Word's First Programmer*. The language Ada is named in her honour.

(ix) LISP (Lisp Processing). LISP is a high-level language, developed in the early 1960s by John McCarthy. LISP was designed mainly for the manipulation of List and tree structures of various kinds. LISP

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is used in Artificial Intelligence application and compiler creations. It is available both in interpreter and compiler versions.

(x) **PL/I (Programming Language I) and PL/M (Programming Language for Microcomputers).** PL/I is a high-level language developed by IBM during 1964-69. It was designed to bring together the key features of FORTRAN, COBOL and ALGOL along with introducing new concepts like multitasking. PL/I did not become popular as it was very complex.

Later on, in the early 1970, Intel corporation modified PL/I and developed a new language for microcomputers, called *PL/M*, which was mainly used for developing operating system.

At one time, High-level languages were widely used for applications development, but most of them are now outdated due to popularisation of 4GLs. The uses of different 3GLs are summarised in Table 8.1.

Table 8.1: Uses of 3GLs

Language	Uses
BASIC (Beginner's All Purpose Symbolic Instruction Code)	Used for all purposes (Commercial, Scientific, Educational, Graphics etc.) by beginners.
COBOL (Common Business Oriented Language)	Mainly used for development of commercial applications on all types of computers.
FORTRAN (Formula Translator)	Used for development of scientific (mathematical) applications.
ALGOL (ALGOrithmic Language)	Used to reflect mathematical algorithms.
Pascal (Name of a Mathematician)	Used for both commercial and scientific applications.
C (No full form)	Very powerful language for development of both system and application software.
LOGO	Used by young children for making drawings on computer.
ADA (Name of a Programmer)	Used to develop embedded applications for defense.
LISP (LISt Processing)	Used to develop artificial intelligence applications.
PL/I and PL/M (Programming Language I and Programming Language for Microcomputers)	Used to develop system software mainly operating systems.

User-friendly Languages

Although high-level languages are simpler to codify than low-level languages, they still require a lot of time to learn programming syntax. Hence,

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these languages are beyond the reach of many computer users, who do not want expertise in programming. Therefore, a new category of languages have been developed which are user-friendly, very easy to codify and simplest to learn. These languages are called *User-friendly Languages* an l popularly known as 4GLs (*Fourth Generation Languages*). Fourth generation languages may be classified into two categories-Xbase and Structured Query Language.

(*i*) **Xbase.** Xbase is generic term denoting any of the programming environment based on the original dBASE programming language. Xbase languages include dBASE, FoxBase, Clipper and FoxPro, Fox Base, Clipper and FoxPro out of which the FoxPro is still being used by programmers while others are outdated.

(*a*) *dBase.* dBase is the first popular fourth generation language, on which the other Xbase languages (Foxbase, Clipper and FoxPro) are based. It is a relational database management system (DBMS) for PCs, developed by Borland. dBase is an interpreter based language, but its programs can be compiled with Clipper. You can write program for any type of application such as preparation of the results of students in dBase as shown in Figure 8.16.

Version of dBase. Various versions of dBase are:

- Vulcan: dBase was originally named Vulcan by Wayne Ratliff, who created it to manage a company football pool.
- DBase II: Hal Lashlee and George Tate renamed Vulcan with dBase II in 1981 and formed Ashton-Tate company to market it. In 1991, Ashton-Tate company was acquired by Borland.
- DBase III: In 1984, dBase II was upgraded to dBase III.
- DBase III plus: In 1986, new features are added to dBase III and dBase III plus was introduced.
- DBase IV. It is a major upgrade of dBase III plus with features like report/screen generation, SQL (Structured Querry Language) and QBE (Querry By Example) interfaces.

(*b*) *FoxBase.* FoxBase is Xbase development system from Microsoft, which is similar to dBase. FoxBase was originally developed by Fox software for DOS. FoxBase+ is the most popular version of FoxBase, which gained a reputation for its higher speed and more compatibility than dBase III plus. As programming in FoxBase III+ was quite similar to that in dBase III+, programmers preferred the former due to its higher speed.

(*c*) *Clipper.* Clipper (latest version 5.2) is the most popular dBase-compatible application development system. It was first developed by Nantucker Corp, which was acquired by Computer Associates in 1992. Originally, it was being used as a dBase compiler for programmers, but later on it became a stand-alone development system with many unique features.

PROGRAMMING EXAMPLE

Write a program to input Student Name, Marks Obtained & Max. Marks. Calculate percentage and display the result. Store the data in following DBF structure:

Field Name	Type	Width	Decimal
NAME	Character	20	
MO	Numeric	4	
MM	Numeric	4	
PERC	Numeric	6	2
RESULT	Character	1	

SOLUTION

Step 1 Load dBASE and Create a DBF file with given structure by giving command CREATE STUD & save it. (Don't enter records)

Step 2 Type MODIFY COMMAND RESULT at dBASE command prompt, type program & save it.

Step 3 RUN the program by typing the command, DO STUD at dBASE command prompt.

PROGRAM

```
   PROGRAM TO ENTER DATA OF STUDENTS
CLOSE ALL
USE STUD
CLEAR
@ 1,30 SAY "DATA ENTRY SCREEN"
@ 3,10 SAY "STUDENT NAME"
@ 5,10 SAY "MARKS OBT"
@ 7,10 SAY "MAX. MARKS"
@ 9,10 SAY "PERCENTAGE"
@11,10 SAY "RESULT"
STORE SPACE(20) TO MNAME
STORE 0 TO MMO, MMM, MPERC
STORE SPACE(1) TO MRESULT
ANSWER = 'Y'
DO WHILE ANS = 'Y'
        @ 3,30 GET MNAME
        @ 5,30 GET MMO PIC "9999"
        @ 7,30 GET MMM PICT "9999"
        READ
        MPERC = MMO*100/MMM
        @ 9,30 SAY MPERC PICT "999.99"
        IF MPERC = 40
                MRESULT = 'P'
        ELSE
                MRESULT = 'F'
        ENDIF
        @ 11,30 SAY MRESUTL
        APPEND BLANK
        REPLACE         NAME    WITH    MNAME
        REPLACE         MO      WITH    MMO
        REPLACE         MMM     WITH    MMM
        REPLACE         PERC    WITH    MPERC
        REPLACE         RESULT  WITH    MRESULT
        @ 13,10 SAY " DO YOU WANT TO CONTINUE" GET ANSWER PICT "Y"
        READ
        @ 3,30 CLEAR TO 11,60
ENDDO
CLOSE ALL
CLEAR
RETURN
```

Fig. 8.16: A programming example in dBASE

Although, now nobody uses clipper, earlier, it was very popular among dBase programmers due to its following features:

- Clipper is a flexible Xbase language for writing efficient, encapsulated, and reusable program modules.
- It provides a powerful, flexible and replaceable database engine.
- It provides the simplest and efficient way to develop sophisticated and friendly user interface.

(*d*) *FoxPro:* FoxPro is the dBase IV compatible Xbase language from Microsoft. FoxPro is an enhansed version of FoxBase,

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which includes GUI (Graphical User Interface) SQL (Structured Querry language) and QBE (Querry By Example) interfaces. Various versions of FoxPro include FoxPro 1.0, FoxPro 2.0, FoxPro 2.6 for DOS /Window and Visual FoxPro 3.0/5.0/6.0. Visual FoxPro 6.0, the latest version of FoxPro is currently very popular among programmers for application development due to object-oriented of features and client/server support.

(*ii*) **Structured Query Language.** Structured Query Language (SQL), developed by IBM, is a standard data definition and data manipulation language (DDL/ DML) of relational databases. It is designed to define, access, querry, organise and update the data and information in relational databases. It is now provided with most RDBMS and non-relational DBMS. SQL is generally hidden by user-friendly interfaces in an end-user environment. It is an English-like query language, intended for interactive use by untrained end users and was originally spelled SEQUEL (*Structured English Query Language*). Although SEQUEL consists of basic vocabulary of English-like words like SELECT, INSERT, DELETE actually it has not much resemblance with English language. Therefore, now, it is generally pronounced as SQL. SQL has now become the favourite among programmers who write programs that access relational databases. We would continue our discussion with some of the common statements of SQL in brief.

SQL Statements. SQL statements are grouped into the following three categories:

(*a*) *DDL* (Data Definition Language) statements

(*b*) *DML* (Data Manipulation Language) statements

(*c*) *DCL* (Data Control Language) statements

Some of the important SQL statements of the above three categories are described in Table 8.2. Using these statements, data in an RDBMS can be defined, manipulated and controlled.

To create a table of Supplier Database in SQL, the following statement is used:

```
CREATE TABLE SUPPLIER
        (SUPPNO CHAR(3)          NOT NULL,
SUPPNAME                         CHAR(20),
CITYCODE                         NUMBER(2),
CITYNAME                         CHAR(3));
```

To query the database, the following statement is used:

```
SELECT SUPPNO, SUPPNAME, CITYCODE, CITYNAME
        FROM SUPPLIER
        WHERE SUPPNO = 'S01';
```

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Table 8.2: Important SQL statements

Command	Description
SQL DDL Statements	
CREATE table	Create a database table
CREATE INDEX	Create an index for a table
ALTER TABLE	Alters the definition of a table
DROP	Delete a table or index from the database
RENAME	Changes the name of a table
SQL DML Statements	
SELECT	Retrieves data from one or more tables
DELETE	Delete one or more rows from a table
INSERT	Inserts one or more rows into a table
UPDATE	Updates existing rows in a table
SQL DCL Statements	
GRANT	Grants security access rights to the database
REVOKE	Revokes security access rights

The uses of different 4GLs are summarised in Table 8.3.

Table 8.3: Uses of 4GLs

Language	Uses
dBASE	Used for development of mainly single user DOS based database appliactions.
FoxBase	Used for development of both single and multiuser DOS based database applications.
FoxPro	Used for development of both DOS and Windows based database applications.
Clipper	Used for development of both single and multiuser DOS based database applications.
SQL (Structure Querry Language)	Used to define, access quarry, organised and update data in relational database.
PL/SQL (Procedural Language/ Structured Query Language)	Used as a development tool that extends the facilities of oracle's SQL database language
PRO * C	Used to generate native C code by embedding SQL commands.

8.8. Object Oriented Languages

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We have discussed that the object oriented programming is the latest approach in programming. The languages which are based on object oriented programming (OOP) approach, are called as *Object Oriented Languages*. They may be classified into *Fifth Generation Languages*. Object oriented languages are specially useful for development of GUI (Graphical User Interface) applications. These languages also offer a unique feature of Reusable Code. Some of the popular object oriented languages are Smalltalk, C++, Object COBOL, Object Pascal, Simula, Eiffel, Java and Visual J++. C++ and Java J++, which are widely used now-a-days for development of Window-based applications are described below:

(*a*) **C++.** C++ is an object-oriented version of C. It was developed by Bjarne strougtrup at Bell Labs in the early 1980s. It has become very popular because it incorporates Object-Oriented Programming (oop) features in traditional C programming. So, C++ is a superset of C. The structure of a C++ program resembles with that of C with few changes in syntax as shown in Figure 8.17. The popular version of C++ is Turbo C++ (latest version 6.0).

```
// Program to calculate the perimeter of a circle
# include <iostream.h>
void main()
{           float pi = 3.14159'
            float rad, peri;
            cont << "Enter radius"
            cin >> rad;
            peri = 2* pi * rad;
            cont << "perimeter "<< peri;
}
```

Fig. 8.17: An example of a C+ program for calculating perimeter of a circle

(*b*) **Java.** Java is an object-oriented programming language from the Java Soft division of Sun. Java is mainly used for developing Internet and Intranet applications. Using Java, you can develop client/server applications for the World Wide Web. Although Java is similar to C, C++ and Objective C, it is not based on any of these languages.

Features of Java: Java language offers the following features:

- Java is an interpreter-based language. The source code of a java pogram is converted into byte code, which is then converted into machine code during execution by the Java interpreter, called *Java Virtual Machine*. With Java Virtual Machine, Java programs can be run on any computer and hence they are hardware independent.
- Java is a difficult-to-learn language. So, it is not meant for the beginners.
- Java provides a special class called *Java Applet*, which can be run by an already running Java application such as a Web browser. Java applets

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can be downloaded and run on any Web browser (e.g., Internet Explorer, Netscate Navigator, etc.) capable of interpreting Java.

- Java provides a reusable object called *Java Bean*. A Java Bean is similar to an Active controls, which execute only on computers supporting OLE (Object Linking and Embedding) at the operating system level. Using Java Beans, the developer can quickly create applications.

The uses of different object oriented languages are summarised in Table 8.4.

Table 8.4: Uses of object-oriented languages

Language	Uses
Smalltalk	Used for development of mainly graphical applications.
C++	Used for development of all types of object oriented applications.
Object COBOL	Used for development of object oriented applications on mainframe computer.
Object PASCAL	Used for general object oriented applications.
Simula	Mainly used in a research environment.
Eiffel	Used for general object oriented applications.
Visual J++	Very popular for development of Windows based applications.

Object Based Languages. There are certain languages, which support most of the features of object oriented programming except inheritance. These languages are not pure object oriented languages and are known as Object Based Languages. For example, Ada, an high level language designed for process control is an object based language.

8.9. Key Point Summary

- There are two approaches used in programming—Procedure Oriented and Object Oriented.
- In procedure oriented programming, an application problem is viewed as a sequence of steps while in object oriented programming, it is viewed as a collection of different units, called objects.
- Object oriented programming uses the Concepts of Classes, Encapsulation, Data Hiding, Data Abstraction, Inheritance and Polymorphism.
- A software development project is managed by a team of system analysts and programmers.
- A system analyst performs the role of a problem investigator, problem solver, manager and motivator.
- Programmers are responsible for development, testing, implementation and maintenance of the system.

- Various steps of a programming process are—(*a*) Understanding the problem, (*b*) Understanding the requirements, (*c*) Developing the algorithm, (*d*) Checking the algorithm, (*e*) Coding the program, (*f*) Entering the code, (*g*) Translating program, (*h*) Executing and testing the program, (*i*) Debugging the program, and (*j*) Document the program.
- The two major types of program tools are program flowcharts and pseudocodes.
- Program flowchart is a symbolic representation of each step of program and is the best tool to develop the program logic.
- The different symbols of flowchart are Input/Output, Process, Terminal, Connector and Flowline symbols.
- Pseudocode uses simple English statements to represent the program logic.
- The programming languages are classified into four types—(*a*) Low-level, (*b*) High-level, (*c*) User-friendly, and (*d*) Object-oriented languages.
- The computer languages are also classified into five generations based on their historical development.
- Machine language and Assembly language are low-level languages.
- Machine language is a first generation while assembly language is a second generation language.
- BASIC, COBOL, FORTRAN, ALGOL, Pascal, C, LOGO, Ada, LISP, PL/I and PL/M are various high-level languages (Third Generation Languages).
- dBase, FoxBase, Clipper, FoxPro, SQL, PL/SQL and PRO*C are various user friendly languages (Fourth Generation Languages).
- C++, Smalltalk, Object COBOL, Object PASCAL, Simula, Eiffel and Java/Visual J++ are various object-oriented languages (Fifth Generation Languages).

