Information
Technology

PROFESSIONAL COMPETENCE COURSE

STUDY MATERIAL

INFORMATION TECHNOLOGY

PAPER 6A

INFORMATION TECHNOLOGY

This study material has been prepared by the faculty of the Board of Studies and a team of experts comprising of CA Anjan Bhattacharya and Ms. Veena Hingarh. The objective of the study material is to provide teaching material to the students to enable them to obtain knowledge and skills in the subject. Students should also supplement their study by reference to the recommended text books. In case students need any clarifications or have any suggestions to make for further improvement of the material contained herein, they may write to the Director of Studies.

All care has been taken to provide interpretations and discussions in a manner useful for the students. However, the study material has not been specifically discussed by the Council of the Institute or any of its Committees and the views expressed herein may not be taken to necessarily represent the views of the Council or any of its Committees.

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PREFACE

Computers are an inherent part of the life today. Virtually, in every walk of life, a person is expected to be able to use computers. The impact of information technology in several aspects of accounting profession and practice has been pronounced over the last two decades in India. An accountant who does not understand computer-based accounting system is likely to be left high and dry in the profession. A working knowledge of contemporary information technology is a basic bread and butter requirement of Chartered Accountants today. Hence, the knowledge acquired by the student through the study of the subject "Information Technology" will be very helpful in the long run.

Though the level of knowledge required for Information Technology paper is only "working knowledge", students are advised to make an early start of this study material. Chapters 1 covers the basic concepts relating to computer hardware, its functioning and the software. Chapter 2 covers Data storage , Retrieval and Data Base Management Systems. Chapter 3 is devoted to discussion on Computer Networks and Network Security. In chapter 4, we have discussed various aspects of Internet, E-Commerce and other technologies.

Students possessing no previous exposure to computers would find it difficult to understand these topics in the very first reading. Hence, one should give repeated and intensive reading to each chapter over a period of time. During the course of study, keep preparing notes on important terms covered under each topic. Students will sometimes encounter certain technical terms, which are not explained in the initial chapters, but such terms would have been explained under appropriate heading in the subsequent chapters. Students are advised to make a note of such items and try to understand the concepts when they find the explanation of these items in the study material. A conceptual clarity of the subject would help the students in understanding the topics on development tools viz. flowcharting and decision tables which are discussed in chapter 5 and chapter 6. It is very easy to acquire good marks in flow-charting and decision table if the algorithm of the problem is clearly understood. However, students generally flounder in these two areas. Merely cramming of solutions of various problems given in the study material is not going to help you. Before preparing a flow-chart, it is very important to understand the logic of the problem clearly. First of all, prepare an algorithm (a list of steps to be followed to arrive at the solution) for the given problem. Once the algorithm is clear in the mind, it can be easily depicted in the form of a flowchart. The accuracy of the answer should also be tested using a set of test data as explained in the study material.

Once a topic is thoroughly understood, write answers to self-examination questions given at the end of each chapter. Further, inculcate the habit of referring to some of the prescribed text books Under the new scheme, students are required to undergo Information Technology Training for 100 hours. A practical hands-on-experience on computer will help the students in understanding the technicalities of the subject easily.

Few important points for the Examination

1. Don't indulge in "selective reading". All the topics covered in the syllabus should be prepared thoroughly.

2. Instead of writing lengthy essay-type answers, break your answer into number of points covering all the aspects of the question asked. Before you start attempting a question, read it carefully, visualise clearly what is expected to be answered. Don't attempt a question in haste.

3. Answer should be specific and to the point according to the weightage of marks allotted. If a question carries only two to three marks, a precise definition or stating important points will be sufficient. However, if the question carries more marks, a brief description of each point should be given. Avoid giving unnecessary details. It will not fetch you extra marks.

4. Wherever possible, try to include relevant diagrams, rough sketches etc. but don't waste time in drawing very neat pictures.

5. It is always better to adopt the standard terminology. In case you are following a different methodology from the one given in the study material, clearly specify it in your answer sheet.

6. Any assumptions made while answering a question should be clearly stated.

If the students follow the above guidelines, we are sure that they will not find any difficulty in preparing themselves for the examination. In case of any specific problem, they are always welcome to write to us.

Happy reading and Best of Luck.

SYLLABUS

PAPER – 6 : INFORMATION TECHNOLOGY AND STRATEGIC MANAGEMENT

(One paper – Three hours – 100 Marks)

Level of Knowledge: Working knowledge

Section A : Information Technology (50 Marks)

Objective:

To develop an understanding of Information Technology and its use by the business as facilitator and driver.

Contents

1. **Introduction to Computers**

(a) Computer Hardware

Classification of Computers - Personal computer, Workstation, Servers and Super computers

Computer Components - CPU, Input output devices, Storage devices

(b) BUS, I/O CO Processors, Ports (serial, parallel, USB ports), Expansion slots, Add on cards, On board chips, LAN cards, Multi media cards , Cache memory, Buffers, Controllers and drivers

(c) Computer Software

Systems Software - Operating system, Translators (Compilers, Interpreters and Assemblers), System utilities

General Purpose Software/ Utilities - Word Processor, Spread Sheet, DBMS, Scheduler / Planner, Internet browser and E-mail clients

Application Software - Financial Accounting, Payroll, Inventory

Specialised Systems – Enterprise Resource Planning (ERP) , Artificial Intelligence , Expert Systems, Decision Support Systems – An Overview

2. **Data Storage, Retrievals and Data Base Management Systems**

(a) Data and Information Concepts: Bits, Bytes, KB, MB, GB, TB

(b) Data organization and Access

Storage Concepts : Records, Fields, Grouped fields, Special fields like date, Integers, Real, Floating, Fixed, Double precision, Logical, Characters, Strings, Variable character fields (Memo); Key, Primary key, Foreign key, Secondary key, Referential integrity, Index fields.

Storage techniques: Sequential, Block Sequential, Random, Indexed, Sequential access, Direct access, Random access including Randomizing

Logical Structure and Physical structure of files

(c) DBMS Models and Classification:

Need for database, Administration, Models, DML and DDL (Query and reporting); Data Dictionaries, Distributed data bases, Object oriented databases, Client Server databases, Knowledge databases

(d) Backup and recovery – backup policy, backup schedules, offsite backups, recycling of backups, frequent checking of recovery of backup

(e) Usage of system software like program library management systems and tape and disk management systems – features, functionalities, advantages

(f) Data Mining and Data Warehousing - An overview

3. Computer Networks & Network Security

(a) Networking Concepts – Need and Scope, Benefits

Classification: LAN, MAN, WAN, VPN; Peer-to-Peer, Client Server

Components- NIC, Router, Switch, Hub, Repeater, Bridge, Gateway, Modem

Network Topologies– Bus, Star,, Ring, Mesh, Hybrid, Architecture :Token ring, Ethernet

Transmission Technologies and Protocols – OSI, TCP/IP, ISDN etc.

Network Operating System

(b) Local Area Networks- Components of a LAN, Advantages of LAN

(c) Client Server Technology

Limitation of Single user systems and need for Client Server Technology

Servers - Database, Application, Print servers, Transaction servers, Internet servers, Mail servers, Chat servers, IDS

Introduction to 3- tier and "n" tier architecture (COM, COM+)

(d) Data centres: Features and functions, Primary delivery centre and disaster recovery site

(e) Network Security

Need; Threats and Vulnerabilities; Security levels; techniques

4. Internet and other technologies

(a) Internet and world-wide web, Intranets, Extranets, applications of Internet, Internet protocols

(b) E-Commerce - Nature, Types (B2B, B2C, C2C), Supply chain management, CRM, Electronic data interchange (EDI), Electronic fund transfers (EFT), Payment portal, E-Commerce security;

(c) Mobile Commerce, Bluetooth and Wi-Fi

5. Flowcharts, Decision Tables.

CONTENTS

INFORMATION TECHNOLOGY

CHAPTER 2 – DATA STORAGE, RETRIEVAL AND DATA BASE MANAGEMENT SYSTEMS

CHAPTER 3 – COMPUTER NETWORKS & NETWORKS SECURITY

CHAPTER 1

INTRODUCTION TO COMPUTERS

In this Chapter we shall discuss what we understand by the term 'computer', its functions and various generations through which computer technology has advanced. Various categorizations of computers according to their purpose and size etc. shall also be discussed in this study paper. We will also overview hardware and software requirements. Hardware consists of the mechanical and electronic components, which one can see and touch. Computer hardware falls into two categories: processing hardware, which consists of the central processing unit, and the peripheral devices. The software comprises of system and application programs, the operating systems and various other general purpose software.

1.1 HISTORICAL DEVELOPMENT OF COMPUTERS

The modern computer with the power and speed of today was not a solitary invention that sprang completed from the mind of a single individual. It is the end result of countless inventions, ideas, and developments contributed by many people throughout the last several decades. The history of automatic data processing begins with Charles Babbage's attempt to build an automatic mechanical calculator at Cambridge, England, in 1830. By the 1930's punched cards were in wide use in large business, and various types of punched card handling machines were available. In 1937, Howard Aiken, at Harvard, proposed to IBM that a machine could be constructed which would automatically sequence the operations and calculations performed. This machine used a combination of Electro-mechanical devices, including relays.

First Generation computers : UNIVAC (Universal Automatic Computer) was the first general purpose electrical computer to be available and marks the beginning of the first generation of electrical computers. The first generation electrical computers employed vacuum tubes. These computers were large in size and required air conditioning. The input and output units were the punched card reader and the card punches. Because of the inherently slow speed of these input/output units, the power of the CPU was subjugated to their speed. IBM-650 was however, the most popular first generation computer and was introduced in 1950 with magnetic drum memory and punched cards for input and output. It was intended for both business and scientific applications.
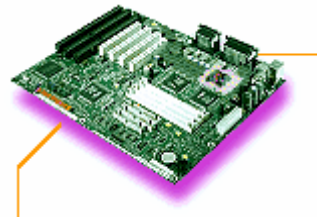
Fig-1.1 (a)   Fig. – 1.1 (b)

Second generation computers: These computers employed transistors (see figure 1.1 (a) and other solid state devices. Their circuits were smaller than the vacuum tubes, and generated less heat. Hence the second-generation computers required less power, were faster and more reliable. IBM 1401 was the most popular second-generation computer. There were two distinct categories of the second-generation computers for business and scientific applications. They employed magnetic tape as the input/output media. Second generation computers successfully displaced the unit record equipment on cost benefit grounds in many installations.

Third generation computers: These employed integrated circuits in which all the elements of an electronic circuit are contained in a tiny silicon wafer. The third generation computers are much cheaper and more reliable than the second-generation computers. They are speedier with much vaster capacity and admit connection of a wide variety of peripherals particularly magnetic disk units. They are based on the principles of standardisation and compatibility. The core storage of a given model of a computer can be expanded by adding modules and it still permits the use of order program. The third generation computers can be used for both scientific and business applications.

The third generation computers permit multi-programming which is interleaved processing of several programmes to enhance the productivity of the computer, time-sharing which is the use of the computer by several customers at a time, operating systems which optimise the man-machine capabilities and such data communications facilities as remote terminals. They also permit use of such high level languages as FORTRAN and COBOL. The mini computers are also one of the developments in the third generation computers.

Each generation of computers has an effect on the MIS centralisation and decentralisation issue. The first generation computers were high in costs and large in size; therefore information systems were sought to be centralised to serve benefits of hard ware economies. The second-generation computers were substantially cheaper and the trend was towards MIS decentralisation. Third generation computers however, offered communication capabilities and the use of remote terminals and the trend was reversed to centralisation.

Fourth Generation Information Systems : Fourth generation machines appeared in 1970's utilizing still newer electronic technology which enabled them to be even smaller and faster than those of the third generation. Many new types of terminals and means of computer access were also developed at this time.

One of the major inventions, which led to the fourth generation, was the large scale Integrated Circuit (LSI) The LSI is a small "chip" which contains thousands of small electronic components which function as a complete system. In effect an entire computer can be manufactured on a single chip of size less than 1/3 inch square. A single chip may perform the functions of the entire computer, calculator or control device. Research into future developments promises the manufacture of large computer systems with enormous memory capacity on small chips. This will reduce the cost and increase the speed of new systems still further.

Micro computers : In July, 1977, at National Computer Conference in Dallas, Commodore Ltd. startled the computing world by announcing a fully assembled microcomputer in a single housing called the Personal electronic Transactor (PET) The machine consisted of keyboard, processor unit, CRT and built in cassette tape recorder for $595. The programming language BASIC was built into the system. Thus, for less than $600, a fully programmable, powerful computer system was available for home or personal use. Later in 1977, Radio Shack Corporation announced the TRS 80 computer.

The IBM family of personal computers: In [1981] International Business Machines (IBM) made its first appearance in the field of microcomputer with the announcement of the IBM Personal Computers. The term personal computer captured the notion that an individual can have her or his own computer. With the advent of IBM PC, computers had stepped out of large organisations and entered into the home. However, instead of adopting 8-bit microprocessor, IBM selected Intel 8088 - a 16 - bit microprocessor which made the IBM PC "an overnight success". In [1983], IBM's first addition to the PC-family - XT model was introduced, which added a high capacity hard disk storage facility to the PC. In [1984], IBM introduced two new high powered models of PC *viz* Compaq Desk Pro, the first member of the PC family to have more basic computing power than the original PC and the IBM PC

Figure 1.2

AT model, which had a much greater computing speed than the PC and XT or even the new Desk Pro. When software vendors began to orient their products to the IBM PC, many microcomputer manufacturers created and sold clones of it. These clones called IBM PC compatibles, run most or all the software designed for the IBM PC. Therefore, whatever IBM does in the personal computer erana has immediate and far-reaching effects on PC market. The successor to the IBM PC, the IBM personal system/2, or IBM PS/2 (introduced in 1987), have almost certainly become a milestone in PC history. With IBM's products, the microcomputer took its place as an important tool for use in solving the information processing needs of both large and small businesses.

Other Significant Contributions: Several other personal computers have established their place in PC history. Introduced in [1982], the Commodore-64 was significant because it signaled the buying public that powerful micros could be manufactured and sold at a reasonable cost $599. In the same year, Compaq Computer Corporation bundled the equivalent of an IBM PC in a transportable case and named it the Compaq Portable. Thus began the era of the portable computer. In [1984], Apple Computer introduced the Macintosh with a very "friendly" graphical user interface - proof that computers can be easy and fun to use.

Microcomputers have many of the features and capabilities of the larger system. The cost of microcomputers has dropped substantially since their introduction. Many now sell a microcomputer for as low as Rs. 15,000. This reduction in cost will bring about a significant increase in the number of microcomputers in use. The major application for microcomputer lies in the field of industrial automation, where they are used to monitor and control various manufacturing processes. Their low cost and lightweight make it feasible to carry them on site or into a field or to package them with other portable equipments as part of larger system.

The second decade (1986- present) of the fourth generation observed a great increase in the speed of microprocessors and the size of main memory. The speed of microprocessors and the size of main memory and hard disk went up by a factor of 4 every 3 years. Many of the mainframe CPU features became part of the microprocessor architecture in 90s. In 1995 the most popular CPUs were Pentium, Power PC etc. Also RISC (Reduced Instruction Set Computers) microprocessors are preferred in powerful servers for numeric computing and file services.

The hard disks are also available of the sizes up to 80 GB. For larger disks RAID technology (Redundant Array of Inexpensive Disks) gives storage up to hundreds of GB. The CDROMs (Compact Disk-Read Only Memory)and DVDs(Digital Video Diks) are have become popular day by day. The DVDs of today can store up to 17 Giga bytes of information.

The computer networks came of age and are one of the most popular ways of interacting with computer chains of millions of users. The computers are being applied in various areas like

simulation, visualization, Parallel computing, virtual reality, Multimedia etc.

Fifth Generation : Defining the fifth generation of computers is somewhat difficult because the field is in its infancy. The most famous example of a fifth generation computer is the fictional HAL9000 from Arthur C. Clarke's novel, 2001: A Space Odyssey. HAL performed all of the functions currently envisioned for real-life fifth generation computers. With artificial intelligence, HAL could reason well enough to hold conversations with its human operators, use visual input, and learn from its own experiences. (Unfortunately, HAL was a little too human and had a psychotic breakdown, commandeering a spaceship and killing most humans on board.)

Though the wayward HAL9000 may be far from the reach of real-life computer designers, many of its functions are not. Using recent engineering advances, computers are able to accept spoken word instructions (voice recognition) and imitate human reasoning. The ability to translate a foreign language is also moderately possible with fifth generation computers. This feat seemed a simple objective at first, but appeared much more difficult when programmers realized that human understanding relies as much on context and meaning as it does on the simple translation of words.

Many advances in the science of computer design and technology are coming together to enable the creation of fifth-generation computers. Two such engineering advances are parallel processing, which replaces von Neumann's single central processing unit design with a system harnessing the power of many CPUs to work as one. Another advance is superconductor technology, which allows the flow of electricity with little or no resistance, greatly improving the speed of information flow. Computers today have some attributes of fifth generation computers. For example, expert systems assist doctors in making diagnoses by applying the problem-solving steps a doctor might use in assessing a patient's needs. It will take several more years of development before expert systems are in widespread use.

1.2 SIZE OF COMPUTERS

Computer systems are often categorized into super computers, mainframes, minis, and micros. These days computers are also categorized as servers and workstations.

1.2.1 Super computers - These are the largest and fastest computers available but are typically not used for commercial data processing. Instead they are used in specialized areas such as in Defence, aircraft design and computer generated movies, weather research etc. Predicting the weather involves analyzing thousands of variables gathered by satellites, aircrafts and other meteorological stations on the ground. This analysis has to be done in a vary short time. A super computer can handle such situations efficiently. In the medical field, super computers are used to study the structure of viruses, such as those causing AIDS. Designing an aircraft involves simulating and analyzing the airflow around the aircraft. This again requires a super computer. The first super computer was the ILLIAC IV made by

Burroughs. Other suppliers of super computers are CRAY, CDC, Fujit su, Intel Corporation, Thinking Machine Corporation, NEC, SGI, Hitachi, IBM and Sun Microsystem, etc.

In past, a high clock rate was one of the characteristics that distinguished super-computers from ordinary machines. For instance, the high clock rate of Cray processors made them the fastest available during the 1980s. However, microprocessor clock rates have now matched, and even in some cases surpassed the clock rates of super-computers. What distinguishes the super-computer of today from ordinary computers is their high degree of parallelism, i.e., their ability to perform a large number of operations simultaneously. All modern super-computers contain several processors, which can cooperate in the execution of a single program. Each processor can execute instructions following a program path independently of the others. Parallelism is achieved by decomposing programs into components, known as tasks or threads, which can be executed simultaneously on separate processors. Cray SVI super-computer introduced in 1998 can support 1,024 microprocessors, the cycle time is 4 nano seconds and has maximum memory size of 1024 gigabytes. On the other hand, Intel ASCI Red, introduced in 1997 which is a microprocessor-based super-computer, can support upto 9216 processors, Pentium Pro CPU and 584 MB of memory.