8.10. Review Questions

1. Discuss the different programming approaches by giving suitable examples.
2. Define the following terms:
   (*a*) Object
   (*b*) Class
   (*c*) Encapsulation
   (*d*) Data Hiding
   (*e*) Inheritance
   (*f*) Polymorphism
   (*g*) Data Abstraction
   (*h*) OOP
3. Discuss the role of systems analyst and programmers in the development of software.
4. Why do we need object oriented programming approach? Discuss.
5. Discuss the programming process in detail.
6. What are program tools? Explain the difference between flowchart and pseudocode with suitable examples.

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7. Draw and explain different symbols used in drawing a flowchart.
8. Draw the flowcharts to solve the following problems:
   (*a*) To add N natural numbers
   (*b*) To determine the smallest number out of given N numbers.
   (*c*) To print first 10 fibonacci series *i.e.*, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55.
9. Write pseudocode statements:
   (*a*) To add first 10 even numbers
   (*b*) To find out the perimeter of a rectangle where Perimeter = 2 * (Length + Breadth).
10. What do you mean by computer languages? Differentiate among High-level, Assembly and Machine language.
11. List the salient features and typical application areas of the following high level languages:
   (*a*) C (*b*) BASIC
   (*c*) COBOL (*d*) FORTRAN
12. What are fourth generation languages? Why are they called user-friendly languages?
13. Explain the difference between the following:
   (a) Low level and High-level Languages
   (b)Third and Fourth Generation Languages
14. Classify the following languages into First, Second, Third, Fourth and Fifth Generation Languages and write their uses:
   (*a*) CGBOL (*f*) C++
   (*b*) Ada (*g*) Smalltalk
   (*c*) PL/I (*h*) Machine
   (*d*) dBase (*i*) Assembly
   (*e*) SQL (*j*) Pascal
15. Mention three factors that make high-level languages more advantageous than machine level languages.
16. What do you understand by the following and give examples to justify your answer:
   (*a*) Scientific-purpose Languages
   (*b*) Business-purpose Languages.

Unit–9

Modern Information Technology

Notes

Structure

9.1. What is Networking
9.2. Types of Networks
9.3. Network Topologies
9.4. Key Point Summary
9.5. Review Questions

9.1. What is Networking

Network is a group of computers and peripherals, connected by a communications channel. It is capable of sharing files and other resources such as printers, drives, etc. among many users. It ranges from local area networks to wide area networks.

Components of Networking

The typical hardware in networking consists of the following components:

(*i*) **Computers.** They may include mainframes, minis and micros.

(*ii*) **Peripherals.** Printers, Scanners, Plotters, etc. are the peripherals connected to the network.

(*iii*) **Data Communications Equipment.** Modem is the main data communication equipment in a network.

(*iv*) **Cables.** Various types of cables viz. Twisted-pair, Coaxial, Fiber optic, etc. are used for transmission of data in a network.

(*v*) **Network Interface Cards.** It is a PC expansion board that plugs into a personal computer or server and works with the network operating system to control the flow of information over the network. It is connected to the network media, which in turn connects all the network interface cards in the network.

(*vi*) **Hubs.** They are used to extend a network so that additional workstations can be attached.

(*vii*) **Switches.** They are devices capable of forwarding data packets directly to the ports associated with particular network addresses.

(*viii*) **Repeaters.** They are hardware devices that move all packets from one network segment to another by regenerating, re-timing and amplifying the electrical signals.

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(ix) **Bridges.** They are hardware devices used to connect local are networks so that they can exchange data. They work with networks that use different network protocols or wiring.

(x) **Routers.** They are intelligent connecting devices that can send packets to the correct local area network segments to take them to their destination. They link network segments at the network layer of the ISO/OSI model for data communications.

(xi) **Brouters.** They are networking devices that combine the characteristics of bridges and routers. A brouter routes one or more specific protocols and bridges all others.

(xii) **Gateways.** Gateways are shared network connections between local area networks and larger networks whose communication protocols are different.

Uses of a Network

A network is used for a wide range of purposes, some of which are:

- The network provides an intelligent switching capability between the peripheral devices such as printers, scanners, etc. for purpose of sharing.
- The network enables the creation of a large buffer where data accumulates from various computing devices. In case of printer sharing, the buffer activates as a queue on a special device called *print server*.
- In a typical office environment, a network provides the facilities of terminal access to central computing machine such as mainframe.
- A network enables access to external and remote devices.
- A network enables access to database located centrally on a mainframe computer or distributed on client/server machines.
- The environments like Point Of Sales (POS) in retail outlets are not possible without networking.
- Automatic Teller Machines (ATMs) of the banks work on a network.
- Centralised railway and airlines reservation is not feasible without a network of computers.
- Internet is a very big network of networks, which have brought a revolution in the IT.

9.2. Types of Networks

Networks can be divided into the following five categories:

1. Local Area Network (LAN)
2. Wide Area Network (WAN)
3. Metropolitan Area Network (MAN)
4. Wireless Network
5. Internetwork

Let us discuss these.

Local Area Network (LAN)

Local Area Network (LAN) connects several computers 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) and a communication link (such as Modem). *File Server* is a host computer of the network that holds data/ programs and makes access to files, printing and other services available to users of the network. Typically, a server has a more advanced CPU with more memory and storage capacity than a workstation. Large networks may have more than one file servers. Workstation is a user's machine (other than server) that can also function as a stand alone computer. Workstations are also called the terminals of a LAN. They are interconnected and connected to the file server. The significant feature of a LAN is that its workstations are intelligent terminals with a capability of distributed processing. This is unlike in a mainserver or miniframe centralised server based environment where the connected terminals are dumb without their own processing power. The *Peer-to-Peer network* is a type of local area network in which all the resources of each PC is available to other PCs on the network.

The network connecting devices such as hubs, switches, repeaters, bridges, routers and gateways are generally applied whenever expansion of a LAN is required. A local area network is needed to be expanded mainly for following two reasons:

(*i*) Firstly, two or more LAN systems are needed to be integrated for sharing of peripherals and data resources.

(*ii*) Secondly, LAN may be needed to expand beyond geographic limits of optimum performance.

Advantages of LAN. A local area network provides the following advantages to an organisation or a computer user:

- Using a LAN, expensive resources such as disk, files, printers, plotters, modems and software can be easily shared among many users.
- Data management in a LAN environment is more efficient than the centralised processing systems.
- Workstations of a LAN provided security and virus protection by not allowing to download important data from server or uploading unwanted software.
- LANs are more flexible and modular as they can be expanded easiliy by adding more workstations with the support of networking software. If more disk storage is required, you can install another hard disk or connect other fileserver in a LAN. Even you can bridge more than one LAN for sharing and transmitting data.
- Most LANs have fault-tolerant capabilities. So, in the case of power failures, they can safeguard data by disk mirroring and disk duplexing. *Disk mirroring* is a fault-tolerant technique that stores the

same information simultaneously either on two hard disks or two partitions of a hard disk using the same disk controller. *Disk duplexing* is similar to disk mirroring but uses a different disk controller to provide greater dedundancy.

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Wide Area Network (WAN)

As contrast to LAN, Wide Area Network (WAN) connects users across large distances, often crossing the geographical boundaries of cities or states. Thus, WANs are much bigger than LANs. A WAN may consist of several LANs. The individual LANs inside the WANs are generally referred as *sub-networks*.

Wide area network contains a collection of machines, called *hosts*, which run user programs. The hosts are connected by a communication subnet, which carries messages from host to host. In most WANs, the subnets consist of to distinct components— channels and switching elements. The *channels* are the transmission lines, which move data between machines. The *switching elements* are the specialised hardware devices that connect two or more channels. They are also called *data switching exchanges, packet switching nodes* or *routers*.

Types of WAN Subnets. There are two types of WAN subnets—Point-to-Point and Wireless.

(*a*) *Point-to-Point Subnets.* In point-to-point subnet, the network contains numerous cables, each one connecting a pair of switching elements. The two switching elements that do not share a cable communicates via other switching elements. There are several types of topologies possible for point-to-point subnets viz. Ring, Star, Tree, etc. These topologies are discussed in the subsequent part of the unit.

(*b*) *Wireless Subnets.* In a wireless subnet, networks of WAN are connected through satellite or ground radio systems. In this system, each switching element of subnet has an antenna through which it can send and receive data. In some systems, the switching elements may be connected to a substantial point-to-point subnet.

Difference between LANs and WANs. Wide are networks differ from local area networks in many ways as described in Table 9.1.

Table 9.1: Differences between LANs and WANs

Wide Area Networks	Local Area Networks
1. They are spread over distances up to thousands of kilometers.	1. They are spread within a local area upto few kilometers.
2. They use complex protocols and extensive error recovery methods.	2. They use simple protocols and do not employ extensive error recovery methods.
3. The data is generally transmitted as analog signals.	3. The data is generally transmitted as digital signals.

4. Number of terminals in a WAN is unlimited.	4. The number of terminals in a LAN is limited.
5. The data transmission rate is slow (9.6 kbps to 1 Mbps)	5. The data transmission rate is fast (1 to 16 Mbps)

Metropolitan Area Network (MAN)

Besides LANs and WANs, there are certain networks which are bigger than LANs but smaller than WANs. These networks extend beyond the confines of a LAN but do not spread over in a wide area. These networks, which are usually confined to a single metropolitan city are known as *Metropolitan Area Networks* (MANs). A MAN operates at 100 megabits per second or faster and is capable of voice and data transmission over a distance of up to 80 kilometers. A MAN has only one or two cables and does not contain switching elements. The key feature of a MAN is that it uses a communication standard, called *Distributed Queue Dual Bus* (DQDB) or 802.6 (an IEEE standard). DQDB consists of two unidirectional cables or buses to which all computers of the network are connected.

Wireless Network

A wireless network connects portable computers such as laptops and palmtops to the main desktop computer. This network can be in many forms, such as a Wireless LAN or a cellular network. In a wireless LAN, computers communicate directly in digital form within a confined geographical area. In a cellular network, the computers are connected using a cellular phone with a traditional analog modem. Although wireless networking and mobile computing are related, they are not identical. In mobile computing, portable computers are sometimes wired when you connect them with telephone lines. However, in wireless networking portable computers are never wired.

Uses of Wireless Network. A wireless network is used for the following purposes:

- Portable office for sending and receiving telephone calls, faxes, electronic mails, files, etc.
- Rescued workers at disaster sites where there is no telephone system.
- Military for exchanging confidential information.

Internetwork

A collection of interconnected networks is called an internetwork or internet. A collection of LANs connected by a WAN is a common form of internet. It is important to mention here that the term 'internet' (with lowercase i) is not same as the term 'Internet' (with uppercase i). The term 'internet' refers to a network in general sense while the term "Internet' refers to a specific worldwide internet, which is the world's largest network of networks. An internetwork is formed when distinct networks such as a LAN and a WAN or two LANs are connected together.

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9.3. Network Topologies

The layout of the cabling in connecting devices in order to form a network is called *topology* of the network. The structured topology makes the process of addition and deletion of a node in the network easier. The common network topologies are Mesh, Bus, Star, and Ring. Let us discuss these.

Mesh Network

In the mesh network, the nodes are connected randomly using the communications links. The mesh network is either fully connected or connected with partial links. In fully connected mesh topology, each node is connected to every other node as shown in Figure 9.1. So, there is no need of any routing protocol as nodes are directly connected. However, in a partially connected mesh topology, each node is not connected to every other node. So, a router protocol or procedure is used to transfer information among widely scattered nodes, which are not directly connected.

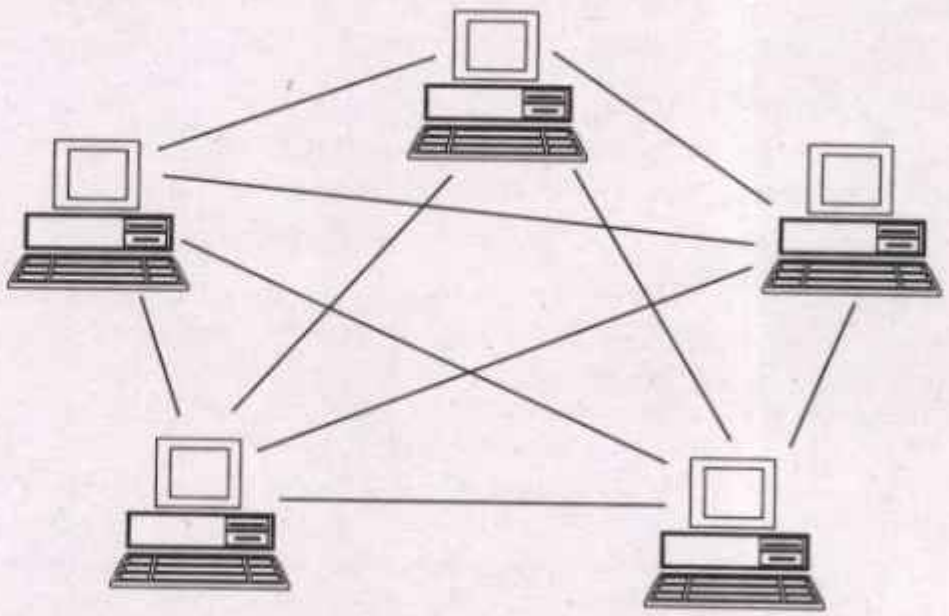

Fig. 9.1: Mesh network

Advantages of Mesh Network. Fully connected mesh networks are very reliable, as alternate paths are always available if direct link between two nodes is disconnected. Partially connected mesh networks are very useful for WANs as their nodes are widely scattered.

Disadvantages of Mesh Network. Fully connected mesh networks are very expensive as adding a node requires installation of new links and one more extra interface in each node. Partially connected mesh networks are less reliable as compared to fully connected mesh networks.

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Bus Network

The bus network consists of a single communication channel to which each node is connected. Each node has a device that sends messages along the bus in either direction as shown in Figure 9.2. A given message contains data, error-checking code, the address of the node that sends the message, and the address of the node that receives the message. When a message passes through each node, that node checks the message for its address. If the node finds its address in a message, it reads the data along with error checking code and sends a message to the sender that data has been received.

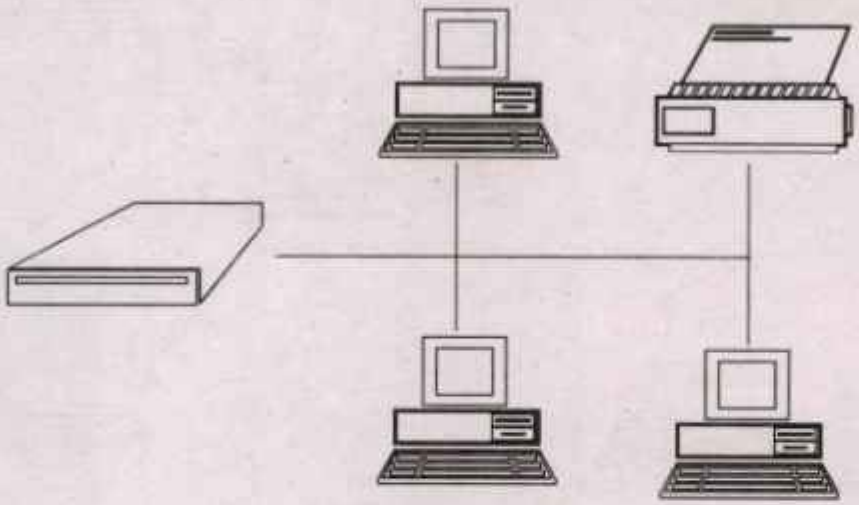

Fig. 9.2: Bus network

Advantages. The bus network is simple in layout and ease in connectivity. So, it is easier to find errors in locating cable faults in bus network. The bus network is ideal for one to many data transmissions.

Disadvantages. A problem occurs with a bus network when two or more nodes send messages at the same time. This creates an interference pattern, and when one of the node on the network detects this pattern, it stops all transmissions. Another problem with a bus network is that a broken connection along the bus brings the whole network down.

Star Network

Star network is an improvement over the bus topology. In a star network, each node is connected via its own path to a central hub which acts as a switching station as shown in Figure 9.3. The hub reads the addresses of messages sent by the nodes and routes the messages accordingly.

Advantages. In the star network, the hub prevents data collisions. When a given node's connection to the network is broken, the rest of the network can remain operational.

Disadvantages. Wiring costs for star network is higher than other topologies, because each node requires its own individual cable. The major problem of star network is that in case the hub fails the entire network is halted.

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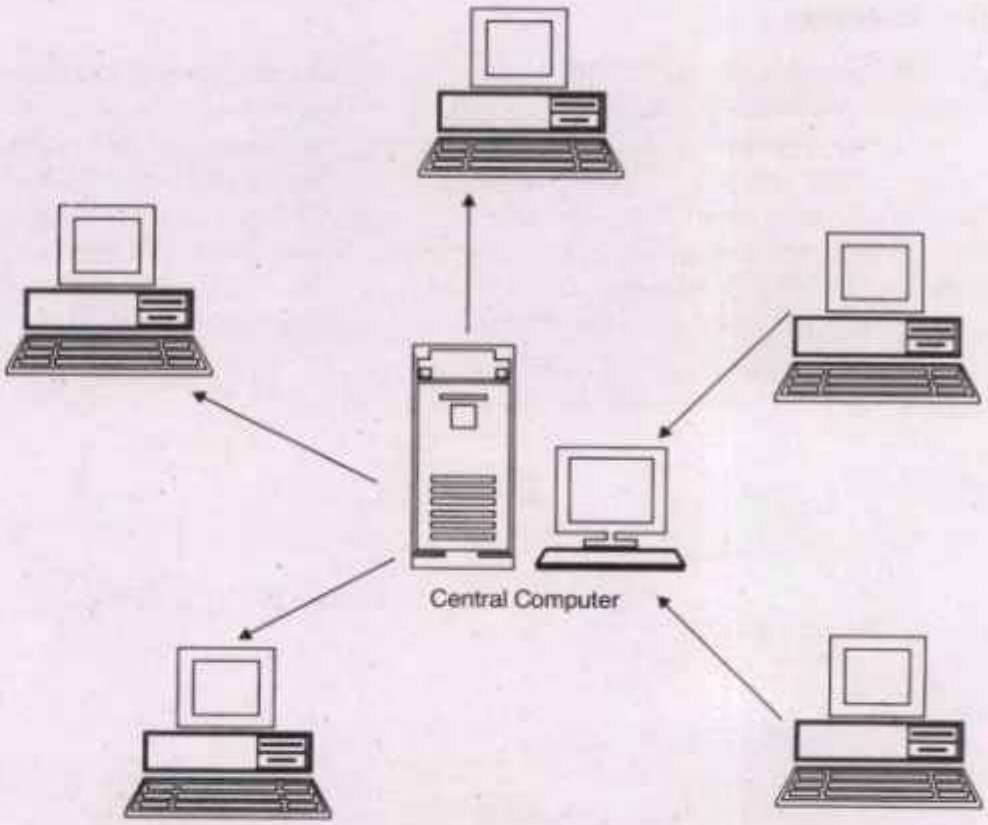

Fig. 9.3: Star network

Ring Network

In a ring network, each node is connected on a circular path as shown in Figure 9.4. Unlike bus topology, in a ring network the data transmission is unidirectional. In ring network, a token (a code indicating that the network is clear) circulates continuously around the network until a given node sends a message. When a node sends a message, it intercepts the token, changes it to indicate that the network is in use. The message includes data, error checking code, and the address of the node receiving the message. The message passes around the circular path until it reaches its addresses. The node that receives the message copies it and then passes it back along the path until it reaches the sender. The sender then removes the message from the network and changes the token back to its original state.

Advantages. The ring network does not have any routing problem as every node on the ring receives the data. As every generated packet eventually returns to the sender node, so there is no need of acknowledgment of successful data transmission. Ring network also avoids data collisions.

Disadvantages. Like bus network, the ring network will go down if a single connection is broken.

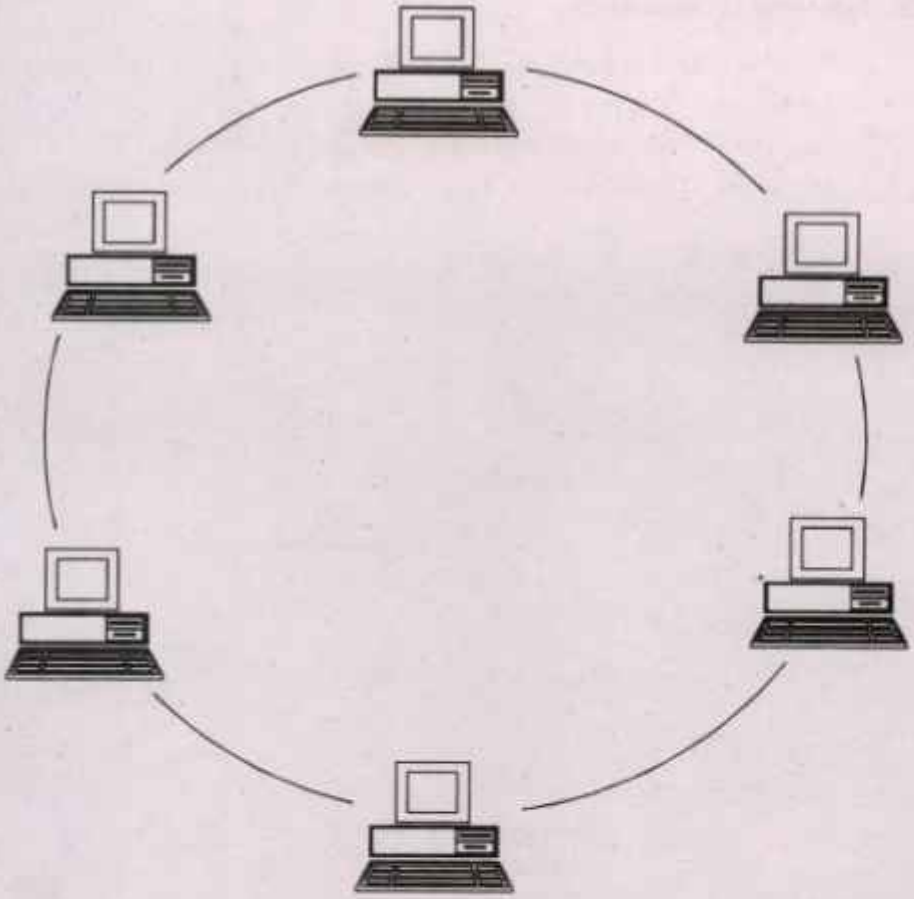

Fig. 9.4: Ring network

9.4. Key Point Summary

- The typical hardware in networking consists of Computers, Peripherals, Modem, Cables, Network Interface Cards, Hub, Switches, Repeaters, Bridges, Routers, Brouters and Gateways.
- Various types of networks are LAN, WAN, MAN, Wireless Network and Internetwork.
- A LAN connects several computers within a confined geographical area, such as a building; a MAN is confined to a single city; while a WAN connects users across cities and countries.
- The term 'Internetwork or Internet' refers to a network of networks in general sense while the term 'Internet' refers to a specific worldwide network of networks.
- The common network topologies are mesh, bus, star and ring.

Notes

9.5. Review Questions

1. What is LAN? What is the difference between a Star LAN and a Bus LAN?
2. Explain the difference among a LAN, a MAN and a WAN.
3. What is a Router? How is it different from a Gateway and a Bridge.

Unit–10

Overview of Internet

Notes

Structure

10.1. Introduction
10.2. What is Internet
10.3. History of Internet
10.4. Applications of Internet
10.5. Modes of Connecting to Internet
10.6. Internet Tools and Services
10.7. Addressing System on Internet
10.8. Key Point Summary
10.9. Review Questions

10.1. Introduction

Telecommunication refers to the electronic transmission of all forms of information, including digital data, voice, sound and video from one location to another over some form of transmission medium. This transmission medium may be a telephone line or microwave signal. The importance of telecommunication in businesses and personal purposes is increasing very rapidly with new developments and technologies. ISDN (Integrated Services Digital Network), E-mail, Internet, Intranet, Video Conferencing, Paging and Cellular technologies have become very popular during last few years. In this chapter, we are discussing the overview of most widely used data communication and telecommunication technology—Internet.

10.2. What is Internet

Internet is the most recent telecommunication technology, which have brought a technological revolution not only in offices but also in homes. Internet is the world's largest computer network, which connects several computers of different types belonging to various networks all over the globe. Internet can also be defined as a technology for linking local area networks (LANs) into a huge global computer network. So, Internet is a network of networks.

Differences between Internet and Online Services

Online services are commercial networks that are owned by different agencies, while there is no owner of Internet. Online services charge users for

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access while no one pays for using Internet. Online services are profit making firms that offer current news, chat rooms and other information to their subscribers over standard telephone lines. They also provide Internet access. Internet, on the other hand, is a large network of networks that facilitates data communication services. The commercial networks that charge user for access are:

- America On Line (AOL)
- CompuServe
- Prodigy
- Genie

Authorities Governing Internet

Internet is not governed by a single authority. There are many authorities as shown in Figure 10.1 that control the Internet today. They are:

(*i*) **Internet Society (ISOC).** It is a voluntary membership organisation, which promotes global interchange of information on Internet.

(*ii*) **Internet Service Provider (ISP).** It sells Internet subscriptions to the public.

(*iii*) **Internet Architecture Board (IAB).** It provides addresses for computers on the Internet and sets rules for naming addresses.

(*iv*) **Internet Engineering Task Force (IETF).** The technical and operational problems on Internet are solved by Internet Engineering Task Force.

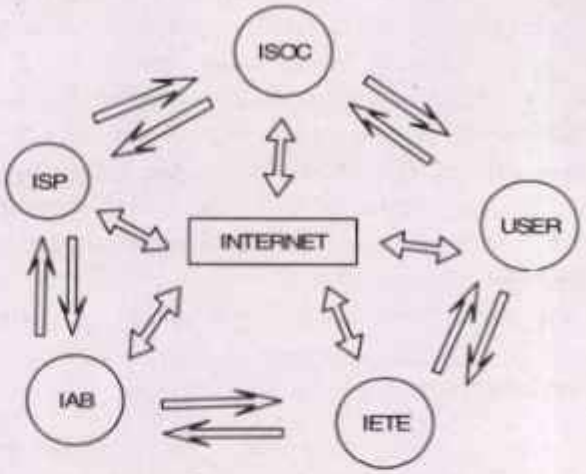

Fig. 10.1: Various authorities governing Internet

10.3. History of Internet

The history of Internet began in 1957 when USSR launched the first artificial earth satellite – Sputnik and US formed the Advanced Research Projects Agency (ARPA) within the Department of Defense (DOD). In 1969, USA set up a network called *ARPANET* for research into networking. The need for such a network arose because a few resourceful computer scientists

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wanted to share files among people working on the same or similar projects. In 1972, Ray Tomlinson of BBN (Bolt Beranek and Newmann, Inc.) developed an E-mail program to send messages across a distributed network. In 1974, the design of TCP (Transmission Control Protocol) was specified in detail by Vint Cerf and Bob Kahn. BBN also started the commercial version of ARPANET – Telnet.

In 1981, a cooperative network was started at the City University of New York, which was called *BITNET*. BITNET is the acronym for "Because It's Time NETwork". A protocol suite, TCP/IP (*Transmission Control Protocol/Internet Protocol*) was established by INWG (InterNetworking Working Group) in 1982. In 1983, ARPANET disintegrated into ARPANET and MILNET (MILitary NETwork). ARPANET became a network for research and educational purposes while MILNET was integrated with Defense Data Network for defense purposes. The *Domain Name System (DNS)* was introduced in 1984. Organisations during 1980s generally had LAN and UNIX based systems, which communicated very well with ARPANET as they supported Internet Protocol (IP). In 1986, NSF (National Science Foundation) constructed its own network, called *NSFNET*. This network had five supercomputing centres, which were interconnected. The speed of data transfer on this network was 56 Kbps. In 1987, NSF signed a cooperative agreement with Merit Network, Inc. for managing the NSFNET backbone. In 1989, NSFNET backbone upgraded to T1 NSFNET, which provided speed of 1.544 Mbps. In 1992, it was further upgraded to T3 NSFNET, which provided speed of 44.736 Mbps. In the same year, WWW (*World Wide Web*) was released and ISOC (Internet SOCiety) was founded.

10.4. Applications of Internet

Internet is the world's largest computer network, which connects several computers of different types belonging to the various networks all over the globe. Internet is very popular among millions of users worldwide because there is no application area left where Internet is not helping us. Various applications of Internet are –

- Internet helps people to communicate with each other sitting at any corner of the world. Using E-mail services, people can send messages to any part of world within few minutes.
- Internet is the major media for creating and viewing any kind of information related with Science, Art, Music, History, Computers, Engineering, Medicine, Management, Religion, Movies, Games, etc. We can see our horoscope on Internet. We can also watch news, sports and movies on Internet.
- Internet is the vast virtual market place for advertising and selling products through the latest concept of E-commerce.
- It helps organisations to link their wide spread offices and employees.
- It helps people to learn and to find suitable jobs for them.
- It helps people to chat with each other, so that they can talk with their old friends and make new friends across anywhere in the world.

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- It provides all types of entertainment to people such as movies, games etc.
- It helps people to share any information through conferencing. We can do audio and video conferencing on Internet.
- Web publishing (Electronic Publishing) is the new approach of publishing, which is replacing paper books with electronic books.
- Internet Banking and WAP (Wireless Applications Protocol) are the latest developments of Internet applications. Through Internet Banking, you can avail many banking services without going to your bank. Using WAP, you can avail Internet facilities on your mobile phone.

These are just few areas where Internet is helping us. In fact, there is no limit of Internet applications.