Super computers can process 64 bits or more at a time. Their processing speed ranges from 10,000 million instructions per second (MIPS) to 1.2 billion instructions per second. They can support up to 10,000 terminals at a time.

1.2.2 Mainframe computers: Mainframes are less powerful and cheaper than Super computers. However, they are big general-purpose computers capable of handling all kinds of scientific and business applications. Mainframes can process at several million instructions per second. A Mainframe can support more than 1,000 remote terminals.

Mainframes have large on-line secondary storage capacity. A number of different types of peripheral devices like magnetic tape drive, hard disk drive, visual display units, plotters, printers and telecommunication terminals can be attached with main-frame computers. They have high-speed cache memory which enables them to process applications at a faster rate than mini or microcomputers. They also offer the facility of multiprogramming and time-sharing.

Prices of Mainframe computers range between 1 crore to 5 crores depending upon the configuration. It is customary of Mainframe computer manufacturers to produce models ranging in size from small to very large, under a family designation. Computers belonging to a family are compatible *i.e.,* program prepared for one model of a family can run on another bigger model of the family. Major suppliers of Mainframe computers are IBM, Honey well, Burroughs, NCR, CDC and Sperry etc. Mainframes can be used for a variety of applications. A typical application of these computers is airline reservation or railway reservation system. The airlines have a mainframe computer at their head office where information of all flights is

stored. Various terminals located at the booking offices are attached to the central date bank and up-to-date information of all flights can be obtained at any terminal.

1.2.3 Mini Computer - This type of computer performs data processing activities in the same way as the mainframe but on a smaller scale. The cost of minis is lower. Data is usually input by means of a keyboard. As the name implies, a minicomputer is small compared with a mainframe and may be called a scaled-down mainframe as the processor and the peripherals are physically smaller.

Minicomputers cost about Rs. 5 lacs to Rs. 50 lacs. The most popular minicomputer or minis, are the Data General Nova, DEC, PDP-11 and the IBM series/1. These systems can serve as information processors in small-to-medium sized firms or as processors in computer networks for large firms. Primary storage capacity starts at about 640K and can go as high as few mega bytes (MB) A minicomputer system consists of a CPU, several disk drives, a high-speed printer, perhaps a few magnetic tape units, and number of terminals. Programming languages include BASIC, PASCAL COBOL, C and FORTRAN. Much prewritten application software is also available.

Originally minicomputers were developed for process control and system monitoring etc. They were complicated to program and had minimal input/output capabilities as they were mainly concerned with "number crunching" rather than handling large amounts of data relating to business transactions. However, they are now fully developed, powerful computers with a wide range of peripherals to perform a wide range of data processing and computing activities. Minicomputer systems can be equipped with most of the input/output (I/O) devices and secondary storage devices that the large mainframe systems can handle, such as terminals and rigid disks. They are also making possible the installation of distributed data processing systems. Instead of a company having one large mainframe computer, it may have mini-computer at each of its remote locations and connect them to each other through telecommunications.

Minis certainly overlap mainframes. As minis become more powerful, they tend to perform with equal efficiency the jobs for which mainframes were used in the very near past, and the same is true for micros in relation to minis. Therefore, there is no definite delineation among the three types of computer systems, and the lines of demarcation are constantly changing.

1.2.4 Microcomputers: A microcomputer is a full-fledged computer system that uses a microprocessor as its CPU, these are also called personal computer systems. Microcomputers were first available for widespread use in the 1970s, when it became possible to put the entire circuitry of computers (CPU) onto a small silicon chip called microprocessor. A microprocessor is a product of the microminiaturization of electronic circuitry; it is literally a "computer on a chip". Chip refers to any self-contained integrated circuit. The size of chips, which are about 30 thousandths of an inch thick, vary in area from fingernail size (about 1/4 inch square) to

postage-stamp size (about 1-inch square) These days, relatively inexpensive microprocessors have bean integrated into thousands of mechanical and electronic devices-even elevators, band saw, and ski-boot bindings. In a few years, virtually everything mechanical or electronic will incorporate microprocessor technology into its design.

The microprocessor is sometimes confused with its famous offspring, the microcomputer. A microprocessor, however, is not a computer. It only provides a part of CPU circuitry. This chip must be mounted together with memory, input and output chips on a single circuit board to make it a microcomputer. Thus, a microcomputer often called a micro is a small computer consisting of a processor on a single silicon chip which is mounted on a circuit board with other chips containing the computer's internal memory in the form of read-only-memory (ROM) and random-access-memory (RAM) It has a keyboard for the entry of data and instructions and a screen for display purposes. It has interface for the connection of peripherals in the form of mouse, plotters, printers, cassette units, disk drives and light pens etc. IBM PC, APPLE II, TENDY TRS-80 are some of the popular microcomputers.

When people use the terms personal computers and microcomputers, they mean the small computer that are commonly found in offices, classrooms, and homes. Personal computers come in all shapes, and sizes. Although most models reside on desktops, others stand on the floor, and some are even portable.

The terms *microcomputer* and *personal computer* are interchangeable; however, PC - which stands for personal computer has a more specific meaning. In 1981, IBM called its first microcomputer the IBM PC. Within a few years, many companies were copying the IBM design, creating "clones" or "compatible computers" that aimed at functioning just like the original. For this reason, the term PC has come to mean that family of computers that includes IBM and compatibles. The Apple Macintosh computer, however, is neither an IBM nor a compatible. It is another family of microcomputers made by Apple computers.

The earliest microcomputers were capable of supporting only a *single user at a time*. Now-a-days, multi-user microcomputer systems are also available and are becoming more prevalent. In multi-user systems, a powerful microcomputer may be used to substitute for Mainframe or minicomputer. single-user personal computers are also being connected to one another to form network. Multi-user microcomputers play key roles in some of the networks that are developed.

Currently IBM and Apple are the two most prominent manufacturers of microcomputers. A typical microcomputer consists of a processor on a single silicon chip mounted on a circuit board together with memory chips, ROM and RAM chips etc. It has a keyboard for the entry of data and instructions and a screen for display purposes. It has interfaces for connecting

peripherals such as plotters, cassette units, disc drives, light pens, a mouse and joysticks.

A microcomputer including optional peripherals and other add-on-units may consist of the elements listed below.

(a)   8, 16, or 32 bit processor,

(b)   Internal memory 256 MB expandable to 512 MB and more;

(c)   Backing storage-cassette, floppy disc, microfloppy discs, micro-drive, silicon disc or hard disc, CD-ROMS, DVDs, pen drives etc.;

(d)   Keyboard and screen (input and output);

(e)   Interface (for the connection of peripherals);

(f)   Bus (communication and control channels);

(g)   Printer and/or plotter (multicolour text and graphics);

(h)   Pulse generator (clock);

(i)   Light pens, mouse, paddles/joysticks, Multimedia (graphics and games);

(j)   Software (programs)

Microcomputer systems are used by even the smallest of business, however their primary market is the personal home computer market. In the home, these computers can be used for a wide variety of tasks-from keeping track of the family budget to storing recipes to monitoring the home burglar alarm system. Currently, a small microcomputer system can be purchased for approximately Rs. 30,000. A more sophisticated microcomputer system with a 80 Giga bytes hard disk and 256 MB of primary storage can be purchased for approximately Rs. 25,000 to Rs. 40,000. With high-quality printer and additional memory (up to 512 MB), these microcomputer systems can cost in the vicinity of Rs. 50,000 to Rs. 75,000.

Examples of microcomputers are IBM PCs, PS/2 and Apple's Macintosh

1.2.5 Workstations : Between minicomputer and microcomputers - in terms of processing power - is a class of computers known as WORKSTATIONS. A workstation looks like a personal computer and is typically used by one person. Although workstations are still more powerful than the average personal computer, - the differences in the capabilities of these types of machines are growing smaller.

Workstations differ significantly from microcomputer in two areas. Internally, workstations are constructed differently than microcomputers. They are based on different architecture of CPU called *reduced instruction set computing* (RISC), which results in faster processing of instructions.

The other difference between workstations and microcomputers in that most microcomputers can run any of the four major operating systems* - DOS, Unix, OS/2, and Microsoft Windows NT), but workstations generally run the Unix operating systems or a variation of it. The biggest manufacturer of workstations is Sun Microsystems. Other manufacturers include IBM, DEC, Hewlette Packard and Silicon Graphics.

Many people use the term workstation to refer to any computer or terminal that is connected to another computer. Although this was once a common meaning of the term, it has become outdated. These days, a workstation is powerful RISC - based computer that runs the Unix Operating System and is generally used by scientists and engineers.

1.2.6. Server : A **server** is a computer system that provides services to other computing systems—called clients—over a network. The term is most commonly applied to a complete computer system today, but it is also used occasionally to refer only to the hardware or software portions of such a system. Servers occupy a place in computing similar to that occupied by minicomputers in the past, which they have largely replaced. The typical server is a computer system that operates continuously on a network and waits for requests for services from other computers on the network. Many servers are dedicated to this role, but some may also be used simultaneously for other purposes, particularly when the demands placed upon them as servers are modest. For example, in a small office, a large desktop computer may act as both a desktop workstation for one person in the office and as a server for all the other computers in the office.

Servers today are physically similar to most other general-purpose computers, although their hardware configurations may be particularly optimized to fit their server roles, if they are dedicated to that role. Many use hardware identical or nearly identical to that found in standard desktop PCs. However, servers run software that is often very different from that used on desktop computers and workstations.

Servers should not be confused with mainframes, which are very large computers that centralize certain information-processing activities in large organizations and may or may not act as servers in addition to their other activities. Many large organizations have both mainframes and servers, although servers usually are smaller and much more numerous and decentralized than mainframes.

Servers frequently host hardware resources that they make available on a controlled and shared basis to client computers, such as printers *(print servers)* and file systems *(file servers)* This sharing permits better access control (and thus better security) and can reduce costs by reducing duplication of hardware.

1.3 ADVANTAGES AND LIMITATIONS OF COMPUTERS

1.3.1 Advantages of Computer System : In a nutshell, computers are fast, accurate, and reliable; they don't forget anything; and they don't complain. We will now describe them in detail.

Speed: The smallest unit of time in the human experience is, realistically, the second. Computer operations (for example, the execution of an instruction, such as multiplying the hours worked times the rate of pay) are measured in **milliseconds, microseconds, nanoseconds, and picoseconds** (one thousandth, one millionth, one billionth, and one trillionth of a second, respectively)

Accuracy: Errors do occur in computer-based information systems, but precious few can be directly attributed to the computer system itself. The vast majority can be traced to a program logic error, a procedural error, or erroneous data. These are *human errors*.

Reliability: Computer systems are particularly adept at repetitive tasks. They don't take sick days and coffee breaks, and they seldom complain. Anything below 99.9% **uptime**, the time when the computer system is in operation, is usually unacceptable. For some companies, any **downtime** is unacceptable. These companies provide **backup** computers that take over automatically if the main computers fail.

Memory Capability: Computer systems have total and instant recall of data and an almost unlimited capacity to store these data. A typical mainframe computer system will have many billions of characters stored and available for instant recall. High-end PCs have access to about a billion characters of data. To give you a benchmark for comparison, a 15-page report contains about 50,000 characters.

1.3.2 Limitations of Computer systems : The computer is one of the most powerful tools ever developed. But we've all read articles similar to the one about the man who was treated for pneumonia and then charged by the hospital's computer for the use of the delivery room and nursery. Such "computer failures" may be amusing, but most such foul-ups happen because people fail to consider some basic computer limitations. Without reliable programs and sound logic, no computer system will perform adequately.

Program must be reliable: The computer does what it's programmed to do *and nothing else*. This doesn't mean that it must be stupid. A clever program can be written to direct the computer to store the results of previous decisions. Then, by using the program's branching ability, the computer may be able to modify its behavior according to the success or failure of past decisions. But a program that has operated flawlessly for months can suddenly produce nonsense. Perhaps some rare combination of events has presented the system with a

situation for which there's no programmed course of action. Or perhaps the course of action provided by the programmer contains an error that's just being discovered. Of course, a reliable program that's supplied with incorrect data may also produce nonsense.

Application logic must be understood: The computer can only process jobs which can be expressed in a finite number of steps leading to a specify goal. Each step must be clearly defined. If the steps in the solution cannot be precisely stated, the job cannot be done. This is why the computer may not be helpful to people in areas where subjective evaluations are important. For example, it may not be able to tell a sales manager if a new product will be successful. The market decision may hinge on educated guesses about future social, political, technological and economic changes. But the computer can tell the manager how the product will fare under assumed price, cost, and sales volume conditions. These assumed values could be fed into the computer. An analysis program can then manipulate them in response to a series of "what if" questions to project the effects that the manager's questions will have on profits.

Even if program steps are finite and understood, there are still some tasks whose execution could take millions of years, even on a supercomputer. Joseph Weizenbaum, a computer scientist at MIT observed that a program could be written to try every legal chess move in a given situation. Every response to a move could then be evaluated, and the subsequent moves and countermoves could all be identified until the computer found a move, which, if suitably pursued, would guarantee a win. Weizenbaum notes that this program would certainly be finite, but the time needed to execute it would be unimaginably large. Although in principle the computer could do the job, in practice it cannot. The term **combinatorial explosion** is used for this type of problem where a finite number of steps generate an impossibly large number of computer operations.

1.4 COMPONENTS OF A COMPUTER SYSTEM- CPU

The hardware are the parts of computer itself including the Central Processing Unit (CPU) and related microchips and micro-circuitry, keyboards, monitors, case and drives (floppy, hard, CD, DVD, optical, tape, etc.) Other extra parts called peripheral components or devices include mouse, printers, modems, scanners, digital cameras and cards (sound, colour, video) etc... Together they are often referred to as a personal computers or PCs.

The schematic diagram of a computer is given below :
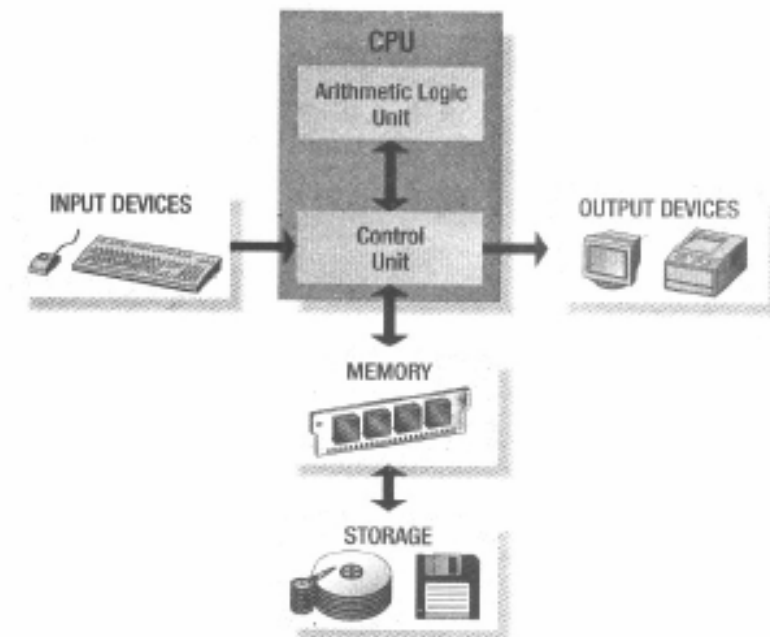
Fig. 1.3 The computer schematic

We will now briefly discuss each of the above components.

1.4.1 Central Processing Unit: The Central Processing Unit (CPU)—also known as the processor—is the heart, soul and brain of the computer. In a microcomputer, the entire CPU is contained on a tiny chip called a microprocessor. Though the term relates to a specific chip or the processor a CPU's performance is determined by the rest of the computer's circuitry and chips. Currently the Pentium chip or processor, made by Intel, is the most common CPU though there are many other companies that produce processors for personal computers. One example is the CPU made by Motorola which is used in Apple computers. It is the most important component on the system's motherboard. The processor computes and processes data and delivers the results based on the instructions that are fed to the PC. Every CPU has at least two basic parts, the control unit and the arithmetic logic unit.

(i) The Control Unit

All the computer's resources are managed from the control unit. One can think of the control unit as a traffic cop directing the flow of data. It is the logical hub of the computer.

The CPU's instructions for carrying out commands are built into the control unit. The instructions, or instruction set, list all the operations that the CPU can perform. Each instruction in the instruction set is expressed in microcode- a series of basic directions that tell the CPU how to execute more complex operations. Before a program can be executed, every command in it must be broken down into instructions that correspond to the ones in the CPU's instruction set. When the program is executed, the CPU carries out the instructions, in order, by converting them into microcode. Although the process is complex, the computer can accomplish it at an incredible speed, translating millions of instructions every second.

Different CPUs have different instruction sets. Manufacturers, however, tend to group their CPUs into "families" that have similar instruction sets. Usually, when a new CPU is developed, the instruction set has all the same commands as its predecessor plus some new ones. This allows software written for a particular CPU to work on computers with newer processors of the same family – a design strategy known as **upward compatibility**. Upward compatibility saves consumers from having to buy a whole new system every time a part of their existing system is upgraded. The reverse is also true. When a new hardware device or piece of software can interact with all the same equipment and software its predecessor could, it is said to have **downward**, or backward, compatibility.

(ii) The Arithmetic Logic Unit

Because computers store all the data as numbers, a lot of the processing that takes place involves comparing numbers or carrying out mathematical operations. In addition to establishing ordered sequences and changing those sequences, the computer can perform only two types of operations: arithmetic operations and logical operations. Arithmetic operations include addition, subtraction, multiplication, and division. Logical operations include comparisons, such as determining whether one number is equal to, greater than, or less than another number. Also, every logical operation has an opposite. For example, in addition to "equal to" there is "not equal operation has an opposite. For example, in addition to "equal to" there is "not equal to".

Some of the logical operations can be carried out on text data. For example, a word is required to be searched in a document, the CPU carries out a rapid succession of "equals" operations to find a match for the sequence of ASCII codes that make up the word being searched.

Many instructions carried out by the control unit involve simply moving data from one place to another – from memory to storage, from memory to the printer, and so forth. However, when the control unit encounters an instruction that involves arithmetic or logical, it passes that instruction to the second component of the CPU, the arithmetic logical unit, or ALU. The ALU includes a group of registers – high-speed memory locations built directly into the CPU that are used to hold the data currently being processed. For example, the control unit might load

two numbers from memory into the registers in the ALU. Then, it might tell the ALU to divide the two numbers (an arithmetic operation) or to see whether the numbers are equal (a logical operation)

1.4.2 Various features of the Central Processing Unit : Over a period of time, the processor has evolved from slow 286s or 386s running at speeds as low as 20 MHz to present day Pentium III and IV running at a whooping 3 GHz (3000 MHz.) Now we take a closer look at the various features that the Central Processing Unit of a PC offers.

Clock Speed: The clock speed is the speed at which the processor executes instructions. Clock speed is measured in megahertz (MHz)—which is a million cycles per second. Therefore, a 450 MHz processor performs 450 million instructions per second. Higher the clock's speed, the faster the processor, the better the system performance. Also, some microprocessors are super scalar, which means that they can execute more than one instruction per clock cycle.