10.5. Modes of Connecting to Internet

Connecting to the Internet through the host machine by providing user name and password is called *Logging In*. There are four modes of connecting to the Internet, which are:

(*a*) Host/Terminal Connection

(*b*) Individual Computer TCP/IP Link or Dial-up Networking

(*c*) Dedicated Access

(*d*) Dial-up Access through LAN

Let us discuss these.

Host/Terminal Connection

Host/Terminal Connection is the least expensive type of Internet access. In this method, our computer is not really connected to the Internet but we are using it as a terminal, which is remote to an Internet host or server. This method requires a modem and a phone line. Using host/terminal connection, only text base applications can be accessed on the Internet and we cannot access graphical applications. As using this method we get access to the shell of a UNIX computer, it is also called *Shell Access Connection*. Host/Terminal Connection offers the following advantages:

- Ideal for University and College students as it is more economical.
- Provides good speed for accessing text only documents.

Individual Computer TCP/IP Link or Dial-up Networking

TCP/IP is an abbreviation of two Internet protocols—Transmission Control Protocol (TCP) and Internet Protocol (IP). TCP permits two Internet-connected computers to get a reliable connection. IP is responsible for routing the data packets to a desired destination address. TCP/IP link requires a modem or an ISDN adapter and an analog phone line or an ISDN line. With this link, the user computer is assigned a temporary IP address and is directly connected to the Internet.

TCP/IP links can either be SLIP or PPP links. The differences between SLIP and PPP links are listed in Table 10.1.

Table 10.1: Differences between SLIP link and PPP link

SLIP Link	PPP Link
1. SLIP stands for Serial Line Internet Protocol.	1. PPP stands for Point of Point Protocol.
2. SLIP is an older protocol.	2. PPP is a new protocol.
3. It is slower in speed.	3. It is faster in speed.

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Individual Computer TCP/IP Link or Dial-up Networking offers the following advantages:

- Most suitable for Internet cafes because using a phone line and a hub, many computers can be simultaneously connected to Internet with cheaper cost.
- Most suitable for homes as a single PC can be easily connected to Internet using a modem and telephone line. Moreover, the Internet & phone line charges per hour is also not very high.
- Using ISDN line, the Internet access becomes cheaper and faster.

Dedicated Access

Dedicated link connection is a permanent Internet connection. It allows the user's computer to remain connected to the Internet round the clock. It can be set up over a telephone line using a router or a modem. A *router* is an electronic device that examines each data packet on receiving and provides the way to send it towards its destination. So, router transmits data from one network to another. We can also use a modem in place of a router. A router provides higher transmission speed while a modem provides low speed. Dedicated link offers the following advantages:

- Dedicated link connections are generally used by big organisations providing on line Internet services to their customers. It is ideal for big organisations needing Internet with permanent connection.
- Ideal for institutes providing on-line education through Internet.
- Ideal for E-commerce and web publishing due to highest speed and round the clock access.

Dial-up through LAN

Dial-up through LAN is an intermediate type of connection between TCP/IP link and Dedicated link as it provides some features of both these connections. It is set between LAN and Internet servers. It is generally used to exchange a large volume of E-mail messages on a little Internet traffic. Dial-up Access through LAN is ideal for those organisations which need to send large volume of E-mails to their branch offices and customers on daily basis because this mode provides a high speed.

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The differences among various ways of connecting to Internet are shown in Table 10.2.

Table 10.2: Differences among various ways of connecting to Internet

Host/ Terminal Connection	Individual Computer TCP/IP Link	Dedicated Access	Dial-up Access through LAN
1. No direct connection with Internet.	1. Direct Temporary connection.	1. Direct Permanent connection.	1. Direct Temporary connection.
2. Requires a modem and a phone line.	2. Requires a modem/ISDN adapter and a phone line/ ISDN line.	2. Requires a modem/Router and a phone line.	2. Requires a LAN, modem and a phone line.
3. Limited Access with slow speed.	3. Average access with average speed.	3. High access with high speed.	3. Average access with speed.
4. Does not provide GUI interface.	4. Provides GUI Interface.	4. Provides GUI interface.	4. Provides GUI interface.
5. Used by students on UNIX machines.	5. Used by individuals & Internet cafes at home or small offices.	5. Used by big organisations for all Internet applications.	5. Used by organisation to exchange large volume of E-mails.

10.6. Internet Tools and Services

Internet provides the following important tools and services:

1. Browsers
2. Search Engines
3. Electronic Mail
4. File Transfer Protocol
5. Usenet
6. Telnet
7. Internet Relay Chat
8. Other Tools

Let us discuss these.

Browsers

Surfing refers searching information on Internet without knowing what we are searching. Surfing on Internet is done by programs, which are called browsers. Browsers help non-technical people to work on Internet because they are very user-friendly. You need not have to remember the commands. Browsers help you always while surfing the Internet. The differences between a text only browser and a graphical browser are shown in Table 10.3.

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Table 10.3: Differences between a text only browser and a graphical browser

Text Only Browser	Graphical Browser
1. It shows web pages with text only without graphics and animation.	1. It shows complete web pages with text, graphics, animation and sound.
2. It is comparatively very slow.	2. It is very fast.
3. Example: Lynx	3. Examples: Netscape Navigator, Internet Explorer and NCSA Mosaic.

The popular browsers are as follows:

(*i*) **World Wide Web (WWW).** World Wide Web (WWW) is the most popular browser of Internet. It is a series of servers that are interconnected through hypertext and hyperlinks. It is the most favorite means of searching the Internet. It is simply known as the *Web*. It is very popular because:

- It is very easy to use.
- It is attractive in screen layouts.
- It provides information to any one interested.
- It provides user a simplified way to access text, graphics, animation, sound and other forms of information.

Hypertext, Hypermedia and Hyperlinks. Hypertext is the text that contains connections within the text to other documents besides the regular text. It is actually a way of presenting information on the web. Using hypertext, the user can jump from one page to another by clicking on the underlined or highlighted words called hyperlinks as shown in Figure 10.2.

Fig. 10.2: A web page showing hyperlinks

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Hypermedia is higher version of hypertext that contains links not only to text but also to other forms of information such as sound movies, pictures etc. It enables user to retrieve multimedia resources on Internet.

HTML. HTML stands for hypertext markup language. It is the encoding scheme used to create and format a Web page. It is an improved version of Standard Generalised Mark up Language (SGML). HTML is a versatile language and can be used on any platform. It can be used to display any type of document on the host computer, which can be geographically at a different location. HTML provides tags to make the Web page look attractive. We can use graphics, colors, fonts, etc. to enhance the presentation of Web page using HTML. HTML allows the creation of hyperlinks to any limit.

(*ii*) **Gopher.** Gopher is a browser for locating information on the Internet. It enables the user to locate all textual information stored on Internet servers through a series of easy to use, hierarchical menus. Internet has thousands of gopher servers around the world. Each gopher site has thousands of listings, which are orgainised in form of menus and submenus. We browse the Internet by selecting various items from these menus. Gopher is based on the concept of clients and servers. Clients are the software that requests information for a user. Servers are the software that provide information to clients. When the user initiates the Gopher software for surfing and selects an item from the menu, the server transfers the user to the appropriate file on the selected server. Now, the user jumps to another server and in this way the process continues and user move from one site to another while surfing on Internet. The salient features of Gopher are:

- It is an Internet based document retrieval system.
- It displays a set of resources on Internet in the form of menus.
- It is very simple to operate as we need not know the address of sites and UNIX commands.
- Using Gopher, we can gather information in the form of text, images and sound.
- With Gopher we can also access services in the form of Telnet connections.

Gopherspace. It is the universe of Gopher servers connected to the Internet throughout the world. Each Gopher server has an Internet address and port number of its own. It also has links to other Gopher servers.

(*iii*) **Microsoft Internet Explorer.** Microsoft Internet Explorer as shown in Figure 10.3 is the most popular browser for Internet. It is based on MCSA Mosaic. It is distributed under a licensing agreement with Spyglass Inc. It is shareware software that can be downloaded

from Internet. It enables us to connect to the Internet for gaining access to the huge volume of information on millions of computers connected with Internet.

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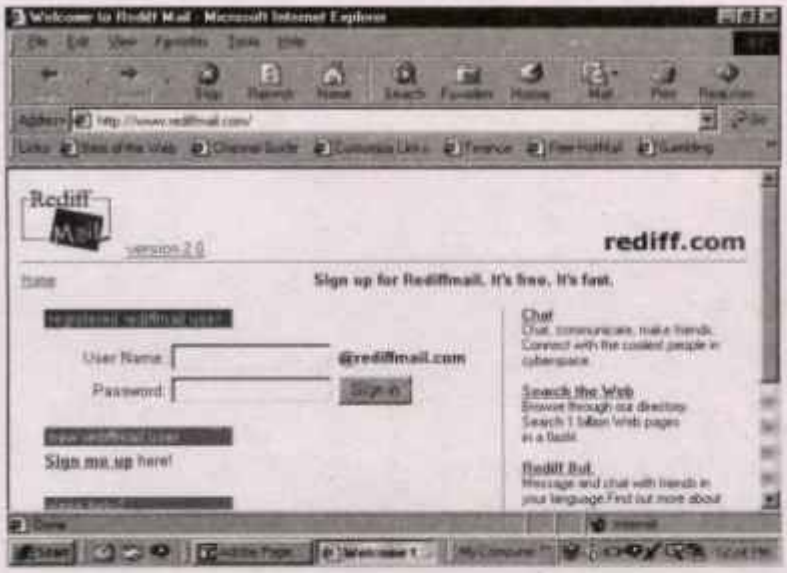

Fig. 10.3: The opening screen of Microsoft Internet Explorer

Microsoft Internet Explorer offers the following features:

- It offers channels by which the latest web contents are automatically delivered to us from the world's best content providers. We can view these channels on right side of our computer monitor screen (desktop).
- We can subscribe to our favourite sites so that the contents are automatically updated. Updated web sites can be downloaded in the background while we are doing other things on our PC.
- We can add a web page to our list of favourites for easy access.
- We can search the web sites using explorer bar that appears in the left side of the browser window, when we click the 'Search' button on the toolbar.
- We can view web pages in many languages.
- Microsoft Internet Explorer offers a feature AutoComplete by which we can type first few characters of URL and Internet Explorer writes the complete address.
- We can browse the web safely in Microsoft Internet Explorer as there are different levels of security for different areas of the web to protect our PC.

(*iv*) **Netscape Navigator.** Netscape Navigator is another popular graphical browser for Internet, which is somehow similar to Microsoft Internet Explorer. We can download it free of cost from the site *http://home.netscape.com*.

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Search Engines

Search engine is an Internet accessible search service that enables us to search for information on the Internet using a browser. The commonly used Search Engines are–

- Yahoo
- Rediff
- Infoseek
- Lycos
- Webcrawler

Electronic Mail

E-mail is the most common service available on Internet. E-mail stands for Electronic Mail. Using E-mail, we can send mail to any part of world in the form electronic documents, which can include both text and graphics. The users of Internet create their own E-mail accounts along with giving the passwords so that no unauthorised person can access their mails. E-mail is becoming so popular that people prefer it to postage mail.

E-mail Server and E-mail Client. The E-mail server differs from E-mail client as discussed in Table 10.4.

Table 10.4: Differences between E-mail Server and E-mail client

E-mail Server	E-mail Client
(*i*) It runs on the computer of Internet Service Provider (ISP) viz. VSNL, Mantra etc.	(*i*) It run on the computer of Internet user.
(*ii*) It receives the mail sent by user and send it to its destination over the Internet.	(*ii*) It enables the user to read the mails received, to compose new mails and to sent them to E-mail server.

E-mail Protocols. E-mail protocols are communication standards of E-mail. Various E-mail Protocols are:

(*a*) *SMTP.* SMTP stands for Simple Mail Transfer Protocol. It specifies the procedure for sending and receiving text messages over Internet by the E-mail servers. It also specifies the format of E-mail message.

(*b*) *POP or POP3.* POP stands for Post Office Protocol. In this protocol, the E-mail server stores the incoming messages only temporarily. When messages are downloaded by E-mail client, they are deleted from the server.

(*c*) *IMAP or IMAP4.* IMAP stands for Internet Message Access Protocol. It stores messages on the mail server rather than facilitating downloading to the user's computer. It is more convenient that POP3 as all of user's mail is kept in one central location where it can be organised and achieved.

Notes

Downloading

Downloading refers to copying software from a remote computer to your computer through Internet. Using FTP (File Transfer Protocol), Internet users can copy any file from remote computer to their computer. You can download the required information from the web pages using the popular browser of Internet—WWW.

Web Page and Portal. A Web page is a document containing single unit of information that is available via World Wide Web (WWW). It may contain text, graphics, images, pictures, sound, video, animation, hypertext, hypermedia and hyperlinks. Using hypertext and hypermedia, you can move from one page to another by clicking on hyperlinks (the underlined or highlighted words). Portal is a website that contains hyperlinks to many other websites based on the required information. For example, Yahoo, Rediff, MSN India, Indya, JobsDB, Top-education, etc. are some of the popular portals. There are two types of portals—Horizontal Portals and Vertical Portals.

(*a*) *Horizontal Portals (Hortals).* These are websites, which contain links to information on a broad range of subjects such as education, sports, music, health, jobs, sex, romance, religion, etc.

Examples :

- Yahoo (*http://www.yahoo.com*)
- Rediff (*http://www.rediff.com*)
- MSN India (*http://msn.co.in*)
- Indya (*http://indya.com*)
- India.com (*http://www.india.com*)

(*b*) *Vertical Portals (Vortals).* These are websites, which contain links to information on a particular subject.

Examples :

- Jobs (*http://jobs.com*)
- Tourism (*http://tourism.com*)
- Sports (*http://sports.com*)
- Science (*http://science.com*)
- Travel (*http://travel.com*)

File Transfer Protocol

File Transfer Protocol (FTP) is a tool of Internet used for copying files from one Internet host to another. Copying a file from any remote server to our host computer is called *downloading*. There are two types of FTP—Regular FTP and Anonymous FTP. In *Regular FTP*, Internet users can transfer files from those remote computers only where they have their own account and identification using passwords. In *Anonymous FTP*, files are available to all Internet users for downloading. In this method of FTP, Internet users log on by entering the words 'anonymous', 'guest' or 'ftp' instead of a user name and provide their E-mail addresses as their passwords. Anonymous FTP is

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the easiest way for upload and download files, however users are restricted by the security system of the remote computer. Anonymous sites permit us to access their files without establishing an account with them. By using anonymous FTP, we can access public archives on the Internet. There are two modes for transferring flies in FTP—ASCII mode and Binary mode. In *ASCII mode*, we can download mainly plain text and postscript files. However most files in Internet are transferred in *binary mode*. For example, zip, jeg, mpeg, com, exe and gif files are transferred in binary mode. Program files such as .c and .h files are transferred in ASCII mode.

Using FTP Internet users can also transfer files to servers and save them to a directory on remote computer. This is called *uploading*.

Usenet

Usenet is a world wide computer based discussion system on Internet. It consists of special groups set up by Internet user on a range of topics from entertainment activity to scientific research. These groups of topics in Usenet are called *newsgroups*. Usenet consists of thousands of newsgroups, each of which consists of articles send by Internet Users.

Accessing the Usenet. A special type of program called a *newsreader accesses* Usenet, which helps us to handle the volume of news available on Usenet. With newsreader, we can select the news, which we want to read or discard the news, which we don't.

Newsgroups. Various groups of topic in Usenet are called Newsgroups. Usenet is a forum in which people share news on a defined topic through large electronic bulletin-boards on Internet. Usenet newsgroups are organised into various categories called hierarchies. These hierarchies include the following three sub-categories:

(*a*) *Standard Newsgroups*. These include high quality discussions, which can not be established without a formal voting procedure. The top-level standard newsgroup hierarchies are described in Table 10.5.

Table 10.5: The top level newsgroups hierarchies

Hierarchy Name	Description
Comp	Every thing related to computers
Sci	Discussions on science and Engineering
Soc	Social groups
News	News about Usenet
Rec	Recreational subjects such as sports, aviation, music, arts, etc.
Talk	Random discussions on controversial subject including sex, politics, religion, etc.
Misc	Other topics viz. health, law, hooks, etc.

(b) *Alt Newsgroups*. These include discussions, which can be established by anyone with the requisite technical knowledge.

(c) *Biz Newsgroups*. These include discussions for commercial uses.

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Telnet

Telnet is an Internet exploration tool that is used for logging on remote computers on the Internet. Using Telnet, we can communicate with a wide range of remote systems with which we have an account. Telnet is mainly used to access databases on other systems. It is frequently used by libraries. Using telnet, we can use our computer from anywhere in the world. Telnet is actually an Internet standard protocol for remote terminal connection service. Telnet is one of the simplest tool on Internet. With telnet, employees of branch office can access data on the computer in the head office. Using telnet, we can also log on to and use third party computers that have been made assessable to the public. For example, using telnet we can read the catalog of the United States library of congress. We can also use telnet to obtain other services such as Gopher and Web servers.

Differences among E-mail, FTP and Telnet. Various differences among E-mail, FTP and Telnet are listed in Table 10.6.

Table 10.6: Differences among E-mail, FTP and Telnet

E-mail	FTP	Telnet
1. E-mail (Electronic Mail) is the most common service on Internet, which is used to send mail to any part of world in the form of electronic documents.	1. FTP (File Transfer Protocol is an Internet tool used for copying files from one Internet host to another.	1. Telnet is an Internet exploration tool used to log on remote computers on the Internet.
2. E-mail is similar to postage mail.	2. FTP is entirely different than postage mail.	2. Telnet is also not related to postage mail.
3. Each Internet user requires an E-mail address and password to use an E-mail service.	3. FTP works in two modes—in one mode user requires ID and password on remote machine while in another user can be anonymous or guest.	3. Telnet also works in two modes - one requiring the user identification and another does not require user ID and user ca be anonymous or guest.
4. E-mail service offers an address book containing addresses of E-mail users.	4. FTP does not provide any address book or other database.	4. Telnet helps users to access database on remote machines.

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Internet Relay Chat

Internet Relay Chat (IRC) is most popular tool on Internet used by people to talk to each other using the computer. It is the only place where we can go and talk to people from anywhere in the world in the form of exchanging text and audio. It is used by people sitting at their homes anywhere in world to talk to each other electronically using computer. It is generally called *chatting*. In chatting, each participates discussions are displayed on the screens of all the other taking part in a conversation as shown in Figure 10.4. We can either join an existing conversation or start our own conversation on any topic. There are no constraints on the topics that may be discussed. We can discuss sports, religion, health, sex education, etc. Now-a-days chatting has become a great fun. People spend hours in Cyber-Café for chatting. They make new friends, some fall in love and few evn marry. Chatting has become the most interesting tool on Internet.

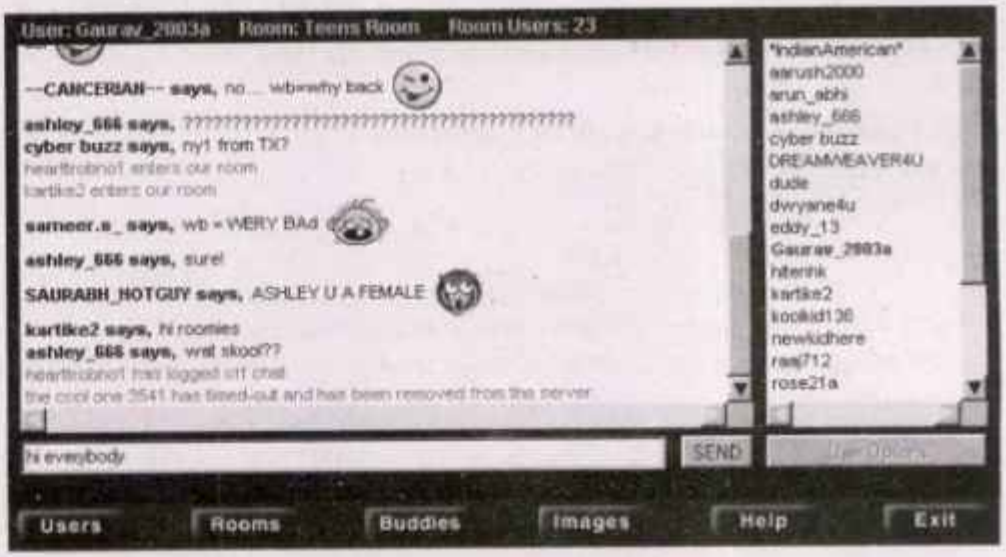

Fig. 10.4: A chatting screen

Other Tools

Besides the above discussed tools and services of Internet, there are some other tools, which are:

(*i*) **VERONICA.** VERONICA stands for Very Easy Rodent Oriented Net-wide Index to Computer Archives. It is index of Internet Gopher items and titles which provides keyword searches of Gopher items and titles. It is menu-driven and hence is very easy to operate.

(*ii*) **WAIS.** WAIS stands for Wide Area Information System. It searches text documents containing the specified keywords. It identifies documents, which are most closely related to the topic specified.

(*iii*) **Archie.** It is an Internet search program used to locate files and directories on anonymous FTP servers on the Internet.

10.7. Addressing System on Internet

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The addressing system on Internet is called Uniform Resource Locator (URL). It has the following two forms:

(*a*) Letter Addressing system or Domain Name System (DNS)

(*b*) Number Addressing System or Internet Protocol (IP) Addressing System

Let us discuss these.

Letter Addressing System or Domain Name System (DNS)

Domain name is a readable computer address that identifies the location of a computer on the Internet. Domain Name System is the conceptual system of naming domains that form the hierarchical organisation of the Internet. This system is also called Letter Addressing System. The general format of this system is:

Name-of-user@Name-of-host.subdomain.domain

where,

Name-of-user is the name of Internet account for logging into the host computer

Name-of-host is the name of each computer on the Internet.

Subdomain is generally the name of organisation.

Domain is a group of computers that are administered as a unit in Internet letter addressing system, which is easily understood by a person.

There are two types of domains–Geographic and Non-geographic domains.

(*i*) **Geographic Domain.** The last part of domain name indicates the name of the country where the computer is located. This is called Geographic Domain. The examples of few geographic domains are listed in Table 10.7.

Table 10.7: Examples of geographic domains

Domain Name	Country
.au	Australia
.ca	Canada
.cu	China
.in	India
.jp	Japan
.uk	Great Britain
.us	USA

(*ii*) **Non-geographic Domain.** The part of domain name that indicates the type of organisation where computer is located is called Non-geographic Domain. The examples of non-geographic domains are listed in Table 10.8.

Table 10.8: Examples of non-geographic domains

Domain Name	Type of organisation
.gov	Government Agencies
.edu	Educational Institutions
.com	Commercial
.mil	Military
.net	Network
.org	Organisations other than Educational & Commercial

Number Addressing System or Internet Protocol (IP) Addressing System

In this system, a unique 32-bit address is assigned to each computer that is connected to the Internet. It is given in four-part decimal number (*e.g.* 132.116.42.51). Each part represents 8 bits of the 32-bits address, which cannot exceed 255. The 32-bit address is called a *doted quad* while each 8 bit part is called an *octet*. The 32-bit address is also called *IP address* or *Internet Address*. For example, 5.232.59.82 is an IP address where 5,232,52 and 82 are octets. IP address identifies the location of a particular computer on the Internet. IP addresses are organised from left to right and consist of sequence of domain and sub-domain codes. This system of addressing on Internet is also called Number Addressing System. It is directly understood by the machine.

10.8. Key Point Summary

- Internet is the world's largest computer network.
- Online services are owned by different agencies, while there is no owner of Internet.
- Various authorities that govern Internet are ISOC, ISP, IAB and IETF.
- The history of Internet began in 1957.
- ARPANET, BITNET, MILNET and NSFNET are the various networks developed during the historical advancement of Internet.
- Various applications of Internet are in the areas of E-mail, Banking, E-Commerce, Web Publishing, Education, Business, Entertainment, etc.
- Various modes of connecting to the Internet are Host/Terminal Connection, Dial-up Networking, Dial-up Access through LAN and Dedicated Access.
- The important tools and services of Internet are Browsers, Search Engines, Electronic Mail, File Transfer Protocol, Usenet, Telnet and Internet Relay chat.
- Browsers help non-technical people to work on Internet without remembering the commands.

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- The popular browsers are World Wide Web (WWW), Gopher, Microsoft Internet Explorer and Netscape Navigator.
- Yahoo and Rediff are the popular search engines for searching any information on the Internet.
- Electronic mail is used to send mails electronically.
- Various E-mail protocols are SMTP, POP or POP3 and IMAP or IMAP4.
- Using FTP (File Transfer Protocol), Internet users can copy any file from remote computer to their computer.
- There are two types of FTP—Regular and Anonymous.
- There are two types of Portals (Websites)—Horizontal and Vertical.
- Usenet is a world wide computer based discussion system on Internet.
- Newsgroups (groups of topics in Usenet) are of three types—Standard, Alt and Biz.
- Telnet is used for logging on remote computers on the Internet.
- Internet Relay Chat (IRC), populary called chatting is used by people to talk to each other using the computer.
- URL (Uniform Resource Locater) is the addressing system an Internet, which is of two forms: (*a*) Domain Name System, and (*b*) Internet Protocol (IP) Addressing System.
- There are two types of domains—Geographic and Non-geographic.

10.9. Review Questions

1. (*a*) Define the Internet and discuss. Why is it so popular?
   (*b*) Describe briefly the various applications of Internet.
2. Differentiate the Internet from online services. Name three online services.
3. What are TCP/IP? Discuss their role in Internet.
4. What is IP address? What is its significance for computers?
5. What is logging In? Explain the various modes of connecting to Internet.
6. What are the various tools and services available on Internet? Explain them briefly.
7. What is Surfing? Name three popular browsers used to surf the Internet.
8. Explain the following terms:
   (*a*) WWW
   (*b*) Usenet
   (*c*) Newsgroups
   (*d*) Telnet
   (*e*) FTP
   (*f*) Upload
   (*g*) Download
   (*h*) Search Engine
9. What are E-mail Protocols? Explain them briefly.

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10. What is a Domain Name System? Explain the different types of domains.
11. Name the four authorities that govern Internet.
12. Discuss briefly the historical development of Internet.
13. Differentiate between the following:
    (*a*) Hypertext, Hypermedia and Hyperlink
    (*b*) Hortal and Portal
    (*c*) Standard, Alt and Biz Newsgroup
    (*d*) E-mail, FTP and Telnet
14. Write the full form of following abbreviations:
    (*a*) ARPANET
    (*b*) IRC
    (*c*) URL
    (*d*) SMTP
    (*e*) POP
    (*f*) WWW
    (*g*) BITNET
    (*h*) IAB
    (*i*) TCP
    (*j*) FTP

Unit–11

Multimedia and Computer Graphics

Notes

Structure

11.1. Introduction
11.2. What is Multimedia?
11.3. Applications of Multimedia
11.4. Components of Multimedia
11.5. Hardware for Multimedia
11.6. Software for Multimedia (Authoring Tools)
11.7. Graphics Files
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11.1. Introduction

Multimedia is the most exciting and extremely useful computer technology. It has now become an essential part of your computer. All present day PCs are multimedia computers. Multimedia is a woven combination of text, graphics, sound, animation and video.

Computer graphics is the most predominant component of a multimedia application. It is a human nature that a subject is better explained to them when represented in pictorial or graphical form, instead of textual matter. So, graphics are used more often than text to explain a concept besides providing visual effects of information. In this unit, we will discuss all the basic concepts and applications of multimedia and computer graphics.

11.2. What is Multimedia?

Multimedia means many media. Medium is a vehicle for communication, such as text, graphics, speech, still photography, etc. The technology that uses some combination of various media like text, images, sound and movement is called multimedia. When the end user or viewer is allowed to control what and when the elements are delivered, it is called *interactive multimedia*.

In the past few decades only newspapers, radio and television were the sources of communication. They were actually called media at that time. Newspapers were generally consisted of textual data or some black and white pictures without ant presentation. Audio and video were the sources of communication for radio and television respectively. So, all the sources of communication could provide information only in single medium.

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With the advancement in technologies in computers, multimedia came into existence, which gave birth to those applications having number of media involved. Newspapers used attractive fonts, colored pictures and good presentations. Television used computer software, high-resolution cameras for accurate pictures and good sound recorders. These advancements led to new technologies in the field of multimedia, which we are observing today.

Multimedia System

A multimedia system makes use of many different ways of communication, which include text, data, graphics, image, voice and video. It can be defined as follows:

Multimedia system is a computer platform, communications network or software tool if it supports the interactive use of at least one of the types of information like audio, video, still images in addition to text and graphics.

Various media in a multimedia system can be divided into the following three types:

(*a*) *Print*. This is a static media type, which includes text, graphics and natural image.

(*b*) *Audio*. This is a dynamic media type, which includes natural and synthetic sound, speech and the music.

(*c*) *Video*. This is also a dynamic media type, which includes natural and synthetic image sequences, giving motion to an application.

The important question arises now whether multimedia is a computer itself or a computer software product. In practical sense, it is the combination of both. A multimedia computer must have a specific configuration like appropriate motherboard, CPU, RAM, CD-ROM, sound card, video capture card, speakers, etc. Besides these, the general multimedia software currently available in the market such as CorelDraw, PhotoShop, Macromedia Director, Flash, 3D Studio MAX and Dreamweaver must also be present on your computer.

Advantages of Multimedia System

A multimedia system is an interactive and non-linear media in comparison to a conventional form of media such as broadcast television. It offers the following advantages to the computer user:

- The interaction between the user and the information makes multimedia a very powerful media for activities that require the process of communicating information for purposes such as education and training, business presentations, manuals, multimedia databases, advertising and electronic publishing.
- Due to interactive feature of multimedia, the user can request the broadcaster the type of information required. For example, in a multimedia version of news bulletin you can request the broadcaster the type of news you are interested in and when you want to hear it by clicking the mouse button.