Cache: Processors incorporate their own internal cache memory. The cache acts as temporary memory and boosts processing power significantly. The cache that comes with the processor is called Level One (L1) cache. This cache runs at the processor's clock speeds, and therefore is very fast. The L1 cache is divided into 2 sections—one for data, the other for instructions. Generally, more the L1 cache, faster the processor.

Additionally, PCs also include a much slower secondary, or Level Two (L2) cache. This cache resides on the motherboard and delivers slower performance when compared with the L1 cache. To overcome this limitation, newer chips (Pentium II and Pentium III) house the L2 cache in a cartridge along with the CPU.

Architecture: The CPUs architecture determines the manner in which it processes data. New CPUs employ multi-staged pipelines for transmitting data. To ensure proper data flow through these lines, the CPU includes a kind of prediction and error correction mechanism.

Slot: Different processors use different sockets or slots to fit onto the motherboard. Based on the type of processors, there are two main types of slots for connecting to the motherboard—Socket 7 and Slot 1.

Socket 7 is a 321-pin socket for Pentium class CPUs—Pentium MMX, K5, and K6—ranging from 75 MHz to 200 MHz processors. However, the Pentium II/III CPUs use Slot 1 for connecting to the motherboard.
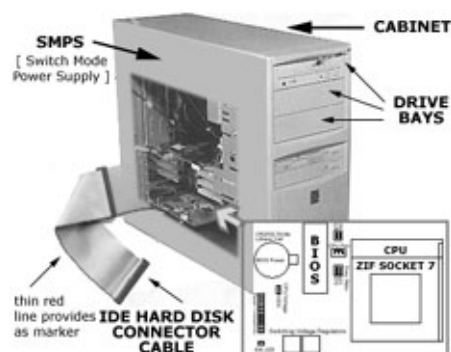
Instead of the usual manner in which a CPU fits onto the motherboard, Slot 1 CPUs fit onto the motherboard as a daughter card, allowing for faster communication between the CPU and the L2 cache.

Density: A CPU is made up of millions of small transistors. A CPU performs all the calculation and manipulation operations by synchronising between the transistors. Therefore, the shorter the distance between two transistors on a CPU, the faster the performance. Older CPUs had a distance of one micron between the transistors. But, newer CPUs have a distance as small as 0.35 micron between two transistors, delivering faster performance.

MMX: MMX stands for Multimedia Extensions—a set of instructions built in to the CPU, specifically intended for improving the performance of multimedia or graphic applications— mainly games. However, one needs to have applications specifically designed to take advantage of MMX.

CPU generates lots of heat when in operation. If the CPU is not cooled properly, then it might lead to all sort of errors, including system crashes. Therefore, the CPU is usually covered by a heat sink and a small cooling fan to dissipate the heat generated by the processor.

The microprocessor, is not made by the manufacturers of micro computers but by companies, such as Motorola and Intel, that specialise in the development and manufacture of microprocessors. All the Apple's Macintosh-series micros use Motorola chips : the Motorola 68000 in earlier models, the Motorola 68020 in the Machintosh II, and the Motorola 68030 in recent models. The system board for IBM Personal Computer uses Intel Processors.

When someone talks about a "286", "386", "486" or Pentium machine, he or she is referring to a micro that uses an Intel 80286, 80386, 80486 or Pentium chip.

1.4.3 Types of Microprocessors - Currently three classes of microprocessors are used for personal computers: 8-bit, 16-bit and 32-bit. Basically, an 8-bit machine can process 8-bits (1 character) of data at a time, and each instruction will be represented by an 8-bit code. A 16-bit machine can process two bytes (or 16 bits) of data at a time, and the number of instructions is increased over that 8-bit machine.

All the microprocessors use a bus-type design to transfer bits within the computer and to input/output devices. The electric path or lines that transfer these bits are called **buses**. An 8-bit machine usually has 8-data buses that transfer 8-bits at a time between components of a computer.

A personal computer transfers data to its I/O devices through input/output ports connected to

a bus. A **port** is a hardware device that allows a series of bits to be transferred to a bus for data input or, inversely, the transfer of data from a bus to the port for data output.

The 8-bit personal computers were based on two types of 8-bit microprocessors viz 8080/Z80 and the 6502. The industry standard operating system CP/M ran on 8080/Z80, and therefore many personal computers including Zenith, Tandy, TRS80, Morrow, Northstar, etc. were based on this microprocessor. Apple II, and Commodore computers were based on the 6502 microprocessor, and each used its own proprietary operating system.

The 16-bit personal computers were based on two classes of microprocessors: the 8086/8088 (Intel) and MC 68000 (Motorola) The industry standard MS-DOS operating system for IBM - PC is built around the 8088 microprocessor. Apple's Macintosh is built around the MC 68000 as is the AT&T UNIX PC. IBM AT used Intel 80286 microprocessor. Most of the PCs made during the 1980s had 16-bit processors. The 16-bit systems have provided many sophisticated functions such as colour graphics, database features etc. once limited to mini computers.

Personal computers based on the Intel 80386 and 80486 DX, SX are 32-bit processors and can process four 8-bit bytes at a time. The 32-bits microprocessors have tied the personal computers into more sophisticated information handling functions. The 386 processor used a new mode of operation called virtual 86 mode. This allowed operating systems such as Unix and OS/2, and special programs such as Microsoft Windows, to run several DOS programs at the same time. This feature is specially important for DOS-based control programs such as Microsoft Windows, because it allows software to simulate multitasking with DOS operating system which otherwise cannot perform true multitasking.

The 486 processor combined a 386 DX processor, a maths coprocessor and a cache memory controller onto a single chip. This increased the speed of the processor drastically. The SX versions of Intel chips, such as the 386SX and 486SX, are less expensive and less powerful than the processors upon which they are based.

For the moment, the most powerful member of the Intel family of microprocessors is the Pentium. With the Pentium processor, Intel broke its tradition of numeric model names. The speed and powers of the Pentium dwarf those of all its predecessors in the Intel family. The 486 has approximately 1.2 million transistors, the Pentium has over 3 million and can process 100 million instructions to 200 million instructions per second.

Introduced in 1993, the Pentium processor allowed computers to more easily incorporate "real world" data such as speech, sound, handwriting and photographic images. The name Pentium,

mentioned in the comics and on television talk shows, became a household word soon after introduction.

Released in the fall of 1995 the Pentium Pro processor is designed to fuel 32-bit server and workstation-level applications, enabling fast computer-aided design, mechanical engineering and scientific computation. Each Pentium Pro processor is packaged together with a second speed-enhancing cache memory chip. The powerful Pentium pro processor boasts 5.5 million transistors.

The 7.5 million-transistor Pentium II processor launched in 1997 incorporates Intel MMX technology, which is designed specifically to process video, audio and graphics data efficiently. It was introduced in innovative Single Edge Contact (S.E.C) Cartridge that also incorporated a high-speed cache memory chip. With this chip, PC users can capture, edit and share digital photos with friends and family via the Internet; edit and add text, music or between-scene transitions to home movies; and, with a video phone, send video over standard phone lines and the Internet.

In 1998, Intel introduced Pentium II Xeon processors designed to meet the performance requirements of mid-range and higher servers and workstations. Consistent with Intel's strategy to deliver unique processor products targeted for specific markets segments, the Pentium II Xeon processors feature technical innovations specifically designed for workstations and servers that utilize demanding business applications such as Internet services, corporate data warehousing, digital content creation, and electronic and mechanical design automation. Systems based on the processor can be configured to scale to four or eight processors and beyond.

Continuing Intel's strategy of developing processors for specific market segments, the Intel Celeron processor (1999) is designed for the Value PC market segment. It provides consumers great performance at an exceptional value, and it delivers excellent performance for uses such as gaming and educational software.

The Pentium III processor (1999) features 70 new instructions—Internet Streaming SIMD extensions— that dramatically enhance the performance of advanced imaging, 3-D, streaming audio, video and speech recognition applications. It was designed to significantly enhance Internet experiences, allowing users to do such things as browse through realistic online museums and stores and download high-quality video. The processor incorporates 9.5 million transistors, and was introduced using 0.25-micron technology.

The Pentium III Xeon processor (1999) extends Intel's offerings to the workstation and server market segments, providing additional performance for e-Commerce applications and advanced business computing. The processors incorporate the Pentium III processor's 70 SIMD instructions, which enhance multimedia and streaming video applications. The Pentium III Xeon processor's advance cache technology speeds information from the system bus to the processor, significantly boosting performance. It is designed for systems with multiprocessor configurations.

The Intel Pentium 4 Processor is designed to deliver performance across usages—such as image processing, video content creation, games and multimedia—where end-users can truly appreciate the performance. With a PC based on the Intel Pentium 4 Processor with HT Technology, one gets advanced performance and multitasking capabilities for today's digital home and digital office applications. Hyper-threading enables multi-threaded software applications to execute two software threads in parallel, thereby improving system responsiveness. Intel Pentium 4 Processors enabled with HT Technology deliver performance and multitasking gains that result in increased productivity and efficiency. It allows the operating system to adjust the processor clock down when running applications that require less power. Increased power efficiency brings savings.

Intel Extended Memory 64 Technology can improve performance by allowing the system to address more than 4 GB of both virtual and physical memory. Intel EM64T also provides support for 64 bit computing to help handle the applications of tomorrow.

1.4.4 Processor Speed - As mentioned earlier, a crystal oscillator paces the execution of instructions within the processor of a microcomputer. A micro's processor speed is rated by its frequency of oscillation, or the number of clock cycles per second. Earlier personal computers rated between 5 and 50 megahertz, or MHz (millions of clock cycles) . Normally several clock cycles are required to retrieve, decode, and execute a single program instruction. The shorter the clock cycle, the faster the processor.

To properly evaluate the processing capability of a micro, one must consider both the processor speed and the word length. A 32-bit micro with a 25 - MHz processor has more processing capability than a 16-bit micro with a 25 - MHz processor.

The Pentium II processors can process in the range of 233 MHz to 300 MHz. The latest Pentium-III and Pentium 4 processors can run at a speed of 2.1 GHz and even higher.

1.5 MOTHERBOARDS

The motherboard or the system board is the main circuit board on the computer. It acts as a direct channel for the various components to interact and communicate with each other. There are various types of motherboards available (depending on the processors that are used) We now provide with an overview of the system motherboard, and about the various components that fit on it.
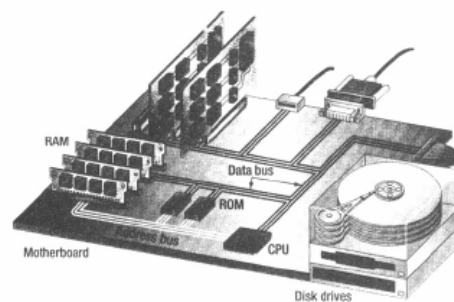
Fig. 1.4

1.5.1 Processor slot: The processor slot houses the processor. Based on the type of processors used, there are two main types of slots—Socket-7 and Slot-1.

BIOS: BIOS stands for Basic Input Output System—a small chip on the motherboard that loads the hardware settings required to load various devices like keyboards, monitors, or disk drives. Most new PCs come with a Flash BIOS—these BIOS can be software upgraded to support new devices.

CMOS: The PC uses the CMOS memory to store the date, time and system setup parameters. These parameters are loaded every time the computer is started. A small Lithium Ion battery located on the motherboard powers the CMOS as well as the BIOS.

Power supply connectors: The power supply connectors allow the user to connect the power supply unit to the motherboard and provide power for the functioning of the various components that fit on to the motherboard.

1.5.2 Expansion Slots and Boards : PCs are designed so that users can adapt, or configure the machines to their own particular needs. PC motherboards have two or more expansion slots, which are extensions of the computer's bus that provide a way to add new components to the computer. The slots accept circuit board, also called cards, adapters, or sometimes-just boards. Modern notebook computers are too small to accept the same type of cards that fit into desktop models. Instead, new components for notebooks come in the form of PC cards,

small devices – about the size of credit cards – that fit into a slot on the back or side of the notebook. Figure –1.5 shows a PC expansion board being installed. The board is attached to the motherboard – the main system board to which the CPU, memory, and other components are attached.
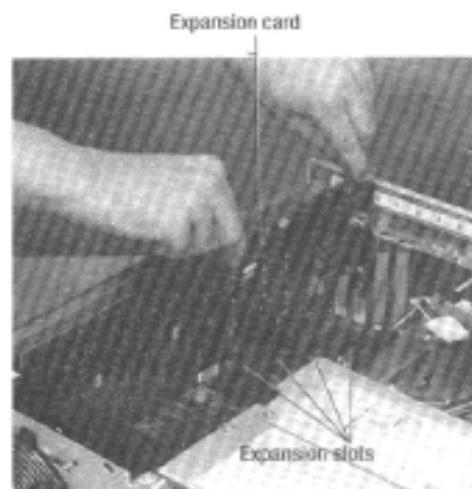
Fig. 1.5

The expansion slots on the motherboard are used for three purposes:

1. To give built –in devices such as hard disks and diskette drives access to the computer's bus via controller cards.

2. To provide I/O (input/output) ports on the back of the computer for external devices such as monitors, external modems, printers, and the mouse (for computers that do not have a built-in mouse port)

3. To give special-purpose devices access to the computer. For example, a computer can be enhanced with an accelerator card, a self contained device that enhances processing speed through access to the computer'' CPU and memory by way of the bus.

The first and second of these are input/output (I/O) functions. Adapters that serve these purposes provide a port to which devices can be attached and serve as a translator between the bus and the device itself. Some adapters also do a significant amount of data processing. For example, a video controller is a card that provides a port on the back of the PC into which

one can plug the monitor. It also contains and manages the video memory and does the processing required to display images on the monitor. Other I/O devices that commonly require the installation of a card into an expansion slot include sound cards, internal modems or fax/modems, network interface cards, and scanners. The third type, the accelerator cards, are often installed to speed up the CPU or the display of video. Some of the slots and connectors are briefly discussed below:

SIMM/DIMM slots: SIMM stands for Single Inline Memory Modules, while DIMM stands for Dual Inline Memory Module. SIMM/DIMM slots are used to house RAM modules.

PCI slots: The PCI (Peripheral Component Interface) slots are used for connecting PCI-based devices like graphics accelerator cards, sound cards, internal modems or SCSI cards.

AGP slot: All Celeron and Pentium-III motherboards come with an AGP (Accelerated Graphics Port) slot. AGP is a dedicated slot meant to provide faster access to AGP-based graphic accelerator cards, thus enhancing the visual experience for the user.

SCSI : It is a device interface that is used to solve the problem of a finite and possibly insufficient number of expansion slots. It is called *small computer system interface (SCSI pronounced "scuzzy")* Instead of plugging interface cards into the computer's bus via the expansion slots, SCSI extends the bus outside the computer by way of a cable. In other words, SCSI is like an extension cord for computer bus. IBM developed SCSI in 1970s. The current standard is SCSI - 3, which allows upto seven devices to be chained on a single SCSI port. Now-a-days many devices support the SCSI interface. Fast, high-speed hard disk drives often have SCSI interfaces, so do scanners, tape drives and optical storage devices.

1.5.3 Cards: Cards are components added to computers to increase their capability. When adding a peripheral device one should ensure that the computer has a slot of the type needed by the device. **Sound cards** allow computers to produce sound like music and voice. The older sound cards were 8 bit then 16 bit then 32 bit. Though human ear can't distinguish the fine difference between sounds produced by the more powerful sound card they allow for more complex music and music production. Colour cards allow computers to produce colour (with a colour monitor of course) The first colour cards were 2 bit which produced 4 colours [CGA]. It was amazing what could be done with those 4 colours. Next came 4 bit allowing for 16 [EGA and VGA] colours Then came 16 bit allowing for 1064 colours and then 24 bit which allows for almost 17 million colours and now 32 bit is standard allowing monitors to display almost a billion separate colours. **Video cards** allow computers to display video and animation. Some video cards allow computers to display television as well as capture frames from video. A video card with a digital video camera allows computers users to produce live video. A high speed or network connection is needed for effective video transmission. **Network cards** allow computers to connect together to communicate with each other. Network cards have connections for cable, thin wire or wireless networks.

1.5.4 Ports and connectors : Ports and connectors let the user connect external devices like printers, keyboards or scanners and let them interface with the PC. The physical interfaces for the ports and connectors are located on the outside—typically at the back of the PC, but they are directly or indirectly (using a connector card) connected to the motherboard. There are various types of ports or connectors, each providing different data transfer speeds to connect various external peripherals.
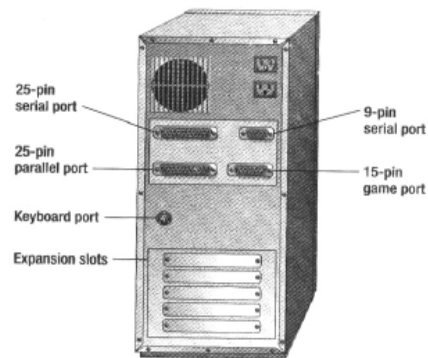
Fig 1.6

Parallel ports: Parallel ports are used to connect external input/output devices like scanners or printers. Parallel ports facilitate the parallel transmission of data, usually one byte (8 bits) at a time. Parallel ports use 25 pin RS-232C.

Com/Serial ports: They are used for connecting communication devices like modems or other serial devices like mice. There are two varieties of Com ports—the 9-pin ports and 25-pin ports. Serial Ports facilitate the serial transmission of data, i.e. one bit at a time.

IDE drive connector: IDE devices like CD-ROM drives or hard disk drives are connected to the motherboard through the IDE connector.

Floppy drive connector: The floppy drive connectors are used for connecting the floppy drive to the motherboard, to facilitate data exchange.

USB connectors: USB stands for Universal Serial Bus. These ports provide the user with higher data transfer speeds for different USB devices like keyboards, mice, scanners or digital cameras.

PS/2 Connectors: PS/2 stands for Personal System/2. PS/2 connectors are used to connect PS/2 based input devices like PS/2 keyboards or mice.

In addition to the common components that are found on the motherboard, newer motherboards also come with integrated graphics accelerator cards or sound cards-there is no need to install a separate card to get the work done.

1.5.5 The bus : If one takes a close look at the system motherboard, one will notice a maze of golden electric circuits etched on both sides of the motherboard. This very maze of circuits etched on the motherboard forms the bus of the pc. A bus acts as the system's expressway - it transmits data between the various components on the motherboard. Theoretically, a bus is a collection of wires through which data is transmitted between the various components of a pc. A bus connects the various components of the pc with the CPUand the main memory (RAM) Logically, a bus consists of two parts—an address bus and a data bus.

The Data Bus : The Data Bus is an electrical path that connects the CPU, memory, and the other hardware devices on the motherboard. Actually, the bus is a group of parallel wires. The number of wires in the bus affects the speed at which data can travel between hardware components, just as the number of lanes on a highway affects how long it takes people to get to their destinations. Because each wire can transfer one bit at a time, an eight-wire bus can move eight bits at a time, which is a full byte. A 16-bit bus can transfer two bytes, and a 32-bit bus can transfer four bytes at a time.