- Hypermedia, which includes hyperlinks among various media, provides user the easiest way of interaction in a multimedia system.
- With multimedia systems, you can experience the applications of virtual reality such as modeling objects and their behaviour in virtual environments with man-machine devices.

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11.3. Applications of Multimedia

Can you imagine the growth of information technology without multimedia? At one time, when PCs became popular during 1980 decade, the information, which you could obtain from your PC, was mainly textual (single medium). Now, the information, which you get on your PC, is a combination of text, graphics, sound, animation and video. Internet applications are developed using multimedia. Most games you play on your PC are multimedia games. The movies (video or animation) that you watch on your PC are also the result of multimedia. If there would be no multimedia, the technologies of computer and information would have been same like 1980 decade and hence there would not have any remarkable growth. Without multimedia, you can not imagine to develop Web sites for Internet. So, perhaps there would not be any Internet without multimedia and if Internet would have emerged, it would be able to provide you only textual information.

The advancement in multimedia technology has opened up new fields for the application development. One such field of multimedia having tremendous potential is *Virtual reality*. It is primarily used in applications for entertainment industry and is a useful tool for performing simulative, remote control applications. A broad categorisation of multimedia applications in various fields as shown in Figure 11.1 is discussed below.

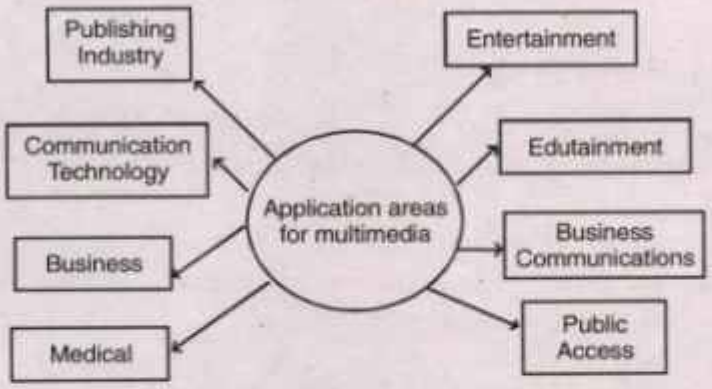

Fig. 11.1: A broad categorisation of multimedia applications

Entertainment

Creating real life games, graphics, sound and animation are applications of multimedia in entertainment. The special technologies of multimedia such as Virtual Reality have made all these applications the mirror images of real life. For example, a flight simulator gives you a feeling of real environment

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to fly airplanes. Virtual goggles, helmets, special gloves and bizarre human interfaces attempt to visulaise you a real life experience. Wide varieties of multimedia games are now available for your PCs. For example, Car racing, Cricket, Prince, etc. are popular multimedia games as shown in Figure 11.2.

Fig. 11.2: Some popular multimedia games

Edutainment

Edutainment is the new application area that refers to imparting education through entertainment. Many computer software such as 3D Studio Max, Flash, Photoshop, etc. are available now with focus on education. These help you to develop your own applications for edutainment. Using such software you can convert your own ideas into desired applications. Many software development companies are now providing the online tutorials for educating users for using their products. Multimedia is enjoying widespread use in training programs as shown in Figure 11.3. Flight attendants get training to manage international terrorism and security through simulation. Mechanics learn to repair engies.

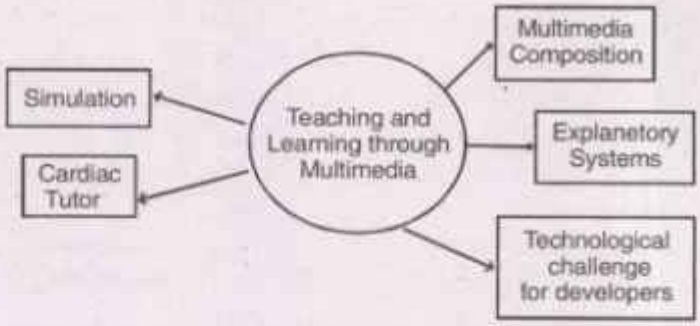

Fig. 11.3: Multimedia in edutainment

An interesting use of multimedia in schools involves the students themselves to learn by following ways:

- They can create their interactive magazines & newsletters.
- They can make original art using graphics software.
- They can interview students, teachers, coaches, artists and leaders by developing interactive software for conducting interviews.
- They can make quick time animation and video movies.

Business

Multimedia is a very powerful tool for enhancing the quality of business communications by sending the data and information in the form of text,

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graphics, audio and video among geographically spread offices of the organisation. Business applications for multimedia include presentations, online training programs, software for marketing, advertising on Internet, software for product demonstrations, multimedia databases, electronic catalogues and business websites. Most presentation software packages allows you to add audio and video clips to the slide show. Voice mail and video conferencing are becoming popular on networks using Internet protocols.

To grow one's business up to new heights, multimedia applications as shown in Figure 11.4 can definitely play an important role. The following multimedia and communication facilities have changed the outlook of the whole businss:

Fig. 11.4: Multimedia in business

(*i*) **Global Team.** The multimedia technology along with communication technology has opened the door for formation of global work groups. Today, the team members who may be working anywhere can work for various companies, no matter whether they are in different cities/countries or speak different languages. Thus, the work place for business has become global.

(*ii*) **Voice Mail.** It is a tool, which send voice over a communication line. It can handle only audio information, which is sufficient for quick and simple exchange of information. Although the voice mail is time and location independent, it is non-interactive. If you want to get a reply, then you have to wait for the voice mail to come. However, you can send and receive voice mail quickly.

(*iii*) **Electronic Mail (E-Mail).** It is preferred to voice mail to exchange information in the form of text and graphics.

(*iv*) **Multimedia Based Fax.** As we know Facsimile (Fax) is used when exactly similar information has to be transmitted. It is more accepted then E-mail as it can handle graphics information easily and provides an exact photocopy of the information.

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(v) **Conferencing.** The activities in an office such as meetings, group discussions and training programmes are some areas where conferencing facilities are needed. For real time meetings that involve geographically disperse group of people, the management and employees of an organisation can avail the benefits of the following types of conferencing:

(a) *Audio Conferencing.* It is an effective means of communication for reporting about a project status through voice. It can be used to solve business problems quickly. It can be used by a group of people who need to meet frequently whatsoever is the physical distance among them.

(b) *Video Conferencing.* Video conferencing is successfully being used by several organisations in India and abroad. It resembles an office meeting, where the participants sitting at geographically separated offices can not only send/ receive voice but can also see other participants with the help of multimedia PCs connected by a network (such as WAN or Internet). Video conferencing brings people together naturally and tries to simulate a real life meeting environment. However, it is not easy to use, as the participant has to continuously look at the camera on the top of the monitor.

(c) *Document Conferencing.* It is also called as *audio-graphic conferencing technology.* It allows people to meet using their PCs and phone lines. After connection, they can share audio information and the data they have stored in their PC. In addition, it allows on line editing of a document by several participating people in the conference.

(vi) **E-commerce based Applications.** Electronic commerce (E-commerce) is an emerging technology of selling and merchandising, where buyers are able to participate in all phases of purchasing process by stepping through electronically rather than the traditional ways of business. The processes in E-commerce include enabling a customer to access product information, to select items to purchase, to purchase items securely and to make payments electronically through online facilities like Internet. During development of E-commerce based applications, the multimedia technology plays a remarkable role in presentation of information.

Public Utilities

Multimedia is emerging as a new boom in the public places. Railway Platforms, Airports, Hotels, Cricket Grounds, Shopping Malls and Museums are the places to be visited by public and you can see how they are transforming themselves to look attractive with the help of Multimedia. Whether it is a Railway Timetable enquiry or screens displaying scores and replays on cricket grounds, you can see applications of multimedia there.

At the public places, multimedia is becoming available as stand-alone terminals or kiosks for providing online information and help using graphics, audio and video. Such installations not only replace traditional information booths but also add value and can work round the clock, even in the mid-night. Hotel kiosks list nearby restaurants, road maps of the city, train and air schedules and other guest services such as automated checkout information. Printers can be connected to these multimedia machines so users can walk away with a printed copy of the information.

Medical

Besides commercial and educational applications, multimedia is playing an important role in health care. A distributed multimedia based project like MEDNET, provides the following services for health care:

(*i*) **Real-time Monitoring of Patients.** The intra-operative monitoring places a real-time control about the condition of the patient.

(*ii*) **Online Consultation by Doctors.** The patients can consult the doctors online using multimedia and Internet technologies.

(*iii*) **Collaboration of Doctors during Surgical Operations.** Through MEDNET technology during complex surgery, the consulting neurophysician (normally difficult to find) whose presence is not necessity may remotely monitor the case along with few other cases. During surgery, the neurophysician can see and listen to the responses of the monitoring equipments on the computer monitor and in case of any problem, he can advice the surgeon who is performing the surgery.

The use of Internet and multimedia technologies for providing high-quality health care to patients in remote areas is called *Telemedicine*. In telemedicine, a remote centre is equipped with high-resolution video imaging equipment and is linked to distant doctors using a network connection such as Internet. Telemedicine provides specialised expertise at low cost to remote areas where doctors normally do not want to go.

Publishing

With advancements in multimedia technologies, the publishing industry is changing drastically today. Besides publishing books in a traditional way on paper, publishers are bringing books on CDs and Web, which is called *E-Publishing* (Electronic Publishing). The publications which are generally meant for family and children such as newspapers, magazines, science fiction books, encyclopaedias, general books, etc. are readily available on-line in multimedia form and give you real time experiences. The on-line news clippings are not only textual but also associated with attractive video clipping and images.

For children the publishing has changed tremendously with the advent of multimedia. Today many encyclopedia and books are available that provide a sort of edutainment (education and entertainment side by side). For example, a dictionary meant for children not only shows the meaning

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of the words but also show its characteristics with pictures. These kinds of media are more entertaining and provide better learning environment for children as compared to the traditional media. In fact multimedia is the best tool available today for increasing general awareness of a child.

For academicians and authors, today many products are available on CDs and Internet for reference and research. Compact discs and web sites contain a large amount of information on most of the topics in multimedia form.

Advantages of Electronic Publishing. Electronic publishing offers the following benefits to the readers:

- Searching a topic on any subject is easier on Web sites and CDs as compared to searching them in books, which are not easily available.
- Reading materials electronically is much cheaper than buying books.
- Any information is available instantly through electronic books and journals, which is not possible through traditional paper books.

Home Services

The advances of computing, communication and multimedia technologies have lead to the beginning of an era where people get multimedia facilities at home. These facilities may be in the form of an Interactive TV or through Internet, which mainly include:

- Basic Television Services
- Interactive Entertainment
- Digital Audio and Video
- Home Shopping through E-mail
- Financial Transaction using E-commerce
- Interactive Single and Multi-user Games
- Digital Multimedia Libraries
- Electronic Versions of Newspapers and Magazines

Cable TV, Telephone, Dot Com and Publishing companies are the main infrastructure providers for these facilities.

11.4. Components of Multimedia

The major components of multimedia are:

1. Textual Information
2. Images
3. Animation
4. Audio
5. Video

Let us discuss these in detail.

Textual Information

Textual information is the main component of multimedia. All multimedia productions contain some text and some products contain a large

amount of text like encyclopedia. The text can have various types of fonts and sizes to suit the professional presentation of the multimedia software. The text is represented in ASCII (American Standard Code for Information Interchange) format in computer memory.

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Images

Unlike text that is represented in universal ASCII format, images are represented in either of following two ways:

(*i*) Bitmaps

(*ii*) Vectors

Although both types of images look same, their representations in memory are different. Let us discuss these.

(*i*) Bitmap Images. A bitmap image consists of dots called *pixels on the screen*. The size and quality of such image depends on the pixel density and number of colours it uses. A bitmap needs a lot of storage area because each dot is represented in memory as 8 bits. So, the size of a bitmap file will be very large if the images use more colours or complex graphics. The software packages, which are normally used for creation of bitmap images, are called *paint programs*. For example, 'Paint accessories' in Windows and 'Corel PHOTO-PAINT' are popular paint programs. Although the bitmap image represents true picture, it blurs when zoomed.

(*ii*) Vector images. In this format, an image is formed as a set of straight or curved lines instead of dots or pixels. A line or curve can be represented by mathematical equations, whose number can be stored as a set of binary codes. So, a vector image needs very less storage space as compared to a bitmap image. The software packages, which are normally used for creation of vector images, are called *drawing programs*. For example, 'CorelDRAW' and 'AutoCAD' are popular drawing programs. An important feature of vector image is that it uses same storage space whether it is small or big. The other advantage of vector image is that unlike bitmap image it does not blur on zooming. The drawback of vector image is that as it needs software to perform calculations on the stored number to draw it, it is displayed slowly on the screen.

Animation

Animation is another vital component of multimedia. It is a continuous series of still images that are displayed in a sequence. There are mainly two types of animations used in multimedia—2D and 3D animations.

(*i*) 2D Animation. It is the most common kind of animation where flat images are drawn one frame at a time. This process is very time consuming but result obtained is spectacular in nature. 2D animation is also known as *Cell Animation*.

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Tweening Facility. Many animation packages are now equipped with tweening facility, which involves the automatic creating of a series of graphic frames between two key-frames (the first and the last frame of the action). The animation packages also involve some special effects such as morphing and warping. *Morphing* takes two images and seamlessly changes one image to another. The second image actually seems to grow out of the first one. *Warping* is variation of the morphing where one image is used to show various changes that take place. It uses the key points of one image to create different effects, unlike mixing up two images as in morphing.

(*ii*) **3D animation.** In 3D animation, images are drawn using 3 axes. 3D animation follows mainly following three steps:

(*a*) *Modeling.* Modeling is the design phase where a 3D object is created. In 2D animation an object can move up sideways in x-y plane, but in case of 3D model, a third axis is used, depth or z-axis. Once an object is created along these three axes, colour, shading and light source can be added to the image to make it more realistic.

(*b*) *Animation.* In second phase, the 3D image is moved along a motion path, which is defined using key-frames of the animation sequence. These key-frames are used to create the in-between frames in the sequence automatically by tweening facility.

(*c*) *Rendering.* In the final stage the entire sequence is rendered to create a 3-D animation. Rendering involves mixing up of all the colours, texture maps, light sources and surface attributes in each frame of the 3D sequence to form a final file of supported extensions (like .avi, .gif, etc.).

Audio

An application having only textual information, graphics and animation but no sound is not a multimedia application in a real sense. It will be like a silent movie, which have no sound. Audio is the critical component of multimedia. Sound is heard and transmitted in air as analog signals. The microphone of a multimedia PC converts sound into electrical signals that can be processed by the computer. The entire process of converting analog or electrical signals of audio to computer data file in the digital format is called *digitisation*.