PC buses are designed to match the capabilities of the devices attached to them. When CPUs could send and receive only one byte of data at a time, there was no point in connecting them to a bus that could move more data. As microprocessor technology improved, however, chips were built that could send and receive more data at once, and improved bus designs created wider paths through which the data could flow.

When IBM introduced the PC-AT in 1984, the most dramatic improvement was an enhanced data bus that was matched with the capabilities of a new microprocessor, the Intel 80286. The data bus of the AT was 16 bits wide and became the de facto standard in the industry. It is still used for PC devices that do not require more than a 16 -bit bus. The AT bus is commonly known as the Industry Standard Architecture, or ISA, bus.

Two years later, however, when the first 80386 chips (commonly abbreviated as the 386) began shipping, a new standard was needed for the 386's 32-bit bus. The first contender was Micro Channel Architecture, or the MCA bus, from IBM. Then came the Extended Industry Standard Architecture (EISA) bus from a consortium of hardware developers who opposed IBM's new standard because it was not backward compatible. The winner of the bus wars was neither MCA nor EISA. It was the Peripheral Component Interconnect, or PCI, bus. Intel

designed the PCI bus specifically to make it easier to integrate new data types, such as audio, video, and graphics.

The Address Bus : The second bus that is found in every microcomputer is the address bus. The address bus is a set of wires similar to the data bus that connects the CPU and RAM and carries the memory addresses. (Remember, each byte in RAM is associated with a number, which is the memory address)

The reason the address bus is important is that the number of wires in it determines the maximum number of memory addresses. For example, recall that one byte of data is enough to represent 256 different values. If the address bus could carry only eight bits at a time, the CPU could address only 256 bytes of RAM. Actually, most of the early PCs had 20-bit address buses, so the CPU could address 220 bytes, or 1 MB, of data. Today, most CPUs have 32-bit address buses that can address 4 GB (over 4 million bytes) of RAM. Some of the latest models can address even more.

One of the biggest hurdles in the evolution of PCs was that DOS, the operating system used in the vast majority of PCs for more than a decade, was designed for machines that could address only 1 MB of RAM. When PCs began to contain more RAM, special software had to be devised to address it. Programmers came up with two devices called expanded memory and extended memory. Windows 95 largely did away with these, although extended memory still exists in the operating system for purposes of backward compatibility.

1.6 STORAGE DEVICES

The CPU contains the basic instructions needed to operate the computer, but it does not have the capability to store programs or large sets of data permanently. Just like the human brain, which helps to determine what to do and when, computers need blocks of space that it can address from time to time to help in processing arithmetical and logical operations and also hold programs and data being manipulated. This area is called memory or storage.
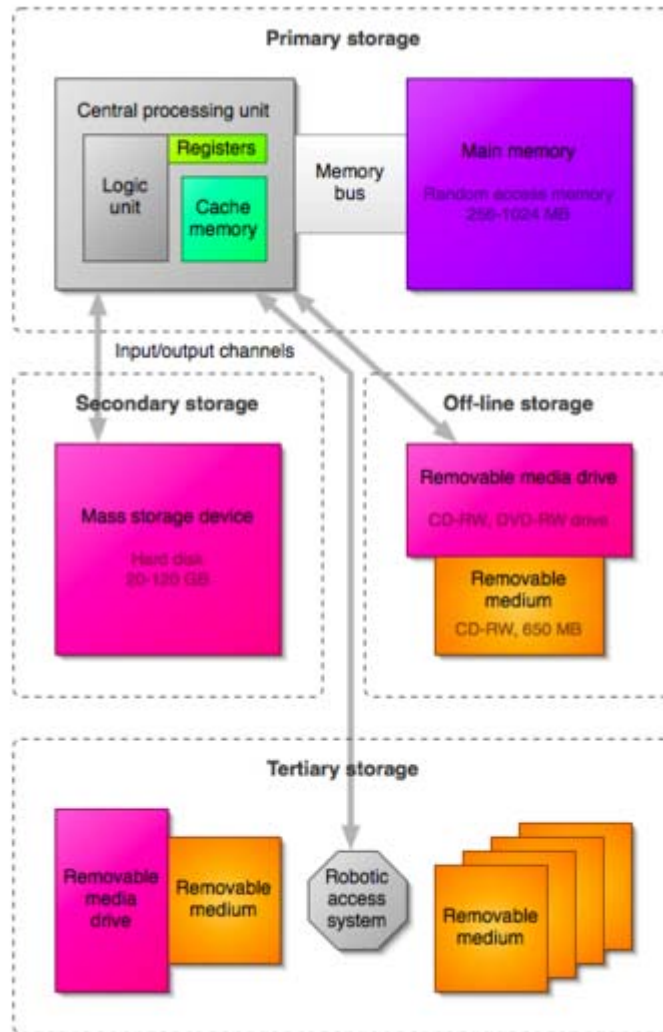
Fig 1.7

1.6.1 Types of storage : Various forms of storage, based on various natural phenomenon, have been invented. So far, no practical universal storage medium exists, and all forms of storage have some drawbacks. Therefore a computer system usually contains several kinds of storage, each with an individual purpose, as shown in Fig. 1.7.

(i)   *Primary storage* : Primary storage is directly connected to the central processing unit of the computer. It must be present for the CPU to function correctly, just as in a biological

analogy the lungs must be present (for oxygen storage) for the heart to function (to pump and oygenate the blood) As shown in the fifure, primary storage typically consists of three kinds of storage:

♦ **Processor registers** are internal to the central processing unit. Registers contain information that the arithmetic and logic unit needs to carry out the current instruction. They are technically the fastest of all forms of computer storage, being switching transistors integrated on the CPU's silicon chip, and functioning as electronic "flip-flops".

♦ **Main memory** contains the programs that are currently being run and the data on which the programs are operating. The arithmetic and logic unit can very quickly transfer information between a processor register and locations in main storage, also known as a "memory addresses". In modern computers, electronic solid-state random access memory is used for main storage, and is directly connected to the CPU via a "memory bus" (shown in the diagram) and a "data bus". The memory bus is also called an address bus or front side bus and both busses are high-speed digital "superhighways". Access methods and speed are two of the fundamental technical differences between memory and mass storage devices. (Note that all memory sizes and storage capacities shown in the diagram will inevitably be exceeded with advances in technology over time)

♦ **Cache memory** is a special type of internal memory used by many central processing units to increase their performance or "throughput". Some of the information in the main memory is duplicated in the cache memory, which is slightly slower but of much greater capacity than the processor registers, and faster but much smaller than main memory. Multi-level cache memory is also commonly used - "primary cache" being smallest, fastest and closest to the processing device; "secondary cache" being larger and slower, but still faster and much smaller than main memory.

(ii) *Secondary, tertiary and off-line storage :* **Secondary storage** requires the computer to use its **input/output** channels to access the information, and is used for long-term storage of persistent information. However most computer **operating systems** also use secondary storage devices as **virtual memory** - to artificially increase the apparent amount of main memory in the computer. Secondary storage is also known as "mass storage", as shown in the figure above. Secondary or mass storage is typically of much greater capacity than primary storage (main memory), but it is also very much slower. In modern computers, **hard disks** are usually used for mass storage. The time taken to access a given byte of information stored on a hard disk is typically a few thousandths of a second, or milliseconds. By contrast, the time taken to access a given byte of information stored in random access memory is measured in thousand-millionths of a second, or nanoseconds. This illustrates the very significant speed difference which distinguishes solid-state memory from rotating magnetic storage devices: hard disks are typically about a million times slower than memory. Rotating optical storage devices

(such as CD and DVD drives) are typically even slower than hard disks, although their access speeds are likely to improve with advances in technology. Therefore the use of virtual memory, which is about million times slower than "real" memory, significantly degrades the performance of any computer.

Tertiary storage is a system where a robotic arm will "mount" (connect) or "dismount" off-line mass storage media (see the next item) according to the computer operating system's demands. Tertiary storage is used in the realms of enterprise storage and scientific computing on large computer systems and business computer networks, and is something a typical personal computer user never sees firsthand.

Off-line storage is a system where the storage medium can be easily removed from the storage device. Off-line storage is used for data transfer and archival purposes. In modern computers, floppy disks, optical discs and flash memory devices including "USB drives" are commonly used for off-line mass storage purposes. "Hot-pluggable" USB hard disks are also available. Off-line storage devices used in the past include magnetic tapes in many different sizes and formats, and removeable Winchester disk /drums.

(iii) *Network storage :* Network storage is any type of computer storage that involves accessing information over a **computer network**. Network storage arguably allows to centralize the **information management** in an organization, and to reduce the duplication of information. Network storage includes:

♦ **Network-attached storage** is secondary or tertiary storage attached to a computer which another computer can access over a local-area network, a private wide-area network, or in the case of online file storage, over the Internet.

♦ **Network computers** are computers that do not contain internal secondary storage devices. Instead, documents and other data are stored on a network-attached storage.

1.6.2 Characteristics of storage : The division to primary, secondary, tertiary and off-line storage is based on **memory hierarchy**, or *distance from the central processing unit*. There are also other ways to characterize various types of storage.

(i)   Volatility of information

♦ **Volatile memory** requires constant power to maintain the stored information. Volatile memory is typically used only for primary storage.

♦ **Non-volatile memory** will retain the stored information even if it is not constantly supplied with electric power. It is suitable for long-term storage of information, and therefore used for secondary, tertiary, and off-line storage.

♦ **Dynamic memory** is volatile memory which also requires that stored information is periodically *refreshed*, or read and rewritten without modifications.

(ii)   Ability to access non-contiguous information

♦ **Random access** means that any location in storage can be accessed at any moment in the same, usually small, amount of time. This makes random access memory well suited for primary storage.

♦ **Sequential access** means that the accessing a piece of information will take a varying amount of time, depending on which piece of information was accessed last. The device may need to *seek* (e.g. to position the read/write head correctly), or *cycle* (e.g. to wait for the correct location in a constantly revolving medium to appear below the read/write head)

(iii)   Ability to change information

♦ **Read/write storage**, or **mutable storage**, allows information to be overwritten at any time. A computer without some amount of read/write storage for primary storage purposes would be useless for many tasks. Modern computers typically use read/write storage also for secondary storage.

♦ **Read only storage** retains the information stored at the time of manufacture, and **write once storage** (WORM) allows the information to be written only once at some point after manufacture. These are called **immutable storage**. Immutable storage is used for tertiary and off-line storage. Examples include CD-R.

♦ **Slow write, fast read storage** is read/write storage which allows information to be overwritten multiple times, but with the write operation being much slower than the read operation. Examples include CD-RW.

(iv)   Addressability of information

♦ In **location-addressable storage**, each individually accessible unit of information in storage is selected with its numerical memory address. In modern computers, location-addressable storage usually limits to primary storage, accessed internally by computer programs, since location-addressability is very efficient, but burdensome for humans.

♦ In **file system storage**, information is divided into *files* of variable length, and a particular file is selected with human-readable directory and file names. The underlying device is still location-addressable, but the operating system of a computer provides the file system abstraction to make the operation more understandable. In modern computers, secondary, tertiary and off-line storage use file systems.

♦ In **content-addressable storage**, each individually accessible unit of information is selected with a hash value, or a short identifier with no pertaining to the memory address the information is stored on. Content-addressable storage can be implemented using software (computer program) or hardware (computer device), with hardware being faster but more expensive option.

(v)   Capacity and performance

♦   **Storage capacity** is the total amount of stored information that a storage device or medium can hold. It is expressed as a quantity of bits or bytes (e.g. 10.4 megabytes)

♦   **Storage density** refers to the compactness of stored information. It is the storage capacity of a medium divided with a unit of length, area or volume (e.g. 1.2 megabytes per square centimeter)

♦   **Latency** is the time it takes to access a particular location in storage. The relevant is typically nanosecond for primary storage, millisecond for secondary storage, and second for tertiary storage. It may make sense to separate *read latency* and *write latency*, and in case of sequential access storage, *minimum*, *maximum* and *average latency*.

♦   **Throughput** is the rate at which information can read from or written to the storage. In computer storage, throughput is usually expressed in terms of *megabytes per second* or *MB/s*, though bit rate may also be used. As with latency, *read rate* and *write rate* may need to be differentiated.

1.6.3 Primary Storage

(a) Semi-conductor memories or integrated circuits : As they are often called, are based on the principle of storage chips. The very thin silicon chip contains a number of small storage cells that can hold data. Instead of being made up of a series of discrete components, these units are constructed as integrated circuits, meaning that a number of transistors are integrated or combined together on a thin silicon wafer to form a complete set of circuits. The faster and more expensive bipolar semi conductor chips are often used in the arithmetic-logic unit and high-speed buffer storage sections of the CPU, while the slower and less expensive chips that employ metal-oxide semi-conductor (MOS) technology are used in the main memory section.

Both *volatile* and *non-volatile* forms of semiconductor memory exist. In modern computers, primary storage almost exclusively consists of dynamic volatile semiconductor memory or dynamic random access memory. A back-up uninterruptible power system is thus desirable in installations with volatile semi-conductor storage. In spite of the volatile storage characteristic, these memory chips have found their way into the newer model of most computers due to several very good reasons.
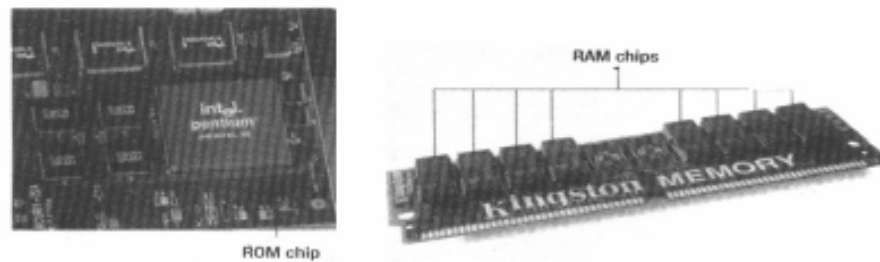
Fig. 1.8

(ii) Random-Access-Memory (RAM) : The memory system constructed with metal-oxide semi conductor storage elements that can be changed is called a random access memory (RAM) When people talk about computer memory in connection with microcomputer, they usually mean the volatile RAM memory. The purpose of RAM is to hold programs and data while they are in use. It is called random access memory since access time in RAM is independents of the address of the word, that is, each storage location (address) inside the memory is as easy to reach as any other location and takes the same amount of time. One can reach into the memory at random and insert or remove numbers in any location at any time. A random access memory is extremely fast but can also be quite expensive.

RAMs can be further divided according to the way in which the data is stored, into dynamic RAMs and static RAMs. The computer designer's decision which to use where depends on what their function is to be, and on their speed and cost.

Dynamic RAM: Dynamic RAM (DRAM) is the most common type of main memory. It is dynamic because each memory cell quickly loses its charge so it must be refreshed hundreds of times each second to prevent data from being lost. Here are some of the types of DRAM that have been or will be popular in most desktop systems (listed from oldest to newest):

– Fast Page Mode (FPM) DRAM was used in most computers until EDO RAM came along.

– Extended Data Out (EDO) DRAM is slightly faster than FPM. One variation called burst EDO (BEDO) DRAM assumes that the next data - address to be requested by the CPU follows the current one so it sends that also.

– Synchronous DRAM (SDRAM) can synchronize itself with the clock that controls the CPU. This makes data transfers more reliable and faster because timing delays are

eliminated. It is anticipated that this form of memory will replace EDO as the most common form of memory.

– Rambus DRAM (RDRAM) is the latest design and Intel has announced that all of their future systems will require it. RDRAM is very fast, but the system must be slightly redesigned to use it. RDRAM sends data down a high-band width "channel" 10 times faster than standard DRAM.

Static RAM: Static RAM (SRAM) is like DRAM but it's a lot faster, larger, and more expensive. It's static because it doesn't need to be continually refreshed. Because of its speed, SRAM is used mainly in a special area of memory called a cache.

The Static RAM retains the stored data as long as the power remains in, whereas with dynamic RAM, the stored information disappears after a few milliseconds have elapsed. The data must, therefore be repeatedly refreshed before it disappears. The power consumption of a dynamic RAM is less than that of a static RAM, which has the advantage of making a higher degree of integration possible. The computer does the refreshing process itself, taking time out from other chores every few milliseconds. It will read all the RAM memory positions while they are still readable and put appropriate new charge on each capacitor. Some dynamic RAM memory circuits include built-in "refresh circuits" to relieve the computer.

(iii) Read-Only-Memory (ROM) : Another type of computer memory is the read-only-memory (ROM) It is used for microprograms not available to normal programmers. The term read-only means that the storage cannot be altered by regular program instructions. The information is stored permanently in such memory during manufacture. The information from the memory may be read out but fresh information cannot be written into it. The microprograms in read-only-memory may be used for a variety of purposes, but a common use is to hold a set of instructions that are needed frequently, for executing small, extremely basic operations, which are not otherwise available in the computer circuitry. One set of instructions found in ROM is called the ROM-BIOS which stands for Read-only Memory Basic Input Output services. These programs perform the basic control and supervisory operations for the computer. For example, it ensures that if a user pressed 'one' on the keyboard, the digit 1 appears on the, screen. ROM may be used for code converter, function generator (e.g. sine, consine, Arctangent etc.) and character generators (e.g. characters displayed in dot matrix form) It also handles the basic needs of the hardware involved, which include all I/O devices.

PROM: Programmable Read Only Memory is a non-volatile memory which allows the user to program the chip with a PROM write. The chip can be programmed once, there after, it can not be altered.

EPROM: EPROM stands for Erasable Programmable Read Only Memory. EPROM chips can be electrically programmed. Unlike ROM and PROM chips, EPROM chips can be erased and reprogrammed. Erasure is performed by exposing the chip to Ultra-violet light.

EEPROM: Electrically Erasable Programmable Read Only Memory is EPROM. However, the data can be erased by applying electrical charges.

(iv) Bubble Memory : Bubble memory is composed of small magnetic domains (bubbles) formed on a thin single-crystal film of synthetic garnet. These magnetic bubbles, which are actually magnetically charged cylinders, only a few thousandths of a centimeter in size, can be moved across the garnet film by electric charges. The presence or absence of a bubble can be used to indicate whether a bit is "on" or "off".

Since data stored in bubble memory is retained when power to the memory is turned off, it can be used for auxiliary storage. Bubble memory has high potential because of its low production costs and its direct access capabilities, thus it may become widely employed as a main memory technology. Since it is small, lightweight, and does not use very much power, bubble memory is finding a great deal of use as an auxiliary storage in portable computers. It is expected that as more portable computers are developed, bubble memory will become more widely used.

(v) Flash memory: Flash memory chips are one of the latest storage devices. These chips, a form of static RAM (SRAM) chips, store data much like those used in the computer's primary storage. However, the data stays recorded even when the power is turned off-flash memory is non-volatile. Since flash memory devices have no moving parts, and are therefore very fast, they may eventually replace slower, mechanical hard disk drives.

(vi) Video RAM: Video RAM (VRAM) is used to accelerate the display of graphics on the screen. It does this by using two "ports," one connected to the CPU and the other to the screen. Data flows in one port and out the other very smoothly. A variation of this is Window RAM (WRAM) that supports memory.

1.7 SECONDARY STORAGE DEVICES

As discussed in section 1.6.1, there are different types of computer storage. Primary storage is built into the CPU whereas secondary storage or auxiliary storage is usually housed in a separate unit or units. Primary storage is very fast-its contents can be accessed in millionth or billionths of a second. But primary storage has a limited capacity. Although the cost per byte has continued to decrease, there is not enough capacity to store all of firms' files. Secondary storage supplements the capacity of primary storage. Secondary storage has an almost infinite capacity measured in millions and billions of bytes. Some secondary storage media (such as magnetic storage) offer direct access to data whereas tape devices offer sequential access. The access speed of secondary storage is slower than that of primary storage. It may be noted that these auxiliary storage media such as floppy disk, magnetic disk etc. can be used for both input and output purpose. We will now discuss these auxiliary storage media and devices.

1.7.1 FLOPPY DISKETTES

In the early 1970's IBM introduced a new medium for storing data. This medium consisted of a circular piece of thin plastic material, approximately eight inches in diameter, that was coated with an oxide material. The circular piece of plastic, called a disk, is enclosed in a square protective jacket with a cut out so that the magnetic surface is exposed. When inserted in the appropriate hardware device, the disk is rotated inside the protective jacket, allowing keyed data or data from main computer memory to be stored on the rotating disk. Once data is stored on the disk, it can be read from the disk into main computer. This medium for input and auxiliary storage is called *a floppy disk or diskette* (*see* figure 1.9 A and 1.9B)

Diskettes are available in a number of different sizes. The original diskette was of the size of 8 inches. During the 1980, most PCs used 5.25-inch diskettes. Today, the 3.5-inch diskette has largely replaced its 5.25-inch cousin. The size refers to the diameter of the disk, not to the capacity.
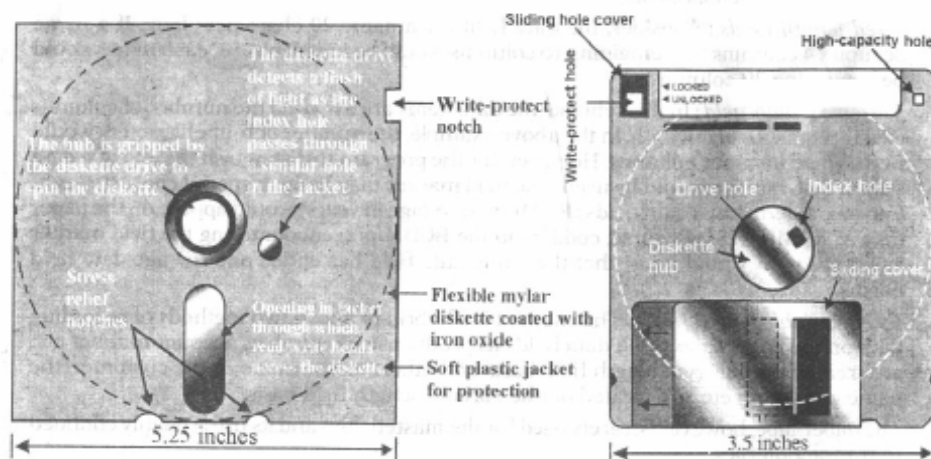
Fig. 1.9 A   Fig. 1.9 B
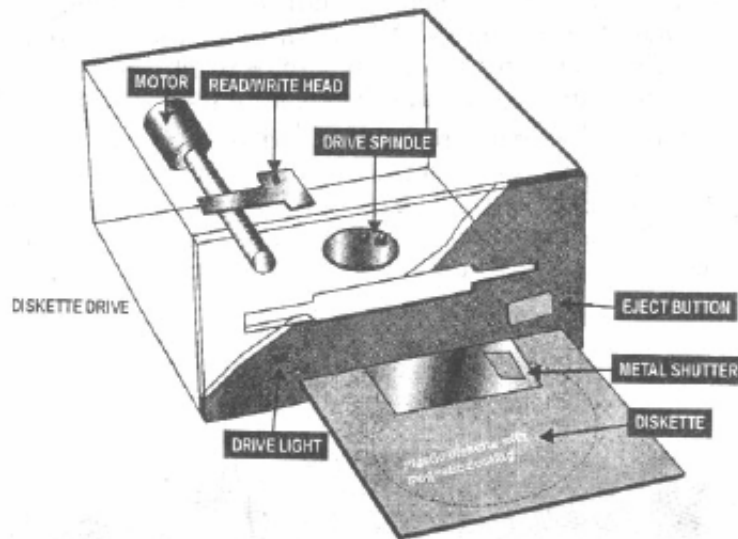
Fig. 1.10

The 5.25-inch type diskette is encased in a flexible vinyl envelope with an oval cutout that allows the read/write head to access the disk. The 3.5-inch type diskette is encased in a hard plastic shell with a sliding metal cover. When the disk is inserted into the drive, the cover slides back to expose the diskette to the read/write head.

The surfaces of diskettes (or disks/tapes discussed later) are coated with millions of tiny iron particles so that the data can be stored on them. Each of these particles can act as a magnet, taking on a magnetic field when subjected to an electromagnet. The read/write heads of a diskette drive (or a hard disk/ tape drive) contain electromagnets, which generate magnetic field in the iron on the storage medium as the head passes over the diskette (or disk or tape)

The diskette drive (Fig. 1.10) includes a motor that rotates the disk on a spindle and read/write heads that can move to any spot on the disk's surface as the disk spins. This capability is important, because it allows the heads to access data randomly, rather than sequentially. In other words, the heads can skip from one spot to another, without having to scan through everything in between.

Floppy diskettes spin at around 300 revolutions per minute. Therefore, the longest it can take to position a point on the diskette under the read/write heads is the amount of time required for one revolution -about 0.2 second. The farthest the head would ever have to move is from the centre of the diskette to the outside edge. The heads can move from the center to the

outside edge in even less time - about 0.17 second. Since both operations (rotating the disk and moving the heads) take place simultaneously, the maximum time to position the heads over a given location on the diskette - known as the maximum access time remains the greater of the two times or 0.2 second.

1.7.1.1 How Data is organised on a disk : When the new diskettes (or a new hard drive) are purchased, the disks inside are nothing more than simple, coated disks encased in plastic. Before the computer can use them to store data, they must be magnetically mapped so that the computer can go directly to a specific point on the diskette without searching through data. The process of mapping a diskette is called **formatting** or **initializing**. Today, many diskettes come preformatted for either PCs or Macs. If unformatted diskettes are purchased, one must format them before they can be used. The computer will warn the user if this is the case, and will format the diskette for him if he wishes so.

The first thing a disk drive does when formatting a disk is to create a set of magnetic concentric circles called *tracks.* The number of tracks on a disk varies with the type (most high-density diskettes have 80) The tracks on a disk do not form a continuous spiral like those on a phonograph record - each one is a separate circle. Most tracks are numbered from the outermost circle to the innermost, starting from zero.
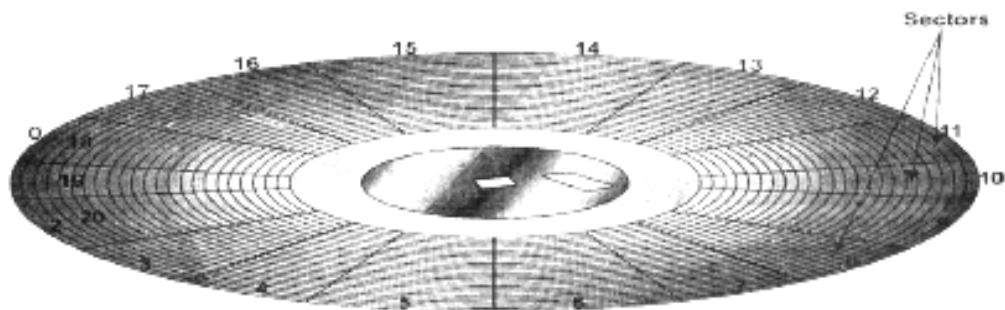
Fig. 1.11

Each track on a disk is also split into smaller parts. Imagine slicing up a disk the way a pie is cut. As shown in Figure-1.11, each slice would cut across all the disk's tracks, resulting in short segments, or *sectors*. All the sectors on the disk are numbered in one long sequence, so the computer can access each small area on the disk with a unique number. This scheme effectively simplifies what would be a set of two-dimensional coordinates into a single numeric address.

When people refer to the number of sectors a disk has, the unit they use is sectors per track - not just sectors. If a diskette has 80 tracks and 18 sectors per track, it has 1440 sectors (80 × 18) - not 18 sectors.

Like any flat object, a disk has two sides. Some early drives could read data on only one side, but today, all disk drives can read and write data on both sides of a disk. To the computer, the second side is just a continuation of the sequence of sectors. For example, the 3.5 inch, 1.44-MB diskette has a total of 2880 sectors (80 tracks per side × 2 sides × 18 sectors per track)

On most diskettes, a sector contains 512 bytes, or 0.5 KB

A sector is the smallest unit with which any disk drive (diskette drive or hard drive) can work. Each bit and byte within a sector can have different values, but the drive can read or write only whole sector at a time. If the computer needs to change just one byte out of 512, it must rewrite the entire sector.

The number of characters that can be stored on a diskette by a disk drive is dependent on following three basic factors:

1   *The number of sides of the diskette used* : The earlier diskettes and drives were designed so that data could be recorded on only one side of the diskette. These drives were called single-sided drives. Now-a-days diskette drives are manufactured that can read and write data on both sides of the diskette. Such drives are called *double-sided drives.* The use of double-sided drives and diskettes approximately doubles the number of characters that can be stored on the diskette.

2   *The recording density of the bits on a track* : The recording density refers to the number of bits that can be recorded on a diskette in one inch circumference of the innermost track on the diskette. This measurement is referred to as bits per inch (bpi) For the user, the diskettes are identified as being either *single density* (SD) or *double density (DD)* A single density drive can store 2,768 bits per inch on the innermost track. Double density can store 5,876 bits per inch. With improved technology, it is anticipated that recording densities in excess of 10,000 bits per inch will be possible.

3   *The number of tracks on the diskette* : The number of tracks is dependent upon the drive being used. Many drives record 40 tracks on the surface of the diskette. Other drives, however, can record 80 tracks on the diskette. These drives are sometimes called double track drives.

Table given below shows how the capacities of diskettes relate to the dimensions.

Table : Formatting specifications for various Disks

Diameter (inches)	Sides	Sectors/ Tracks	Tracks	Bytes/ Sectors	Sector	Bytes	KB	MB
5.25	2	40	9	720	512	368,640	360	.36
5.25	2	40	18	1440	512	737,280	720	1.2
3.5	2	80	15	2400	512	1,228,800	1,200	.7
3.5	2	80	18	2880	512	1,474,560	1,440	1.44
3.5	2	80	36	5760	512	2,949,150	2,880	2.88

Because files are not usually a size that is an even multiple of 512 bytes, some sectors contain unused space after the end of the file. In addition, the DOS and Windows operating systems allocate groups of sectors, called clusters, to each of the files they store on a disk. Cluster sizes vary, depending on the size and type of the disk, but they can range from 4 sectors for diskettes, to 64 sectors for some hard disks. A small file that contains only 50 bytes will use only a portion of the first sector of a cluster assigned to it, leaving the remainder of the first sector, and the remainder of the cluster, allocated but unused.

1.7.1.2 How the Operating System Finds Data on a Disk : A computer's operating system is able to locate data on a disk (diskette or hard drive) because each track and sector is labeled, and the location of all data is kept in a special log on the disk. The labeling of tracks and sectors is called performing a logical or soft format. A commonly used logical format performed by DOS or Windows creates these four disk areas:

♦ The boot record
♦ The file-allocation table (FAT)
♦ The root folder or directory
♦ The data area

The boot record: It is a small program that runs when the computer is started. This program determines whether the disk has the basic components of DOS or Windows that are necessary to run the operating system successfully. If it determines that the required files are present and the disk has a valid format, it transfers control to one of the operating system programs that continues the process of starting up. This process is called booting because the boot program makes the computer "pull itself up by its bootstraps."

The boot record also describes other disk characteristics, such as the number of bytes per sector and the number of sectors per track. The information is required by the operating system to access the data area of the disk

The file-allocation table (FAT): It is a log that records the location of each file and the status of each sector. When a file is written to a disk, the operating system checks the FAT for an open area, stores the file, and then identifies the file and its location in the FAT.

The FAT solves a common filing problem: What happens when a user loads a file, increases it's size by adding text to it, and then save it again? For example, say, one needs to add 5000 bytes to a 10,000-byte file that has no open space around it. The disk drive could move the surrounding files to make room for the 5000 bytes, but that would be time consuming. Instead, the operating system checks the FAT for free areas, and then places pointers in it that link together the nonadjacent parts of the file. In other words, it splits the file up by allocating new space for the overflow.

When the operating system saves a file in this way, the file becomes fragmented. Its parts are located in nonadjacent sectors. Fragmented files do cause undesirable side effects, the most significant being that it takes longer to save and load them.

Users do not normally need to see the information in the FAT, but they often use the folder information. A **folder**, also called a directory, is a tool for organizing files on a disk. Folders can contain files or other folders, so it is possible to set up a hierarchical system of folders on the computer, just as there are folders within other folders in a file cabinet. The top folder on any disk is known as the root. When the user uses the operating system to view the contents of a folder, the operating system lists specific information about each file in the folder, such as the file's name, its size, the time and date that it was created or last modified, and so on.

The part of the disk that remains free after the boot sector, FAT, and root folder have been created is called the data area because that is where the data files (or program files) are actually stored.

1.7.1.3 Care required in using and storing a diskette : On receiving a new diskette, it should be inspected for sign of obvious damage. The surface of the diskette should not be touched with hand or some sharp object. Write-protect precaution should be observed by peeling off or sticking on (as applicable) the aluminum square on the notch.

Correct insertion of disk in the disk drive is essential, otherwise some data stored on the disk is likely to be destroyed or the disk itself may get damaged. The diskette should be inserted slowly in the disk drive only when power to the entire computer system is on. It should be removed prior to turning the system off.

As a defensive measure, it is advisable that a back-up copy of the information stored on each diskette be prepared and stored separately at a safe location. The diskette should be properly labeled for right identification. While storing a diskette, both physical and environmental factors should be considered. Diskette should not be stored in such a way that may sag, slump or compress it. The main enemies of a diskette are temperature and direct sunlight, dust, liquids and vapors and electromagnetic interference. Diskette should be protected from

them. Care should be taken to clean the disk drive head to remove dust regularly.

Floppy diskettes are very cheap and offer both sequential and direct access to data at a substantially high speed. Typically, data may be transferred at the rate of 30,000 to 1,50,000 bytes per second. Records and files on a flexible disk are organised and processed in the same way as with rigid disk systems.

Floppy disk drives are generally smaller and more economical to manufacture than rigid disk systems. That is why these are used as auxiliary storage and I/O media with mini and microcomputer installations. In Mainframes also, these are being used as input medium.

1.7.2 MAGNETIC DISC

Magnetic discs are the most popular *direct access medium.* By direct access we mean that a record can be accessed without having to plod through the preceding records. The other direct access medium is floppy disc (discussed earlier)

Although a shift toward optical technology is occurring, the hard disk is still the most common storage device for all computers. Much of what was discussed about floppy diskettes and disk drives apply to hard disks as well. Like diskettes, hard disks store data in tracks that are divided into sectors. Physically, however, hard disks look quite different from diskettes.

A hard disk is a stack of one or more metal platters that spin on one spindle like a stack of rigid diskettes. Each platter is coated with iron oxides, and the entire unit is encased in a sealed chamber. Unlike diskettes, where the disk and drive are separate, the hard disk and drive is a single unit. It includes the hard disk, the motor that spins the platters, and a set of read/write heads.

Since the disk can not be removed from its drive (unless it is a removable hard disk, which will be discussed later), the terms hard disk and hard drive are used interchangeably.

Hard disks have become the primary storage device for PCs because they are convenient and cost-efficient. In both speed and capacity, they far outperform diskettes. A high-density 3.5-inch diskette can store 1.44 MB of data. Hard disks, in contrast, range in capacity from about 20 GB onward. Most PCs now come with hard disks of at least 80 GB and more.

Two important physical differences between hard disks and diskettes account for the differences in performance. First, hard disks are sealed in a vacuum chamber, and second, the hard disk consists of a rigid metal platter (usually aluminum), rather than flexible mylar.

The rigidity of the hard disk allows it to spin much faster - typically more than ten times faster than diskettes. Thus, a hard disk spins between 3,600 rpm and 7,200 rpm, instead of a diskette's 300 rpm. The speed at which the disk spins is a major factor in the overall performance of the drive.

The rigidity of the hard disk and the high speed at which it rotates allow a lot of data to be

recorded on the disk's surface. It may be recalled, waving a magnet past an electric coil causes a current to flow through the coil. The faster the magnet is waved, and the closer the magnet is to the coil, the larger the current it generates in the coil. Similarly, a disk that spins faster can use smaller magnetic charges to make current flow in the read/write head. The drive's heads can also use a lower intensity current to record data on the disk.

1.7.2.1 Data Storage : Not only do hard disks pack data more closely together, they also hold more data, because they often include several platters, stacked one on top of another. To the computer system, this configuration just means that the disk has more than two sides; in addition to a side 0 and side1, there are sides 2,3,4 and so on. Some hard disk drives hold as many as 12 sides, but both sides of the disks are not always used
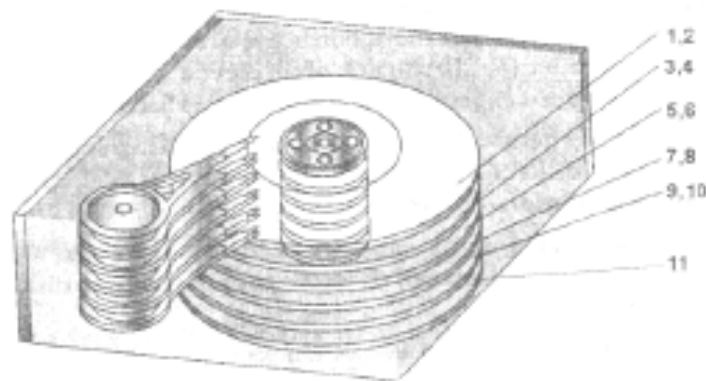
Fig. 1.12

With hard disks, the number of read/write heads specifies the number of sides that the disk uses. For example, a particular hard disk drive might have six disk platters (that is, 12 sides), but only eleven heads, indicating that one side is not used to store data. Often, this is the bottom side of the bottom disk.
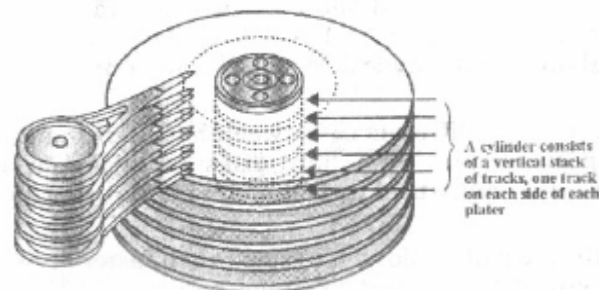
Fig. 1.13

The other point of importance is the fact that read/write heads move in and out simultaneously. Referring to figure 1.13, there are 11 magnetisable faces and there are therefore, 11 read/write heads. Even though, a record on the first disc face were to be accessed, not only the first read/write head would move but the other ten read/write heads would also move in unison. However, only the first read head would be activated, others remaining inactive. As a consequence of this, if the read/write heads have once been moved, all the eleven tracks vertically above and below each other should be read or written before any further movement of the heads take place. This eliminates first component of the seek time *i.e.,* horizontal movement of the read/write heads. This has led to the concept of cylinders (synonymous: seek areas) Any eleven tracks vertically above and below each other constitute more or less a hollow cylinder (*See* Figure 1.13) Therefore, there are 200 cylinders. Because of the simultaneous movement of the read/write heads, it is to be desired that the records are arranged sequentially in cylinders so that when the first cylinder (*i.e.,* first track of all eleven faces) has been read, the heads move to the next cylinder *i.e.,* reading or writing is performed cylinder wise.