Sound can also be recorded and reproduced using digital signals and the unwanted sounds can be reduced drastically in digital recording of the sound. For replaying the sound, audio has to be converted into digital form to produce digital audio. The storage space required for digital audio is huge that is around 1 MB for one minute of audio. A common digital sound file existing in personal computers is known as *WAV file*. Digital sound is used for music CDs. In digital audio system, the entire digitised audio is reconverted into analog form, which can be heard on the speaker.

MIDI versus Digital Audio. MIDI (Musical Instrument Digital Interface) is a communication standard developed in the early 1980's for electronic musical instruments and computers. It allows communication between music and sound synthesisers from different manufacturers by sending messages through connected cables. It provides protocols for details of music such as notes, sequence of notes and name of instrument playing these notes. Unlike digital audio MIDI data is not digitised sound. It is the shorthand representation of music stored in numeric form.

The size of MIDI file is quite smaller than equivalent digital file and MIDI data is device dependent. Playback of MIDI will only be accurate if the MIDI playback device is similar to the device used for its production. Because of the small size, MIDI files are used in Web pages as they are faster in downloading. In some cases MIDI sound is better than digital sound if the MIDI sound source, which you are using, is of high quality.

Video

In the introduction of chapter, we have defined multimedia as a woven combination of text, graphics, sound, animation and video elements. Out of five major elements, we have already discussed first four. Multimedia is incomplete without the fifth element *i.e.*, video. Video can be defined as a movie that gives the illusion of smooth and continuous action, consisting of a series of frames (still photographs) that are flashed on screen at a rapid rate (minimum 24 frames per second).

Video is displayed on a multimedia with the help of video capture cards. A video capture card accepts analog or digital video signals and transforms them into digital data. Digitising and storing 10-second clip of a motion picture on your computer requires large amount of data to be transferred in a very short time approximately 30-35 MB per second and 30 seconds of video requires a full gigabyte of hard disk. Therefore, in digital systems, the video signal is first digitised as a single frame and then data is compressed before it is written to the disk. Different compressing techniques (such as MPEG, P*64, DVI/Indeo, JPEG, RealVideo, VDOwave, etc.) are used to compress a video for delivery and then decode them in real-time for fast playback. MPEG (*Moving Pictures Expert Group*) is the most popular compression technique, which can compress video data by as much as 100 to 1. The MPEG standard compression system allows video sequence of 45 seconds to be fit on a 1.4 MB Floppy Disk. MPEG may become the method of choice for encoding motion images because it has become widely acceptable for both Internet and DVD-Video.

11.5. Hardware for Multimedia

The hardware of a typical multimedia computer usually comprises CD-ROM, sound card, speakers or microphone and sometimes video capture card or digital camera besides CPU, common I/O devices (Keyboard, Mouse, Speakers, Microphone, Scanner and Printer) and storage devices as shown in Figure 11.5. A MIDI interface for playing digital instrument through PC

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interface may also present on the motherboard of multimedia PC. Let us discuss about special hardware components o a multimedia PC in detail.

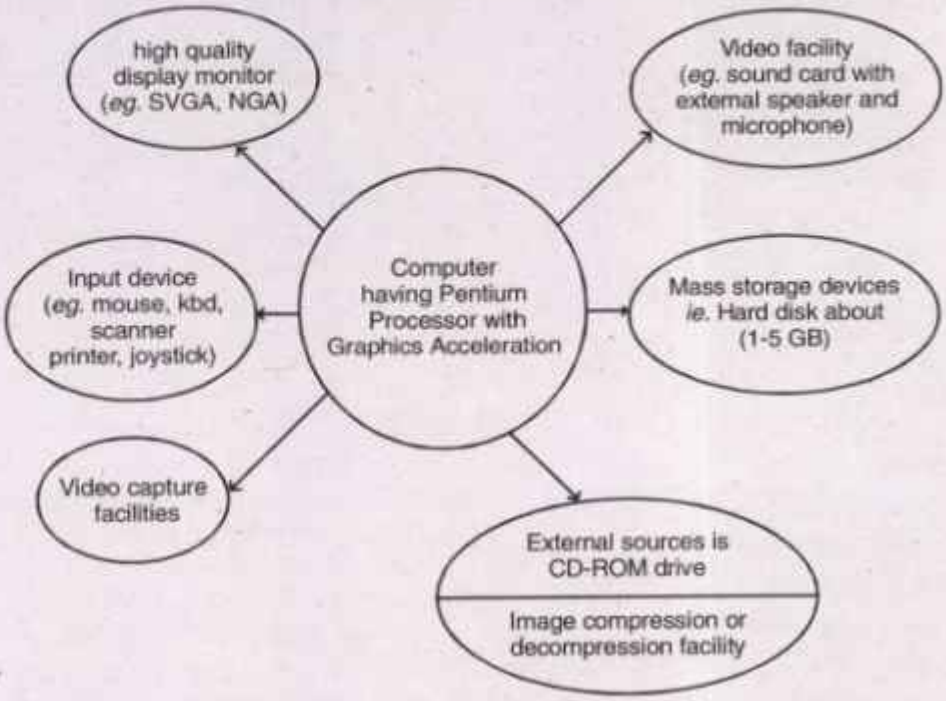

Fig. 11.5: Hardware of a typical multimedia computer

CPU

Pentium processor is the recommended CPU for multimedia computer. However, Apple Macintosh and Silicon Graphics have their own set of powerful processors for multimedia. The math co-processor should be installed in a multimedia PC to avoid poor response time. The powerful co-processor chip is added for supporting graphics and therefore it is called *Graphics Accelerator*. Although the memory capacity (RAM) for a multimedia PC should be at least 8 MB, more memory (16, 32 or 64 MB) enhances the performance of multimedia machine. Now-a-days for running very advanced multimedia software, 128 MB to 256 MB RAM is recommended.

Monitor

The multimedia PC should be equipped with a monitor having either SVGA (Super Video Graphics Array) or AGP (Accelerated Graphics Port) video card. The basic advantage of using these cards is that they have a better resolution thus, the display will be of better quality for the graphics, animation or video. The current standard display for a multimedia PC is SVGA monitor with a resolution of either 1024 × 768 or 1280 × 1024 pixels. The advanced SVGA cards can display resolution of 1600 × 1200 pixels but you need to equip your video card with 8 MB of Video RAM (VRAM). The AGP card is more advanced than SVGA card as it transfers data much more quickly than

the standard PCI (Peripheral Component Interconnect) interface. Therefore, it is the best video card for multimedia computers.

Digital Camera

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Digital camera is a device, which captures and stores real pictures or videos into memory of multimedia PC. The main function of camera is to capture images, like scanners and fax machines. Generally a good photograph is one, which have high image quality, colour fidelity and resolution. For capturing such photograph, you need an analog still-image camera. But now-a-days, digital cameras can also produce quality images. Generally a digital camera takes images in either of the two resolutions, 640 × 480 pixels or 1280 × 1024 pixels. In either case, it captures them in 24-bit colour. Little image compression can also be achieved *i.e.*, the image file can be compressed to occupy less space then usual, in the memory.

Using a Digital Camera. To produce really good images, a digital camera requires a good lens system, high memory and high processing power. An uncompressed 1280 × 1024, 24-bit image file occupies 3.75 MB. The highest quality images, which these camera generates are JPEG files, which occupy less than 1 MB. A digital still image camera works in the following way:

1. A digital camera uses a CCD (Charge-Compiled Device) element to capture the image through the lens when the photographer releases the shutter in the camera.
2. The image captured by the camera can be transferred to the PC in the following two ways, depending upon how the camera store them:
   (*a*) 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.
   (*b*) If the image, which a digital camera captures, is stored on a SmartMedia memory card inserted into the camera, you can connect a serial cable between the camera and a PC. Using suitable software on your PC, you can download pictures from the camera.

Besides still image photography, digital cameras can take short video clips, or capture a brief audio recording to associate with each still image. You can also use digital cameras in video or Voice E-mail/Chatting on Internet.

Video Capture Card

Video capture card is a digitiser card specially designed to capture TV or VCR or camera images (or video signals) and store them into the computer in digital format. This card has a dual function for both audio and video conversion. As we know, generally all TV or VCR signals are analog. The process of converting analog video signal to digital format is called *Sampling*. Using this process, the video capture card placed in the system converts the analog video signals into digital data streams so that these signals can be

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stored in the binary data structure format of 1s and 0s. The digital data file is then compressed to a considerable amount using some compressing program (like Windows WinZip). Once the conversion and compression process is complete, the file can be played back on the computer screen. These digitised files can also be edited according to requirements using various video editing software (such as Adobe Photoshop, Adobe Premiere, Corel PHOTO-PAINT, etc.).

Storage Devices

Multimedia uses digitised audio and video, which not only takes huge amount of storage space, but also requires high-speed storage media. The storage devices for multimedia must be able to send large amount of data back and forth quickly to keep recording and playing audio and video smoothly. Because of this requirement, most of the multimedia PCs use hard disk and compact disk drive drives, which provide high storage capacity, speed and data throughput. Let us discuss about common storage devices of a multimedia PC in brief.

(*i*) **Hard Disk Drive.** It is fixed inside the PC and has plenty of storage like 40 GB or more. Sometimes, two or more hard disk drives are used as an array to work together so that they act like a single hard drive. All the multimedia software are installed on the hard disk.

(*ii*) **CD ROM.** CD ROM (Compact Disk Read Only Memory) is now widely used as a multimedia storage and distribution medium. One CD ROM (simply called CD) can hold up to one and half an hour of digital audio or around fourty to fifty minutes of video or 700 to 750 MB of computer data. It has a very high immunity from damage. A CD ROM stores information using billion of microscopic pits that resides on its surface. As data is read using laser beam, it is very easy to locate information in CD ROMs. The CD ROM drive is used to read information on a CD. The information is stored or written on CDs using an expensive drive, called CD *Writer*.

(*iii*) **DVD ROM.** DVD ROM (Digital Video Disk Read Only Memory) is a digital optical disk capable of storing up to 4.7 GB of data and transferring data at higher speeds. It is a cohesion of multimedia and digital video player, movies and interactivity. DVD is designed for use with a video player and television. DVD is more than just a high quality video formatting. It can combine hours of stunning video, audio and music with computer data and instructions. It offers high quality, high capacity media rich games, with specialised educational and entertainment programs, software libraries, training programs, digitised photo collections and high quality interactive encyclopedias all on a single disk. A single-sided, single layer DVD can contain up to 140 minutes of video enough to handle 96% of all movies without the interruption of flipping the disk over or changing disks. The information on a DVD ROM is read by the DVD ROM drive. Although DVD ROM looks like a CD-ROM as its

diameter and thickness are same with those of CD ROM (120 mm and 1.2 mm respectively), it differs with latter in many ways as shown in Table 11.1.

Table 11.1: Differences between CD ROM and DVD ROM disks

	CD ROM Disk	DVD ROM Disk
1. Data capacity	0.65 GB	4.7 GB
2. Layers	1	1, 2 or 4
3. Laser wavelength	780 nm	640 nm
4. Minimum pit length	0.83 μm	0.4 μm

Laser Disk: Laser disk is mainly used to record and play back high quality digital audio files. Like CD ROM, laser disk uses the same recording media. However, it differs from CD ROM in many ways as shown in Table 11.2.

Table 11.2: Differences between CD-ROM and laser disks

	CD ROM Disk	Laser Disk
1. Storage Form of Video Analog	Digital	
2. No. of channels that it can play back at a time	4 (2 digital & 2 analog)	2
3. No. of sides where digital data is stored	1	0
4. No. of sides where analog data is stored	1	2

11.6. Software for Multimedia (Authoring Tools)

As we know movies, sound, text, graphics and animation are the integral part of multimedia. To produce or support these media elements, various software are available in the market. Some of the popular software used for developing multimedia applications are listed in Table 11.3.

Table 11.3: Popular multimedia software

Software	Use
PhotoShop	Industry standard digital image editing software
Paint	Drawing program for creating simple diagrams & pictures
CorelDRAW	Drawing program for creating high-quality graphics
Flash	Vector-based 2D animation tools package
3D-studio Max	Vector-based 3D animation package
Sound Edit	Sound capture and editing software
Director	Authoring tool for combining different multimedia components

Premiere	Digital video and post-production tool.
FrontPage applications	Authoring tool for intranets and the world wide web
Alias/wave front	3D tool for developing games and films

Notes

Some multimedia software are used to create highly interactive applications with a little or no programming experience as they are very easy to learn and use. Such software are called *authoring tools*. Authoring can be defined as creating highly interactive applications in which the information can flow in both the directions *i.e.*, from application to user and from user to applications. Multimedia Authoring tools help in creating higher quality audio and video applications with very little expensive. Using authoring tools does not require a team of programmers, instructors, corporate communications and context specialists. Using such software anyone with no previous programming experience can develop multimedia applications easily. Macromedia Director and FrontPage are popular authoring programs.

Types of Authoring Tools

Authoring tools can be divided into the following four types:

(*i*) **Time-based Authoring Tools.** They use time scale to decide duration of message on the screen. Some of the authoring tools in this category are Macromedia Action, Animation Works, etc. Time-based authoring tools are used for developing multimedia applications for business purposes.

(*ii*) **Card-based or Page-based Authoring Tools.** These tools allow information to be put in as stack of cards or pages. These pages and cards can further be linked with each other in predefined sequences. Even the cross linkages along with branching facility are also possible in such packages. Hyper Card by Apple, Asymmetric Tool Book and many presentation software are card-based or page-based authoring tools. Such authoring tools are used for developing applications for both educational and business purposes.

(*iii*) **Icon-based Authoring Tools.** These tools allow creation of an Icon based flow script, which is then converted to an application. Macromedia Authoring Professional, Icon Author, etc. are Icon-based authoring tools. Such authoring tools are also used for developing multimedia applications for both business and educational purposes.

(*iv*) **Theatrical Authoring Tools.** These types of tools refer to media elements, as independent cast members, which are assembled using score which is sequential in terms of time, linking and animation. Complex visual effects can be applied on these scores to create powerful presentations. Macromedia Director is one of such package. Theatrical authoring tools are used for developing multimedia applications for educational and entertainment purposes.

Notes

Important Authoring Tools

A few important authoring tools are:

(*i*) Everest Authoring System

(*ii*) Macromedia Director

(*iii*) Quick Time

Let us discuss these in detail.

(*i*) **Everest Authoring System.** This system is best suited for the developers of CBT applications who seek a powerful but easy-to-use window based authoring environment. Its main features are visual programming with icons, direct manipulation of interface elements and procedural programming.

The Everest development environment opens with multiple views of an application. In Everest's application creation, the user starts off with a library and names an initial screen. Dragging a layout object icon from the tool set onto that screen provides the basis for the first screen. Interface and media object icons like list and combo boxes, edit boxes, text displays, bitmap placeholders, sliders and gauges, buttons of all types, video and audio, OLE and animation can also be dragged on to the screen. Once the screen design is accepted to the user, Everest provides an easy method of scripting, navigation and control flow.