Like diskettes, hard disks generally store 512 bytes of data in a sector, but because of their higher tolerances, hard disks can have more sectors per track-54, 63, or even more sectors per track are not uncommon.

The computation of a hard disk's capacity is identical to that for diskettes-but the numbers are larger. The breakdown of the storage capacity for a disk that is sold as a 541-MB disk is given below:

1,632 cylinders × 12 heads (sides) = 19,584 tracks

19,584 tracks × 54 sectors / track = 1,057,536 sectors

1,057,536 sectors × 512 bytes/sector = 541,458,432 bytes
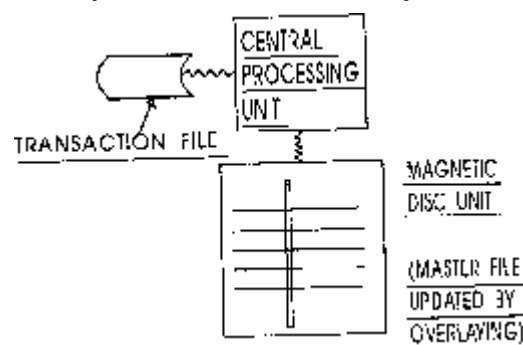
Fig. 1. 14

As depicted in the Figure 1.14, only one magnetic pack is connected to the CPU and serves both as the input and output unit. The implication of this being that a record picked up from a sector and updated in the CPU is deposited back in the same place in that sector. *This mode of storing updated data is known as overlaying i.e.,* original data is automatically erased when the new updated record is being deposited in its place.

This leads to economies in the sense that fewer discs are needed but as a disadvantage it becomes difficult to trace any errors as it is not possible to reconstruct the latest file from the previous version.

In spite of all the capacity and speed advantages, hard disks have one major drawback. To achieve optimum performance, the read/write head must be extremely close to the surface of the disk. In fact, the heads of hard disks fly so close to the surface of the disk that if a dust particle, a human hair, or even a fingerprint were placed on the disk it would bridge the gap between the head and the disk, causing the heads to crash. A head crash, in which the head touches the disk, destroys the data stored in the area of the crash and can destroy a read/write head, as well.

The time required in accessing a record has generally three components.

(i) *Seek Time* : This is the time required to position a movable read-write head over the recording track to be used. If the read-write head is fixed, this time will be zero.

(ii) *Rotational time* : This is the rotational delay also termed latency, to move the storage medium underneath the read-write head.

(iii) *Data transfer time* : This is the time taken to activate the read/write head, read the requested data, and transmit them to primary memory for processing.

The total of these three components is known as the access time and typically ranges from, 8 to 12 milliseconds.

1.7.2.2 Advantages and disadvantages of magnetic disk

The advantages of magnetic disk include :

1. Magnetic rigid disk is a direct access storage medium; therefore, individual records can be retrieved without searching through the entire file.

2. The costs of disks are steadily declining.

3. For real-time systems where direct access is required, disks are currently the only practical means of file storage. Other new types of storage, such as bubble storage, are not widely used yet.

4. Records can be readily updated by writing the new information over the area where the old information was stored.

5. With removable disk packs, a single disk drive can store large quantities of data although all but one of the disks is offline at any given point in time. However, being offline is not a disadvantage for many applications, especially batch applications.

6. Interrelated files stored on magnetic disk can allow a single transaction to be processed against all of these files simultaneously.

The disadvantages of magnetic disk include :

1. Updating a master file stored on disk destroys the old information. Therefore, disk does not provide an automatic audit trail. When disk is used, back-up and audit trail require that each old master file records be copied to another medium prior to update.

1.7.2.3 Removable hard disks: Removable hard disks and drives attempt to combine the speed and capacity of a hard disk with the portability of a diskette. There are many different types of devices in this category. Choosing the best type is usually a matter of balancing the needs for speed, storage capacity, compatibility (will it work in different computers?), and price.

1.7.2.4 Hot-Swappable Hard Disks: At the high end, in terms of both price and performance, are hot-swappable hard disks. These are sometimes used on high-end workstations that require large amounts of storage. They allow the user to remove (swap out) a hard disk and insert (swap in) another while the computer is still on (hot)

Hot-swappable hard disks are like removable versions of normal hard disks: the removable box includes the disk, drive, and read/write heads in a sealed container.

1.7.3 OPTICAL LASER DISKS

Optical laser disk storage is capable of storing vast amount of data. Some industry analysts have predicted that optical laser disk technology may eventually make magnetic disk and tape storage obsolete. With this technology, the read/write head used in magnetic storage is replaced by two lasers. One laser beam writes to the recording surface by scoring macroscopic pits in the disk, and another laser reads the data from the light sensitive recording surface. A light beam is easily deflected to the desired place on the optical disk, so a mechanical access arm is not needed.

There are three main categories of optical laser disks.

1.7.3.1 CD-ROM disks : CD-ROM, a spinoff of audio CD technology stands for compact-disk-read-only memory. The name implies its applications, CD-ROM disks are created as a mastering facility. Most of the commercially produced read-only CD-ROM disks contain reference material. The master copy is duplicated or "pressed" at the factory and copies are distributed with their pre-recorded contents. Once inserted into the CD-ROM disk drive, the text, video images, and so on can be read into primary storage for processing or display.

However, the data on the disk are fixed, they can not be altered.

The capacity of a single CD-ROM is over 650 MB which is equivalent to 250,000 pages of text, or 1500 floppy disks. The tremendous storage capacity has opened the door to a variety of multimedia applications. Multimedia can provide needed flexibility during a presentation. Unlike a video tape, CD-ROM gives the presenter instant random access to any sequence of images on the disk.

CDs may soon take a new direction with the advent of DVD, digital video disk, a high density medium that is capable of storing a full-length movie on a single disk side of a CD (actually, it uses both sides of the disk) DVDs look like CDs and DVD - ROM drives are able to play current CD-ROMs. A slightly different player, the DVD movie player connects to the TV and plays movies like a VCR. The DVD movie player will also play audio CDs.

Each side of a DVD can hold up to 4.7 GB. Therefore, these two-sided disks can contain as much as 9.4 GB of data.

CD Rewritables : Hewlett Packard has introduced the next generation of CD Rewritable (CD-RW) drive. This is the third generation in CD technology which began with CD-ROM and was then followed by the CD-Recordable (CD-R) and CD-RW.

CD-R : It stands for compact disc, recordable. A person can only write once on this CD, though it can be read as many times as wished. It can be played in CD players and CD-ROM drives. In a normal CD, polycarbonate plastic substrate, a thin reflective metal coating, and protective outer coating layers are present. However, in a CD-R, an extra layer is present and is an organic polymer dye lying between the polycarbonate and metal layers and serves as a recording medium. A pregrooved spiral track guides the laser for recording data, which is encoded from the inside to the outside of a CD in a continuous spiral, much like the way it is read. The laser makes that are not dissimilar from the pits and lands of a normal CD. After the encoding process is completed, the data can be read as a normal CD. The CD recorders are sometimes referred to as CD burners. Modern recording devices can also read CDs as well. CD-Rs can be created in any CD-R or CD-RW drive.

CD-RW : The rewriteable compact disc is called a CD-RW. This disc allows for repeated recordings on a disc. It is relatively more expensive than the CD-R. However, in certain circumstances the benefits outweigh the cost.

While the CD-R may use a layer of organic dye, which can only be altered once, the CD-RW uses an allow that can change to and fro from a crystalline form when exposed to a particular light. The technology of this process has a special name called phase changing. The patterns, however, are less distinct than that of other ordinary CD formats due to the greater difficulty of manipulating a metal instead of a dye. The alloy is usually made up of silver, indium, antimony and tellurium. After heating to a particular temperature, the alloy will crystallize when cooled. Heating that particular spot to a greater temperature results in the substance becoming

amorphous when cooled. By controlling the temperature, some areas have crystals and others do not. The crystals will reflect the laser effectively while the non-crystalline areas would absorb most of it.

To rewrite on a CD-RW, the alloy is first made amorphous, then reshaped using the cooler laser. The CD-RW can be rewritten as many as 1000 times. With the rewritable drive, the CD has now got all the functionalities of the floppy drive. The drive is claimed to be simple to use and universally accepted as a conventional floppy disk drive, but with the qualities of a compact disc.

1.7.3.2 WORM disks : It stands for Write once, read many optical laser disks, or WORM disks. These are used by end user companies to store their own proprietary information. Once the data have been written to the medium, they only can be read, not updated or changed. The PC version of a WORM disks cartridge, which looks like a 5¼ inch version of the 3½ inch diskette, has a capacity of 200 MB.

Access times for CD-ROM and WORM drives tend to be quite slow by hard disk drive standards, ranging from 100 to 300 milliseconds.

The WORM disks cartridge is a feasible alternative to magnetic tape for archival storage, for example, a company might wish to keep a permanent record of all financial transactions during the last year. Another popular application of WORM disks is in information systems that require the merging of text and images that do not change for a period of time. A good example is an "electronic catalogue". A customer can peruse retailer's electronic catalogue on a VDT, or perhaps a PC, and see the item while he or she reads about it. And, with a few keystrokes, the customer can order the item as well. The Library of Congress is using WORM technology to alleviate a serious shelf-space problem.

1.7.3.3 Magneto-Optical Disks : Magneto-optical integrate optical and magnetic disk technology to enable read-write storage. The 5¼ inch disks store up to 1000 MB. However, the technology must be improved before the disks can experience widespread acceptance. At present, magneto-optical disks are too expensive and do not offer anywhere near the kind of reliability that users have come to expect of magnetic media. In addition, the access times are relatively slow, about the same as a low-end Winchester disk.

As optical laser disk technology matures to offer reliable, cost - effective, read/write operation; it eventually may dominate secondary storage in the future as magnetic disks and tape do today.

640 MB Magneto Optical Drive : A **magneto-optical drive** is a kind of optical disc drive capable of writing and rewriting data upon a **magneto-optical disc**. Both 5.25" and 3.5" form factors exist. The technology was introduced at the end of the 1980s. Although optical, they appear as hard drives to the operating system and do not require a special filesystem (they can be formatted as FAT, HPFS, NTFS, etc.)

Initially the drives were 5.25" and had the size of full-height 5.25" hard-drives (like in IBM PC XT) Today a 3.5" drive(See fig. 1.15) has the size of 1.44 megabyte diskette drive. 5.25" media looks a lot like a CD-ROM enclosed in an old-style cartridge while 3.5" media is about the size of a regular 1.44MB floppy disc, but twice the thickness. The cases provide dust resistance, and the drives themselves have slots constructed in such a way that they always appear to be closed.

Fig 1.15

The disc consists of a ferromagnetic material sealed beneath a plastic coating. There is never any physical contact during reading or recording. During reading, a laser projects a beam on the disk and according to the magnetic state of the surface, the reflected light varies due to the magneto-optical Kerr effect. During recording, the light becomes stronger so it can heat the material up to the Curie point in a single spot. This allows an electromagnet positioned on the opposite side of the disc to change the local magnetic polarization, and the polarization is retained when temperature drops.

Each write cycle requires both a pass for the laser to erase the surface, and another pass for the magnet to write the information, and as a result it takes twice as long to write data as it does to read it. In 1996, a *Direct Overwrite* technology was introduced for 3.5" discs, to avoid the initial erase pass when writing. This requires special media.

Magneto-optical drives by default check information after writing it to the disc, and are able to immediately report any problems to the operating system. This means that writing can actually take three times longer than reading, but it makes the media extremely reliable, unlike the CD-R or DVD-R technologies upon which data is written to media without any concurrent data integrity checking.

1.7.3.4 Digital Video Disk: DVD (also known as "**Digital Versatile Disc**" or "**Digital Video**

Disc") is an optical disc storage media format that can be used for data storage, including movies with high video and sound quality. DVDs resemble compact discs as their physical dimensions are the same- 120 mm (4.72 inches) or occasionally 80 mm (3.15 inches) in diameter, but they are encoded in a different format and at a much higher density. A video disk can store text, video, and audio data. Video disks can be accessed a frame at a time (to provide still information) or played like a phonograph record (to supply up to an hour of moving action) Any of the 54,000 tracks on the surface of typical video disk can be accessed in about three seconds.

A digital video disk (DVD) is a 5 inch plastic disk that uses a laser to encode microscopic pits in its substrate surface. But the pits on a DVD are much smaller and are encoded much closer together than those on a CD-ROM. Also, a DVD can have as many as two layers on each of its two sides (compared to the single-layered, single-sided CD-ROM) The end result is a medium that can hold as much as 17 gigabytes of data – over 25 times the capacity of a standard CD-ROM disk. The advantages of DVDs are therefore self-evident – a huge storage capacity that enables users to archive large amounts of data on a single, lightweight, removable, reliable, easily-transportable medium. Although VDDs are now used mostly for entertainment – for example, storing video movies or large amounts of prerecorded music-experts predict that DVDs will become the medium of choice for distributing software or archiving large amounts of accounting data.

Video disks were first introduced in 1983, as a video game product. Today, however, they can provide companies with a competitive advantage.

> Video disk systems were developed to help real estate agents conduct better searches for homes and properties for their clients. For example, the client describes the type of home desired – perhaps three bedrooms, a garage, and priced below Rs.200,000. When these data are entered into the video disk system, photographs and even " video tours" of existing homes meeting the description can be summoned to the display screen.

> Video disks are widely used for training applications. At a growing number of companies –Ford, Chrysler, Xerox, Pfizer, and Massachusetts Mutual Life Insurance, to name just a few-video disk systems take on such training tasks as showing how to boost factory performance, helping service technicians do a safer and better job, and training clerks to analyze insurance applications. The U.S. Army has also made extensive use of video disks for training purposes.

Video disks are also used by automobile manufacturers to show their lines and by travel agents to interest clients in resorts. In the future, some industry observers predict that many businesses will develop automatic customer service centres equipped with video disk components so that consumers do not have to depend only on clerks and showrooms. When a desired item flashes on the display screen, the customer can insert a credit card in a device

that resembles a bank's automatic teller machine and order that item immediately. Sears-chain of departmental store introduced systems like this in many of its department stores. Even the U.S. Postal Service is spending close to Rs.5 million to develop an automated video disk system that will allow its patrons to do many of the activities that human postal clerks now perform.

1.7.4 TAPE DEVICES

Magnetic tape is probably the oldest secondary storage technology still in wide use. Its biggest drawback is that it can only access data sequentially. However, many data processing operations are sequential or batch oriented in nature, and tape is still economical. Here we will look at the two most popular forms of magnetic tape for large system MIS applications: detachable reel magnetic tapes and tape cartridges.

1.7.4.1 Detachable Reel Magnetic Tapes : Many of the tapes used with mainframes and minicomputers are stored on detachable reels. These plastic tapes are, like disks, coated with a magnetizable surface (often iron oxide) that can be encoded with 0 and 1 bits . Tapes come in various widths, lengths, and data densities. A common specification is a 2400 feet reel of ½ inch diameter tape that packs data at 6250 bytes per inch. Recording densities of tapes are often cited as bytes per inch (bpi) because in most instances, a character (byte) is represented as a vertical slice of bits across the tracks of tape surfaces.
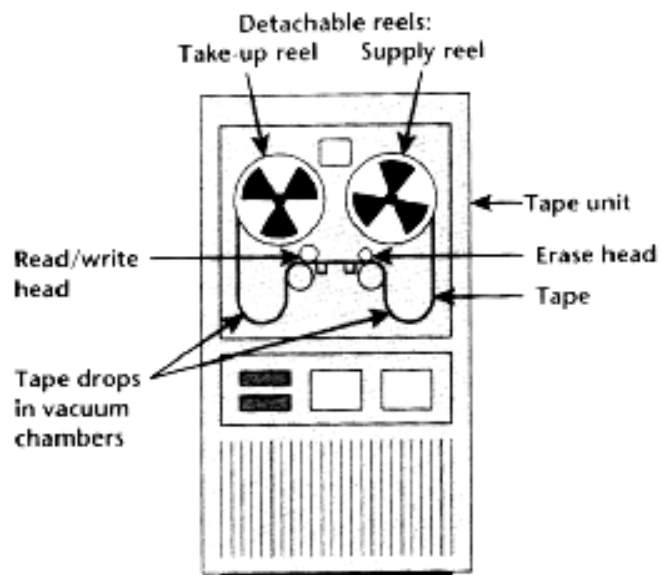
Fig 1.16

Tapes are read on a hardware device called a tape unit (Figure 1.16) Basically, this unit works the same way as the reel-to-reel tape units that were once popular on home stereo systems. An empty take-up reel, running at the same speed as the supply reel on which the tape is initially wound, accepts the tape as it is being processed. The tape is processed by passing it under read/write heads located between the two reels. Depending on the instructions given to the computer system, data can then either be read from the tape or written to it.

1.7.4.2 Tape Cartridge Systems : Catridge tapes represent the leading edge of tape technology. Tape catridges are available for both large and small computer systems.

Tape catridges for microcomputer systems, which resemble cassette tapes in appearance, are frequently used to back up hard disks. These tapes, which are not designed for processing purposes, are sometimes called streaming tapes. The capacities of these tapes vary, but several megabytes of storage are typical. Streaming tapes can usually back up the contents of a hard disk in a few minutes. Among the leading tape cartridge system vendors are Colorado Memory Systems, Everex Systems, Micro Solutions Summit Memory Systems, and Tallgrass Technologies Corporation.

In 1986, IBM introduced a tape cartridge system, the IBM 3480, for its 3090 line of mainframes. Each of these cartridges has a capacity of 200 MB and a data-transfer rate of 3 MB/Sec. Unlike conventional detachable-reel tapes, which uses 9 parallel tracks, these ½ inch tapes store data in 18 tracks. In 1992, IBM released 36 track tape cartridges for use in its mainframes and AS/400 family of midrange computers.

SELF-EXAMINATION QUESTIONS

1. Describe in detail various generations of computers.

2. Write short notes on the following types of computers :-

    (i)   Super computer   (ii) Mainframe computer.

    (iii) Mini computer.   (iv) Micro computer.

    (v)   Workstations   (vi) Server

3. Draw the schematic diagram of a computer. Briefly discuss each of the components covered in it.

4. What are the features of the Central Processing Unit?

5. Discuss, in brief, various types of microprocessors.

6. Discuss various components of a motherboard.

7. What do you understand by the term 'Bus'? Discuss two types of bus available on a computer.

8. Write short notes on the following :

    (i) RAM

    (ii) ROM

    (iii) Bubble memory

    (iv) Flash memory

9. Write short note on floppy diskette as an input medium.

10. What are the factors that determine the number of characters that can be stored in a floppy diskette?

11. Explain the following terms :

    (i) The boot record

    (ii) File allocation table

12. What care is required for using and storage of a diskette?

13. Differentiate between floppy diskettes and hard disks.

14. Briefly explain the various characteristics of a hard disk.

15. What are the advantages and disadvantages of direct access storage?

16. Explain the following terms :

    (i) CD-ROM

    (ii) WORM disk

    (iii) Magneto Optical Disks

    (iv) Video Disk

    (v) Detachable Reel Magnetic Tape

    (vi) Tape Cartridge Systems

UNIT 2 : INPUT AND OUTPUT DEVICES

I/O devices (short for input/output devices) is a general term for devices that send computers information from the outside world and that return the results of computations. These results can either be viewed directly by a user, or they can be sent to another machine, whose control has been assigned to the computer: The first generation of computers were equipped with a fairly limited range of input devices. A punch card reader, or something similar, was used to enter instructions and data into the computer's memory, and some kind of printer, usually a modified teletype, was used to record the results. Over the years, other devices have been added. For the personal computer, for instance, keyboards and mice are the primary ways people directly enter information into the computer; and monitors are the primary way in which information from the computer is presented back to the user, though printers, speakers, and headphones are common, too. There is a huge variety of other devices for obtaining other types of input. One example is the digital camera, which can be used to input visual information.

We will now discuss some of these I/O devices in detail.

1.1 ON-LINE ENTRY

1.1.1. Keyboard : A microcomputer's keyboard is normally its primary input and control device. One can enter data and issue commands via the keyboard. The keyboard is used to type information into the computer or input information. There are many different keyboard layouts and sizes with the most common for Latin based languages being the QWERTY layout (named for the first 6 keys) The standard keyboard has 101 keys. Notebooks have embedded keys accessible by special keys or by pressing key combinations (CTRL or Command and P for example) Ergonomically designed keyboards are designed to make typing easier. Some of the keys have a special use. These are referred to as command keys. Three most common are the Control or CTRL, Alternate or Alt and the Shift keys though there can be more (the Windows key for example or the Command key) Each key on a standard keyboard has one or two characters. Press the key to get the lower character and hold Shift to get the upper. Besides the standard typewriter keyboard, most micro keyboards have function keys, also called soft keys. When tapped, these function keys trigger the execution of software, thus the name "soft key." For example, tapping one function key might call up a displayed list of user options commonly referred to as a **menu**. Another function key might cause a word processing document to be printed. Function keys are numbered and assigned different functions in different software packages. For example., HELP (context-sensitive user assistance) is often assigned to F1, or Function key 1. Most keyboards are equipped with key pad and cursor-

control keys . The keypad permits rapid numeric data entry. It is normally positioned to the right of the standard alphanumeric keyboard.
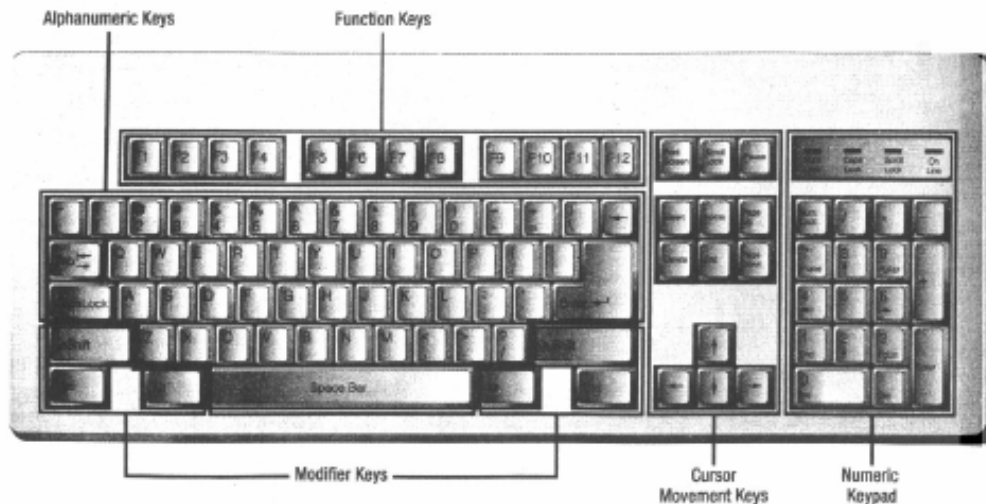
Fig. 1.1.1

The cursor-control keys, or "arrow" keys, allow the user to move the text cursor up (↑) and down (↓), usually a line at a time, and left (←) and right (→), usually a character at a time. The text cursor always indicates the location of the next keyed-in-character on the screen. The text cursor can appear as several shapes depending on the application, but frequently, one will encounter an underscore (_), a vertical line (|), or a rectangle ( ) To move the text cursor rapidly about the screen, simply hold down the appropriate arrow key.

For many software packages, one can use the arrow keys to view parts of a document or worksheet that extend past the bottom, top, or sides of the screen. This is known as **scrolling**. The user can use the up and down arrow keys (↑↓) to scroll vertically and the left and right keys (← →) to scroll horizontally.

In summary, the keyboard provides three basic ways to enter commands:

 ➢ Key in the command using the alphanumeric portion of the keyboard.

 ➢ Tap a function key.

 ➢ Use the arrow keys to select a menu option from the displayed menu.

Other important keys common to most keyboards are the ENTER, HOME, END, PAGE UP AND PAGE DOWN (abbreviated as PGUP and PGDN), DELETE (DEL), BACKSPACE (BKSP), Insert - typeover toggle (INS), ESCAPE (ESC), SPACEBAR, Shift Control (CTRL),

Alternate (ALT), TAB, SCROLLLOCK, CAPSLOCK, NUMLOCK, and PRINT SCREEN keys (see Figure 1.1.1)

1.1.2 Mouse : The Mouse is a small box, from the bottom of which protrudes a small ball bearing. The ball bearing rotates when the user moves the Mouse across his desk and, as it is linked by cable to the microcomputer, this moves the cursor on the display screen. Another type of mouse uses an optical system to track the movement of the mouse. Most modern computers today are run using a mouse controlled pointer. Generally if the mouse has two buttons the left one is used to select objects and text and the right one is used to access menus. If the mouse has one button (Mac for instance) it controls all the activity and a mouse with a third buttons can be used by specific software programs.

Systems using Mouse have displays which include easily identified functions or programs, such as 'store', 'print', 'graphics', 'utilities' and so on. When the cursor alights on the facility required, the user presses a button on the top of the Mouse and it is activated. This is an ideal input medium for those who cannot use keyboards-or are reluctant to learn.

A mouse may have one, two or three buttons. The function of each button is determined by the program that uses the mouse. In its simplest form, a mouse has one button. Moving the mouse moves the cursor on the screen, and clicking the button results in selecting an option. A mouse normally has two or three buttons, but the software package used by the user may use one, two or all three of them.
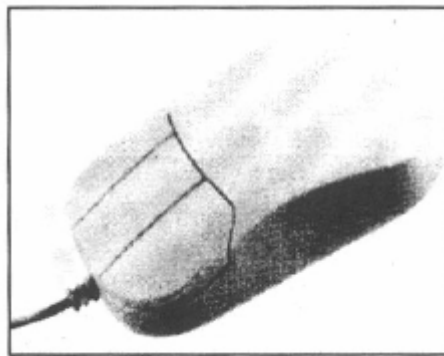
Fig. 1.1.2

A mouse may be classified as a mechanical mouse or an optical mouse, depending on the technology it uses. In a *mechanical mouse*, that projects through the bottom surface rotates as the mouse is moved along a flat surface. The direction of rotation is detected and relayed to the computer by the switches inside the mouse. Microsoft, IBM, and Logitech are some well-known makers of mechanical mouse. An *optical mouse* uses a light beam instead of a rotating ball to detect movement across a specially patterned mouse pad.

A *serial mouse* is connected to the PC through a serial port. A *bus mouse* is similar to a serial mouse except that it comes with a dedicated port and does not need a free serial port on the computer.

1.1.3 Touch Screen : The 'Touch Screen' is a Hewlett Packard innovation and was introduced on their 100 series microcomputers in 1984. An invisible microwave beam 'matrix' criss crosses the screen, emanating from holes along the bottom and sides of the display unit. By pressing the finger against a function or program displayed on the screen, the infrared beam is broken at that intersection and the system activated. In many ways, this is more effective than the 'Mouse' and very popular with users.

Fig. 1.1.3

Two popular technologies exist for touch screens. In one, the screen is made sensitive to touch and the exact position is detected. In the other, the screen is lined with light emitting devices on its vertical sides, photo-detectors are placed on the horizontal sides. When the user's finger approaches the screen, the light beam is broken and is detected by the photo-detectors.

Touch screens are used in information-providing systems. For example, while performing an operation, if the doctor wants to see some test reports of the patient that have been stored in a computer, he can get the information just by touch of his finger. It is also used in airline and railway reservation counters. The user has to indicate the current place of stay and the destination by touching the screen (may be on a map), and all the possible routes with timings, rates, etc. are displayed. These interfaces are also used in travel agents offices to display the names and addresses of all hotels, restaurants, and other places of interest, at a desired destination. Touch screens are also used in stock exchanges where buying and selling of stock is done.

1.1.4 Light Pen : A light pen is a pointing device which can be used to select an option by simply pointing at it, or draw figures directly on the screen and move the figures around.

A light pen has a photo-detector at its tip. This detector can detect changes in brightness of the screen. When the pen is pointed at a particular point on the screen, it records the instant change in brightness that occurs and informs the computer about this. The computer can find out the exact spot
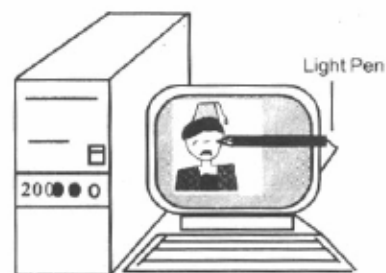
Fig.1.1.4

with this information. Thus, the computer can identify where the user is pointing on the screen.

Light-pens are useful for menu-based applications. Instead of moving the mouse around or using a keyboard, the user can select an option by pointing at it. A light pen is also useful for drawing graphics in CAD. An engineer, architect or a fashion designer can draw directly on the screen with the pen. Using a keyboard and a light pen, the designer can select colors and line thickness, reduce or enlarge drawings, and edit drawings.

These are also used to read the bar charts that are now appearing so frequently on the goods which are available in big departmental stores. By using a laser beam, computers are able to 'read' the information stored on the bar chart or on a thin strip of magnetic material and this is used to keep stock records and cheque costs, etc.

1.1.5 The Track Ball : A track ball is a pointing device that works like an upside-down mouse. The user rests his thumb on the exposed ball and his fingers on the buttons. To move the cursor around the screen, the ball is rolled with the thumb. Since the whole device is not moved, a track ball requires less space than a mouse. So when space is limited, a track ball can be a boom. Track balls are particularly popular among users of notebook computers, and are built into Apple Computer's Power Book and IBM ThinkPad notebooks.
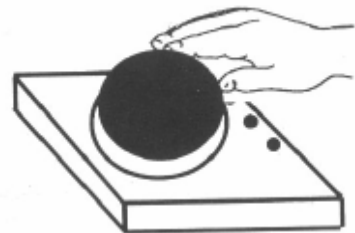
Fig. 1.1.5

1.1.6 Joystick : It is a screen pointing input device. It is a vertical lever usually placed in a ball socket, which can be fitted in any direction to control cursor movements for computer games and for some professional applications.

1.1.7 Display Devices :   Virtually everyone who interacts with a

computer system today uses some type of display device. These peripheral hardware units consist of a television like viewing screen, to which computer output is sent. The two most common types of display devices found today are monitors and terminals.
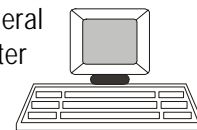
Monitors are the devices found most commonly with microcomputer systems. As mentioned previously, a monitor is just a "box with a viewing screen". On the screen, the user is able to see not only what is entered into the computer, but the computer output as well.

A **computer terminal** or video display terminal (VDT), generally combines input and output functions. It consists of a QWERTY keyboard for inputting information direct to the computer,

and either a printer or a TV screen for displaying information from the computer. Terminals are most commonly found in settings that are remote from the main computer and they interact with the computer through communications lines or networks. Airline agents are familiar examples of people who use communications terminals. Tellers in banks and cashiers in many retail settings also use terminals to perform their work duties.

There can be several types of terminals as discussed below :

A dumb terminal is an input/output (I/O) device that provides for data entry and information exit when connected to a computer but has no additional capability.

An intelligent terminal has an in-built processing capability. It is also user-programmable. It contains not only a storage area but also a microprocessor. The terminal can be programmed to communicate with and instruct the user who is entering data. It can also do some processing of the data internally such as sorting, summarizing, checking both input and computed values for reasonableness and so on, rather than relying on the mini-computer or the main-frame CPU. This feature can reduce the load on the central CPU. Thus, intelligent terminals can be used on a stand-alone basis or can be part of a distributed network of terminals.

Intelligent terminals cost several times more than non-intelligent terminals but the savings they provide for many companies is much more than their cost. Savings come about because the amount of data to be transmitted to the central CPU and the number of times it is interrupted are both reduced. Intelligent terminals also provide a type of back up to the main computer because the terminal can handle some of the processing.

Smart terminals additionally, contain a microprocessor and some internal storage. They have data editing capability and can consolidate input data before sending it to CPU. These terminals are non-programmable by users.

Remote job terminal (also referred to as Remote Job entry or RJE), groups data into blocks for transmission to a computer from a remote site. Some RJE terminals have the capability of receiving back and printing the results of the application program. Such a unit is in itself a small computer, which can be used either as job entry terminal or as a stand-alone computer.

A terminal may be situated at the computer site or situated at a remote place where the data to be input is more readily available. Terminals linked to the computer system by a direct cable are known as *hard-wired terminals.* However, for remote terminals, communication to the main system can be established via *telecommunication* lines such as ordinary telephone lines.

Keyboard printer terminal: The keyboard printer terminal or *teletypewriter* consists of a keyboard for sending information to the computer and a printer, for providing a copy of the input and for receiving information from the computer. The output is normally typed on a continuous role of paper at speeds typically between 20 to 50 characters per second. A paper

tape reader/punch is sometimes incorporated in the design of a terminal to enable information to be keyed in and punched on to paper tape for retention of data or for subsequent input to the computer. In place of the paper tape reader/punch, some more recently designed machines may have magnetic tape cassettes incorporated for the same purpose.

Hundreds of different display devices are now available. Although a number of important features distinguish one display device from another, the three that follow are among the most significant.

(a) Screen Resolution : One of the most important features used to differentiate display devices is the clarity, or resolution, of the images that are formed on –the screen. Most display devices form images from tiny dots - called pixels (a contraction of the two words "picture elements") - that are arranged in a rectangular pattern. The more dots that are available to display any image on -screen, the sharper the image (the greater the resolution) is.

Images are formed on monitor's screen by a card called the display adaptor card. If a user wishes to change the kind of display, e.g, from black and white to colour, the display adaptor card must be changed. The key elements of display adaptor cards the video controller and the memory. A variety of display adaptor cards exist in the market, each with its own special features. Some of the popular display adaptors reported by personal computers are discussed below:

1. MGA- MGA or Monochrome Graphics Adapter is one of first adapters. It is a text -only adapter which generates very clear, easy-to-read characters. It works only with monochrome monitor.

2. CGA - CGA or Colour Graphics Adapter works in both text and graphics mode. It supports both colour and monochrome modes with various resolutions. However, it has relatively poor display quality in text mode. A CGA adapter provides following two combinations of resolutions

    (i)   640 x 200 pixels with 16 colours.
    (ii) 320 x 200 pixels with 4 palettes.

Each of these palettes has 4 different colours. Only one palette can be used at a given time.

3. EGA- An EGA or Enhanced Graphics Adapter combines all features of a MGA & CGA with higher resolutions. It supports up to 16 colours at a time. An EGA usually has a high resolution of either 640 x 200 pixels or 640 x 350 pixels.

4. VGA - VGA or Video Graphics Adapter is a high quality graphics adapter which provides upto 256 colours and also a high resolution. Following are the two typical combinations of resolutions and colours that a VGA provides.

    (i)   640 x 480 pixels with 16 colours.

(ii)   320 x 200 pixels with 256 colours.

5.   SVGA- SVGA or Super Video Graphics adapter is an improvement on the VGA. The two combinations of resolutions and colours provided by SVGA are

(i)   640 x 480 pixels with 256 colours.

(ii)   1024 x 480 pixels with 16 colours

(b) Text and Graphics : Many display devices made today (principal exceptions are inexpensive terminals such as those used in dedicated transaction processing applications) can produce both text and graphics output. Text output is composed entirely of alphabetic characters, digits, and special characters. Graphics output includes such images as drawings, charts, photographs, and maps.

Display devices that are capable of producing graphics output commonly employ a method called **bit mapping**. Bit-mapped devices allow each individual pixel on the screen to be controlled by the computer. Thus, any type of image that can be formed from the rectangular grid of dots on the screen (for example, a 640-by-480 grid) is possible. Character-addressable devices are not bit-mapped and partition the screen into standard character widths- for example, a series of 5-by-7 dot widths - to display text.

Perhaps the most important business-related use for graphics is presentation graphics. Presentation graphics enable managers to easily construct such information-intensive images as bar charts, pie charts, and line charts on their display devices and have these images sent to a printer, plotter, or slide-making machine so that they can be used later for presentations in meetings. Because these types of graphical images are relatively simple, a super-high-resolution workstation that can display photographs and sophisticated artwork is not needed.

Graphics display devices have been widely used for many years in the engineering and scientific disciplines. The display devices used for applications in these areas are extremely sophisticated and expensive.

(c) CRT Versus Flat-Panel : Most of the display devices used today are of the cathode ray tube (CRT) type. These devices use a large tube-type element that looks like the picture tube in a standard TV set. Inside the tube is a gun that lights up the phosphorescent pixels on the screen surface. Although CRT technology is relatively inexpensive and reliable, CRT-type display devices are rather bulky and limited in the resolution that they provide.