(*ii*) **Macromedia Director.** Macromedia Director (simply called *Director*) is more suited for development of interactive movies, multimedia presentations and games than CBT or interactive catalogs that require more database work. Using Director, you can integrate graphics, music, narration, sound effects and digital video into your multimedia application. Macromedia Director provides the following features:

- A central screwing component that provides precise timing control
- Cross-platform compatibility
- Strong and intuitive animation features
- Extensive architecture to add functionality

The application in Director's user interface is a movie, the playback screen is the stage, and the various elements in the movie are cast members. A Director movie consists of frames that comprise many separate, individual channels, each of which can hold a sprite or sound, custom palette, etc. Each *sprite* is an instance of a cast member such as a piece of text, a bit-mapped image, or a digital video clip. As all of the sprites can be accessed during each frame of the movie, an ultimate time-based control can be achieved. Director has 48 separate sprite channels available in each frame. Sprites are only copies of the cast members so their look can be modified in a particular frame without affecting the original copies.

Notes

Each *channel number* represents on stage layer so the sprites can be moved between layers by simply surfing them up and down.

Director can import an impressively broad range of graphics formats. When a file is imported, it automatically becomes a cast member and receives a number. It has the ability to mix with sound files sampled at different rates and sizes. However, it is not possible to mix AIF and WAV files with the audio in digital movie clips. Animation features are also one of the strongest features that can allow to set the sprites in motion differently.

(*iii*) **Quick Time.** It is a software developed by Apple that supports time based media on the Macintosh. It has also been ported for Windows applications. An example of time-based media is video where a sequence of images is displayed on screen to create the illusion of motion. The images are time based because to retain synchronisation with a sound track, the images must be displayed at the correct time in relation to the sound track. Different development environments relate to Quick time for developing an application form scratch as shown in Figure 11.6.

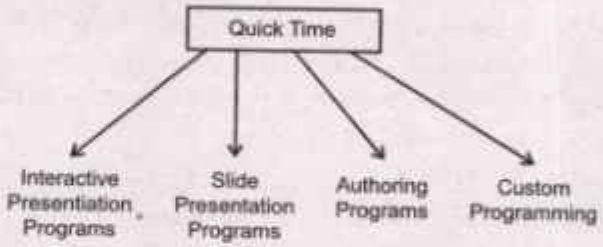

Fig. 11.6: Relationship of quick time with different multimedia development environments

Quick time supports almost all type of video, animation and sound on Macintosh since its introduction. It has many other features but the two most important are— Compressors and Timing Mechaism. The compressors enable the program to reduce the frames to a manageable size, so the computer can stream the information from the disk. The timing mechanism ensures that multiple tracks maintain synchronisation.

Features of Authoring Tools

Authoring software are generally menu-driven systems intended to be easy to use by the multimedia developer. They do not require the trainer to get involved with program code. Authoring systems vary widely in orientation, capabilities and learning capabilities of the user. Most of the authoring systems require some basic knowledge of heuristic thinking and algorithm design. Authoring actually is just a speed-up form of programming, although you need not know the intricacies of a programming language. Various features of authoring software are as follows:

(*i*) **Integrated Multimedia Elements.** Authoring software support a wide area of file format with different media elements. Add-on boards and peripheral devices to play multimedia support the authoring software. Authoring software provide developers with a greater degree of control over each multimedia element than presentation programs. Now, they are geared towards education and training application besides business presentations.

(*ii*) **Script Language Programs.** Authoring software offers the user an ability to write scripts. This feature results in writing new programs, which are not supported by the software itself. Script language programs create multimedia presentations using a series of programming style commands linked together in a word processing typescript. Scripting is closest in the form to traditional programming. The scripting specifies multimedia elements, sequencing hotspots, synchronisation, etc. Besides allowing powerful interactivity, in such languages, program editing of elements (video, audio, etc.) tends to be minimal or non-existent.

Although the scripting supports better and more complex media interactivity, it takes longer time in development and can be difficult to learn. As most scripting languages are interpreted instead of compiled, the runtime speed over other authoring methods is reduced.

(*iii*) **Icon Based Programs.** Icon based programs are actually object oriented development tools where individual multimedia elements are represented by icons rather them script commands. They try to make development of multimedia applications easier by using graphical icons as the control features of authoring program. The main features of Icon based programs are:

- They are easier to learn than scripting program.
- Editing elements in a presentation requires only clicking on its corresponding icon.
- They are suited for rapid prototyping and short development time projects.

(*iv*) **DLLs for Extending Features.** Advanced authoring program can call on special features included in Windows Dynamic Linking Libraries (DLLs). DLLs can be called on for special functions that may not be available in the authoring software program. Object-oriented programming languages such as C++ allow users to create their own DLLs for enhanced function.

(*v*) **Supporting CD ROM or Laser Disk Source.** Authoring software allow full control of CD drives to integrate audio, video and computer files. Multimedia presentations that depend on large amount of sound or video clips require excessive amounts of hard disk space. CD ROM, Laser Disk or DVD Disk helps in providing sources for video, audio or image clips.

(*vi*) **Supporting Videos for Windows.** Audio/Videos captured through TV tuner card or digital camera are easily stored in the hard disk. Most authoring software have the capability to support most multimedia elements (such as Video for Windows) on your disk. They help in developing projects having clippings of videos from TV turner card and digital camera.

(*vii*) **Cross-platform Capability.** Authoring software can be ported from one platform (*e.g.*, Windows) to another (*e.g.*, Macintosh) with appropriate planning and changes. They have capabilities to be altered for presentation on Macintosh or other hardware/software platform. Certain tools are used for transforming and converting file formats and programs while porting from one platform to another.

(*viii*) **Hypertext.** Hypertext is non-linear or non-sequential text so that one can easily jump around from topic to topic. It is simple textual data having capabilities to link graphics, some animation and other text. Hypertext programming interfaces of authoring software allows users to select individual highlighted or underlined words on a screen, which are then linked to additional pages and layers of text. The highlighted or underlined words in hypertext are called hyperlinks. A *hyperlink* connects two nodes and it directly points one node (called *anchor node*) to another (*destination node*). The 'Help' system of Windows and web pages on Internet are very good examples of hypertext. Hypertext systems are useful when presenting and referencing large amounts of textual information. Some hypertext authoring programs provide graphical links for animations, sound and video besides text. The basic elements of hypertext as shown in Figure 11.7 are described below:

(*a*) *Nodes.* A node is a collection of data organised around a specific topic and related or linked to another document.

(*b*) *Links.* Links are the other fundamental units of hypertext. Link is an information embedded in a node that connects it in some way to another node.

(*c*) *Annotation.* It is a special link to a small, additional amount of information. It is quite similar to the footnote in traditional text.

(*d*) *Button.* It is a visual clue in a node that alerts a user that a link exists. It is actually a visual representation of a link in a node.

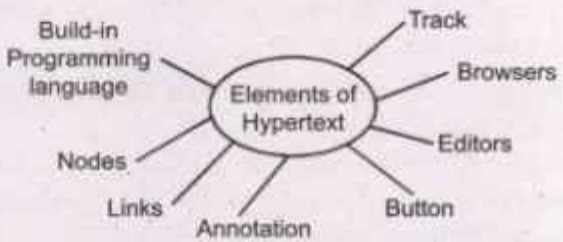

Fig. 11.7: Basic elements of hypertext

(e) *Editor.* An editor is the part of the hypertext systems that enables a user to create a node and link it into the network.

(f) *Browser.* A hypertext browser is a program that can display a diagram of a network of nodes. In a network browser each node would be designated only once and lines should be drawn to show all of the links among all of the nodes.

(g) *Trail.* It is a record of the nodes that a user has accessed while viewing a hypertext document.

(h) *Built in programming language.* It is used to customise the hypertext system to fit one's specific needs. Several hypertext systems have built-in programming languages like HyperCard, HyperTalk and KnowledgePro, which can enable you to build expert systems.

(*ix*) **Run Time Player for Distribution.** The Run Time software is often included in authoring software to run your final product by packaging playback software with the content. Such software can help in synchronisation between the audioand video, which you have included in the application.

11.7. Graphics Files

Most of the times you need to create graphics in one program and then use them or edit them in another program. For instance, you may create a painting or drawing in a program such as paint or CorelDraw and then want to place it in a page layout created in PageMaker.

All graphics programs enable you to save files in a native format-one that is read by that application. In addition, however, there are a number of standard graphics file formats in which you can save the graphics. Saving a graphic in a standard file format is called *exporting the graphic*. While placing a graphic in a standard file format into another document or file is called *importing the graphic*.

Various graphics file formats are described below:

1. **Object-based Vector Graphics.** Encapsulated PostScript (EPS) is the format most widely used for vector-based graphics such as those produced by drawing programs. This format is based on the PostScript page description language used by laser printers and professional image-setters.
2. **Bitmap or Raster Graphics.** BitMap (BMP) is a format widely used bitmap graphics on IBM PCs and compatibles. The PICTure, or PICT, is a format widely used for bitmap graphics on Macintosh computers. Tag Image File Format, or TIFF, is a bitmap graphics format widely used on Macintoshes and on IBM PCs and compatibles. This format is normally used for photographs.
3. **Compressed Bitmap Graphics.** Joint Photographic Experts Group file format, (JPEG) is a format for compressed bitmap graphics.

Notes

This format is widely used for Internet graphics and photo editing applications. Graphic Interchange Format, or GIF, is another common format for compressed bitmap graphics that is widely used on the Internet.

The secondary names for various graphics file formats are listed in Table 11.4.

Table 11.4: Secondary names for various graphics file formats

Graphic File format	Secondary Name *
Encapsulated Post Script	.eps, .epsf
BitMap	.bmp
Picture	.pic, .pict
Tag Image File Formal	.tiff
Joint Photographic Experts Group	.jpg, .jpeg
Graphics Interchange format	.gif

** IBM PCs and compatibles use 3 letter secondary name while Macintoshes use 3 or 4 letters.*

Sources of Computer Graphics

You can either create your own new graphics or make use of pre-existing collection of graphic images by editing them if required. Various sources of computer graphics are:

(*i*) **ClipArt Collections.** Many companies produce artwork that has been saved as files on disk, CD ROM or DVD ROM which is called ClipArt. ClipArt images are categorised into various subject areas such as Education, Business, Travel, People, Sports, etc. You can purchase the ClipArt disk or CDs and make use of various images.

(*ii*) **Photographs.** You can take photographs with a conventional camera and scan the photographs with scanner. These scanned photographs can be edited using a graphics software like Adobe photoshop or Corel Photopaint and hence be used in your application or document.

(*iii*) **Drawings.** You can also draw graphics or diagrams using a DTP software such as Corel DRAW or paint accessory program of Windows.

(*iv*) **Digital Images.** You can take photographs with digital cameras too which capture image in a digital format. So, you do not require a scanner and directly download the photographs to your PC.

11.8. Key Point Summary

- Multimedia is a woven combination of text, graphics, sound, animation and video.

Notes

- Various types of media in a multimedia system are Print, Audio and Video.
- A multimedia system is an interactive and non-linear media in comparison to a convential form of media.
- Multimedia applications are categorised into various areas such as Entertainment, Edutainment, Business, Public Utilities, Medical, Publishing and Home Services.
- Creating real life games, graphics, sound and animation are applications of multimedia in entertainment.
- Edutainment refers to imparting education through entertainment.
- Business applications for multimedia include presentations, online training programs, software for marketing, advertisement on Internet, Audio/Video Conferencing, etc.
- Multimedia is available as stand-alone terminals or kiosks for providing online information and help at various public places such as Hotels, Airports, etc.
- Multimedia plays an important role in health care for real-time monitoring of patients, online consultation by doctors, telemedicine, etc.
- Using multimedia, publishers can bring books on CDs and Web through E-Publishing.
- Multimedia facilities are also available at home in the form of basic television services, interactive entertainment, etc.
- The major components of multimedia are textual information, images, animation, audio and video.
- The text is represented in ASCII format.
- Images are represented in either bitmap or vector forms.
- There are mainly two types of animations used in multimedia—2D (Cell Animation) and 3D animations.
- Animation packages are equipped with techniques like Tweening Facility, Morphing and Warping.
- The three steps of 3D animation are Modeling, Animation and Rendering.
- Digital sound in the form of 'WAV file' is used for music CDs.
- MIDI (Musical Instrument Digital Interface) data provides protocols for details of music such as notes, sequence of notes and name of instrument playing these notes.
- Video is a movie that consists of a series of frames that are flashed on screen at rapid rate.
- The hardware of a typical Multimedia Computer comprises CD ROM, Sound Card, Speakers or Microphone, Video Capture Card, Digital Camera besides the basic devices of computer.
- The monitor of a multimedia PC should have either SVGA or AGP video card.
- Digital camera generates JPEG files, which occupy less than 1 MB.

Notes

- Video capture card converts analog video signal to digital form by a process called sampling.
- The common storage devices of a multimedia PC are Hard disk, CD ROM, DVD ROM and Laser Disk.
- Authoring tools are the software of multimedia.
- Various types of authoring tools are Time-based, Card-based (Page-based). Icon-based and Theatrical authoring tools.
- A few important authoring tools are Everest Authoring System, Macromedia Director and Quick Time.
- Various features of authoring software are Integrated Multimedia Elements, Script Language Programs, Icon Based Programs, DLLs, Supporting CD ROM, Supporting Video, Cross-platform capability, Hypertext and Run Time Player.
- Various graphic file formats are Object-based Vector Graphics, Bitmap or Raster Graphics and Compressed Bitmap Graphics.
- Various sources of computer graphics are ClipArt, Photographs, Drawings and Digital Images.

11.9. Review Questions

1. (*a*) What is multimedia? What are the various media in a multimedia system?
   (*b*) Discuss various advantages of multimedia system.
2. Discuss the various applications of multimedia in the following areas:
   (*a*) Entertainment (*b*) Edutainment
   (*c*) Business (*d*) Medical
3. How does multimedia helps you at various public places? Discuss.
4. What is E-Publishing? What are its benefits to the users?
5. What are the major components of multimedia? Discuss.
6. Explain the differences between the following:
   (*a*) Bitmap and Vector Images (*b*) 2D and 3D animation
   (*c*) Morphing and Warping (*d*) MIDI and Digital Audio
7. What are the main hardware components of a multimedia PC? Discuss.
8. (*a*) What are Authoring Tools? Discuss various types of authoring tools.
   (*b*) Write short notes on any two authoring tools.
9. Discuss the various features of Authoring Tools.
10. Differentiate between the following:
    (*a*) EPS, BMP and JPEG
    (*b*) CD ROM and DVD ROM

(c) SVGA and AGP Cards

(d) Modeling, Animation and Rendering

11. (a) Write the secondary name of the following Graphic File Formats.
    (i) Encapsulated Post Script
    (ii) Bitmap
    (iii) Tag Image File
    (iv) Graphics Image Format
    (b) What are the various sources of computer graphics? Explain briefly.
12. Write short notes on:
    (a) Virtual Reality
    (b) Video Conferencing
    (c) E-Commerce
    (d) Telemedicine
    (e) Sampling
13. (a) What are the hypertext and hyperlink?
    (b) What are the basic elements of hypertext?
14. What is a Digital Camera? How does it work?

Notes

BBA-303

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