Currently challenging the CRT in the display device marketplace is the flat-panel display. The most common of these devices use either a liquid crystal display (LCD) or gas-plasma technology. To form images, LCD devices use crystalline materials sandwiched between two panes of glass. When heat or voltage is applied, the crystals line up. This prevents light from passing through certain areas and produces the display. Gas-plasma displays, which provide

better resolution but are more expensive than liquid crystal displays, use gas trapped between glass to form images.

The biggest advantage of flat-panel displays is that they are lightweight and compact. This makes them especially useful for laptop, notebook, and pocket personal computers.

The Video Controller : As mentioned earlier, the quality of the images that a monitor can display is defined as much by the video controller as by the monitor itself. The video controller is an intermediary device between the CPU and the monitor. It contains the video-dedicated memory and other circuitry necessary to send information to the monitor for display on the screen. It consists of a circuit board, usually referred to simply as a card ("video card" and "video controller" mean the same thing), which is attached to the computer's motherboard. The processing power of the video controller determines, within the constraints of the monitor, the refresh rate, the resolution, and the number of colors that can be displayed.

During the 1980s, when most PCs were running DOS and not Windows, the screen displayed ASCII characters. Doing so took very little processing power, because there were only 256 possible characters and 2,000 text positions on the screen. Rendering each screen required only 4,000 bytes of data.

Windows, however, is a graphical interface, so the CPU must send information to the video controller about every pixel on the screen. At the minimum resolution of 640 480, there are 307,200 pixels to control. Most users run their monitors at 256 colors, so each pixel requires one byte of information. Thus, the computer must send 307,200 bytes to the monitor for each screen.

If the user wants more colors or a higher resolution, the amount of data can be much higher. For example, for the maximum amount of color (24 bits per pixel will render millions of colours) at 1024 768, the computer must send 2,359,296 bytes to the monitor for each screen.

The result of these processing demands is that video controllers have increased dramatically in power and importance. There is a microprocessor on the video controller, and the speed of the chip limits the speed at which the monitor can be refreshed. Most video controllers today also include at least 2 MB of video RAM, or VRAM. (This is in addition to the RAM that is connected to the CPU.)VRAM is "dual-ported," meaning that it can send a screenful of data to the monitor while at the same time receiving next screenful of data from the CPU. It's faster and more expensive than DRAM (Dynamic RAM) Users with larger monitors or with heavy graphics needs usually will want even more than 2 MB of VRAM.

1.2 DIRECT DATA ENTRY

Direct Data Entry (DDE) refers to entry of data directly into the computers through machine readable source documents. DDE does not require manual transcription of data from original paper documents. DDE devices can scan source documents magnetically or optically to

capture data for direct entry into the computer. Magnetic ink character readers and optical character readers are examples of such devices..

We will now describe each of the above devices.

1.2.1 Magnetic ink character recognition (MICR) : MICR employs a system of printed characters which are easily decipherable by human beings as well as a machine reader. There is used special printing font to represent characters. In this font, each character is basically composed of vertical bars (See "2" of Figure 1.2.1) The characters are printed in special ink, which contains a magnetizable material. In "2" of Figure 1.2.1 there are four small gaps and two big gaps.

PAY : ABC Distributing Company

One Hundred forty and fifty cents only

CODE No. OF THE BANK

A/ C NO. OF CUSTOMER

AMOUNT

CHEQUE USING MICR
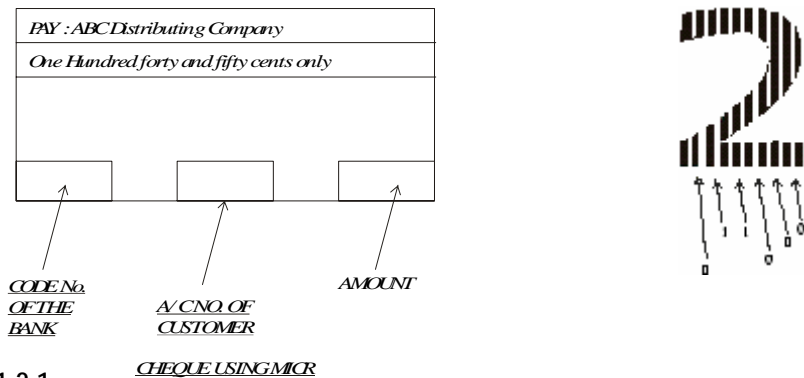
Fig. 1.2.1

When a character is subsequently read it is passed beneath a reading head and big and small gaps send in different types of impulses represented by 1 bit and 0 bit respectively.

This method is primarily used in banking industry, and most cheques are now processed under the MICR approach. The data printed across the bottom of a blank cheque are recorded in MICR form ; the characters represent the bank on which the cheque is drawn, the customer's account number and the amount of the cheque. The cheques themselves are prepared off-line. When they are originally printed by a printing press, the MICR about the bank identification number, as well as the data about the customer's bank account number are printed simultaneously. The cheques then are turned over to the proper bank customer for use. Once the cheques have been cashed or deposited in a bank, an operator uses an off-line encoding machine to encode the amount on the cheque's bottom-right side.

MICR data are used for input purposes. Unlike other media (floppy disk and magnetic disk), MICR can not be used for output purposes.

Advantages of MICR :

(*i*)   MICR possesses a very high reading accuracy. Cheques may be smeared, stamped, roughly handled yet they are accurately read.

(*ii*)   Cheques can be handled directly without transcribing them on floppy disk, magnetic tape etc.

(*iii*)   Cheques can be read both by human beings and machines.

Disadvantages of MICR :

(*i*)   MICR has not found much favour from business.

(*ii*)   Damaged documents, cheques not encoded with amount etc. have still to be clerically processed.

1.2.2 Optical character reading (OCR) : OCR also employs a set of printing characters with standard font that can be read by both human and machine readers. The machine reading is done by light scanning techniques in which each character is illuminated by a light source and the reflected image of the character is analysed in terms of the light-dark pattern produced. Key-board devices are used to give the required print quality. OCR has the potential of reading even handwritten documents straightway.

Optical character readers can read upper and lower case letters, numerics and certain special characters from handwritten, typed and printed paper documents. The specific characters that can be read and whether the characters must be handwritten, typed or printed depends upon the type of OCR being used. Obviously   OCR annihilates the time consuming step of transcription.

ABCDEFGHIJKLMN
OPQRSTUVWXYZ
1234567890

Fig. 1.2.2

The optical character readers have slightly irregular type face as shown in the figure1.2.2. They can read the characters printed by computer printers, cash registers, adding machines and typewriters. Some readers can also read hand-written documents. Figure 1.2.3 shows some handwritten characters that can be read by the recognition devices, most optical character readers can be used to sort out forms as well as to read data into computer storage.

Fig. 1.2.3

Large volume billing applications (*e.g.* the bills of utility companies, credit-card organisations, and magazine subscription outfits) increasingly are being adapted to OCR methods. The customer paying the bill returns the bill, which has OCR data (*e.g.* customer number and amount of the bill) recorded on it, along-with payment. Thus, the billing organisation's bill (or the part returned by the customer) becomes input for recording cash payments received from the customer. This procedure sometimes referred to as the use of "**turn-around documents**" has the advantage of minimizing or eliminating the keying process when cash receipts are received from customers.

Advantages of OCR

(i)   OCR eliminates the human effort of transcription.

(ii) Paper work explosion can be handled because OCR is economical for a high rate of input.

(iii) Since documents have only to be typed or handwritten, not very skilled staff (like the keypunch operators) is required.

(iv) Furthermore, these input preparation devices (typewriters etc.) are much cheaper than the keypunch or the key-to-tape devices.

Limitations of OCR

(i)   Rigid input requirements - There are usually specific (and rather inflexible requirements for type font and size of characters to be used. In typing there is always the scope for strike-overs, uneven spacing, smudges and erasures; and the form design, ink specifications, paper quality, etc. become critical and have to be standardized.

(ii) Most optical readers are not economically feasible unless the daily volume of transactions is relatively high. However, further developments in OCR are likely to make optical readers much cheaper.

OCR characters can be sent as input to the CPU. Also, printers can be used to generate OCR output. Optical character readers can read from both cut form and continuous sheets.

1.2.3. **Optical mark recognition (OMR) :** Optical marks are commonly used for scoring tests. The (Fig. 1.2.4) shows part (just the social security number in the U.S) of a typical test scoring sheet. It is marked by the person taking the test, and can be read by the optical mark page reader. The optical mark reader when on-line to the computer systems, can read up to 2,000 documents per hour. Seemingly this rate is slow but the fact that transcription has been eliminated, the overall time is less than those of the conventional file media.

OMR can also be used for such applications as order writing, payroll, inventory control, insurance, questionnaires, etc. However, it is to be noted that designing the documents for OMR is rather a tough task. They should be simple to understand otherwise errors may result more perhaps than would occur in using traditional source documents and keypunching from them.

<div align="center">

SOCIAL SECURITY NO.

4 6 8 4 6 8 3 2 4

0 0 0 0 0 0 0 0 0

1 1 1 1 1 1 1 1 1

2 2 2 2 2 2 2 2 2

3 3 3 3 3 3 3 3 3

4 4 4 4 4 4 4 4 4

5 5 5 5 5 5 5 5 5

6 6 6 6 6 6 6 6 6

7 7 7 7 7 7 7 7 7

8 8 8 8 8 8 8 8 8

9 9 9 9 9 9 9 9 9

Fig. 1.2.4

</div>

Technical details of optical scanning: In all optical readers, the printed marks and/or characters must be scanned by some type of photo-electric device, which recognises characters by the absorption or reflectance of light on the document (characters to be read are non-reflective) Reflected light patterns are converted into electric impulses, which are transmitted to the recognition logic circuit — there they are compared with the characters the machine has been programmed to recognise, and, if valid, are then recorded for input to the CPU. If no suitable comparison is possible, the document may be rejected.

1.2.4 Smart Card Systems- Smart cards resemble credit cards in size and shape; however, they contain a microprocessor chip and memory, and some include a keypad as well. These

were pioneered in France and many organizations are still just experimenting with them. In many instances, smart cards make it possible for organizations to provide new or enhanced services for customers.

So far, smart cards are used most frequently to make electronic purchases and to electronically transfer funds between accounts. However, the potential applications for these are abound. For example, in the health care industry, smart cards could be used to store the holder's identity, address, insurance data, relatives' details, allergies, and even a brief medical history. If the cardholder was disabled by an accident or illness, the card could be used immediately to assist with treatment. Smart cards could also be used for security applications. For example, a card could contain the digitized fingerprint of the cardholder, which could be compared at a security checkpoint to fingerprints of people who are authorized to enter a secured area.

1.2.5 Bar Code Reader : The most widely used input device after the keyboard and mouse is the flatbed or hand-held bar code reader commonly found in supermarkets and departmental stores. These devices convert the bar code, which is a pattern of printed bars on products, into a product number by emitting a beam of light – frequently a laser beam – which reflects off the bar code image. A light-sensitive detector identifies the bar code image by recognizing special bars at both ends of the image. Once the detector has identified the bar code, it converts the individual bar patterns into numeric digits. The special bars at each end of the image are different, so the reader can tell whether the bar code has been read right side up or upside down.
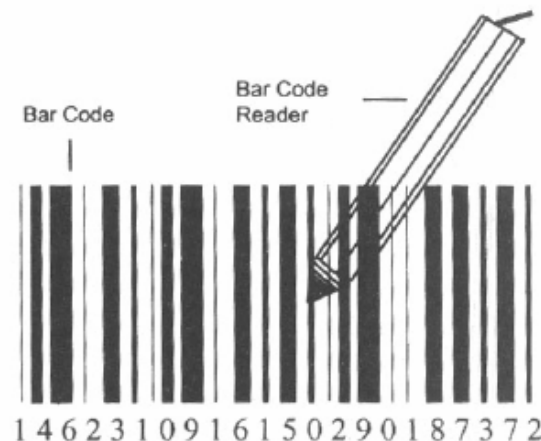
Fig. 1.2.5

After the bar code reader has converted a bar code image into a number, it feeds that number to the computer, just as though the number had been typed on a keyboard.

Bar codes provide the advantages of improved accuracy of data entry, better customer service through faster checkout at the point of sale, and greater control and reliability of inventory records. They are used in industries and organizations that must count and track inventory, such as retail, medical, libraries, military and other government operations, transportation facilities, and the automobile industry.

Two-dimensional (2D) bar codes have been developed that store the equivalent of two text pages in the same amount of space as a traditional UPC. One of the first uses of 2D bar coding was handing barrels of hazardous toxic waste. Now it is commonly used in a variety of industries. For example, every shipping carton sent to one of Wal-Mart's distribution centers must have a 2D bar code. The bar code contains the purchase order, stock numbers, the contents of each box, a product's origin, its destination, and how it should be handled during shipping. These bar codes automate many of the mundane and time-consuming shipping tasks.

1.2.6 Image Processing : Image Processing captures an electronic image of data so that it can be stored and shared. Imaging systems can capture almost anything, including keystroked or handwritten documents (such as invoices or tax returns), flowcharts, drawings, and photographs. Many companies that use document imaging are making significant progress toward paperless offices. There are five distinct steps to document imaging:

♦ *Step1:* **Data capture.** The most common means of converting paper documents into electronic images is to scan them. The scanning device converts the text and pictures into digitized electronic code. This scanner can range from a simple hand held device to a high-end, high-speed scanner capable of scanning more than 2,500 pages an hour. *Hand held scanners* could transform text or graphical images into machine-readable data. Organisations such as publishers and law firms, that frequently receive documents, may use such scanners to convert the typed pages into word processing files. These can also be used for entering logos and other graphics for desk top publishing application. Fax modems are also used to receive electronic images of documents. Some of today's low speed printers and fax machines have removable print heads that can be replaced with a scanning head, enabling the printer to work as an image scanner.

♦ *Step2:* **Indexing**. Document images must be stored in a manner that facilitates their retrieval. Therefore, important document information, such as purchase order numbers or vendor numbers, is stored in an index. Great care is needed in designing the indexing scheme, as it affects the ease of subsequent retrieval of information.

♦ *Step 3:* **Storage.** Because images require a large amount of storage space, they are usually stored on an optical disk. One 5.25-inch optical platter can store 1.4 gigabytes, or about 25,000 documents (equivalent to 3 four-drawer filing cabinets) A 12-inch removable

optical disk stores up to 60,000 documents, and up to 100 optical disks can be stored in devices called jukeboxes.

♦   *Step 4:* **Retrieval**. Keying in any information stored in an index can retrieve documents. The index tells the system which optical disk to search and the requested information can be quickly retrieved.

♦   *Step5:* **Output**. An exact replica of the original document is easily produced on the computer's monitor or on paper, or is transmitted electronically to another computer.

 Advantages of Image Processing : It has been estimated that 90% of the work accountants and others do today is done using paper. It is also estimated that the volume of information required by companies doubles every three or four years. As a result we are faced with being buried by paper. One solution is to make better use of document imaging. More companies are moving to this technology and it is estimated that by 2004 only 30% of our work will be paper-based; 70% will be electronic. The move to document imaging provides the following advantages:

(i)   Accessibility : Documents can be accessed and reviewed simultaneously by many people, even from remote locations.

(ii)   *Accuracy :* Accuracy is much higher because costly and error-prone manual data-entry processes are eliminated.

(iii) *Availability :* There are no more lost or misfiled documents.

(iv)   *Capacity:* Vast amounts of data can be stored in very little space, which significantly reduces storage and office space.

(v)   *Cost :* When large volumes of data are stored and processed, the cost per document is quite inexpensive. As a result, the costs to input, file, retrieve, and refile documents are reduced significantly.

(vi)   *Customer satisfaction :* When waiting time is significantly reduced (due to lost or misfiled documents, queue time, etc.), customers can get the information almost immediately.

(vii) *Security :* Various levels of passwords (network, data base, files, etc.) and clearances can be assigned to restrict document access.

(viii) *Speed :* Data can be retrieved at fantastic speeds. Stored documents can be indexed using any number of identifying labels, attributes, or keywords.

(ix)   *Versatility :* Handwritten or types text can be added to an image, as can voice messages. Documents can be added to word processing files; the data can be included in a spreadsheet or data base.

1.3 TYPES OF COMPUTER OUTPUT

The various types of output from a computer system may be chosen from the following list according to specific requirements :

- Printed;

- Visual display;
- COM(Computer Output on Microfilm);
- Audio;
- Magnetically encoded.
- Graphical

1.3.1 PRINTED OUTPUT : PRINTERS

Printer is one of the most common output devices. It provides the user with a permanent visual record of the data output from the computer. Printers can print on ordinary paper or on specially prepared forms such as dispatch notes, invoices or packing slips. Printers have been developed that are capable of printing from 150 to 2,500 lines per minute, each line consisting of as many as 150 characters. Printers can broadly be subdivided into two categories: impact and non-impact printers. The former are the most common.

1.3.1.1 Impact printers : Impact printers can be described as printers which utilize some form of striking device to transfer ink from an inked ribbon onto the paper being printed to form images or characters. The characters printed are formed by one of two methods : (*i*) they are either distinct, whole alphanumeric images produced by a process known as full character or formed character printer or, (*ii*) they are formed by a dot matrix method which arranges a series of dots to assume the shape of each character being printed.

Impact printers fall into two basic categories-Serial or line printing.

(a) Serial Printers : Regard less of which character generation method is used, serial printers print one character at a time, usually from left to right. Some printers, however, can also print in a bidirectional format at an increased speed. In most business organisations two types of serial printers are used :

(i) **Dot-matrix Printers :** In the early 1970's a new print system called dot matrix printing was developed for use with data processing systems. These small, compact printers offered high speed, relatively low price and greater programmability for graphics and illustrations due to their method of character generation. They became the standard printers for many minicomputers and nearly all microcomputers and, consequently, were also used for word processing requirements. Dot matrix printers utilise wire needles or pins which strike the ribbon against the paper in the pattern necessary to produce each character image. The printing head is a matrix block which consists of rows and columns of holes through which pins appear. The characters being printed are formed by

activating the printing head so that certain pins appear through the holes to from a pattern which resembles each character. The pins are formed into the shape of the character to be printed, then pressed against an inked ribbon and the pattern printed on the paper. The character, whether they are letters, numbers or grammatical symbols are printed as a series of dots which merge together to form the character.

The matrices of these printers can vary in size from printer to printer depending on the print quality required. Some may have 11 rows of pins with 9 columns in each row; while others may have as many as 23 rows with 18 columns per row. The characters can, therefore, be formed from matrices using any combination from 99 to 414 dots printed by the pins. The greater the number of dots printed on the paper, the better the quality of the copy. An example of how a lower case letter 'd' is formed is shown in Figure 1.3.1

```
0  0  0  0  0  0      0  0
0  0  0  0  0  0      0  0
0  0  0  0  0  0      0  0
0  0  0                0  0
0  0      0  0  0      0  0
0  0      0  0  0      0  0
0  0      0  0  0      0  0
0  0      0  0  0      0  0
0  0  0            0  0  0
```
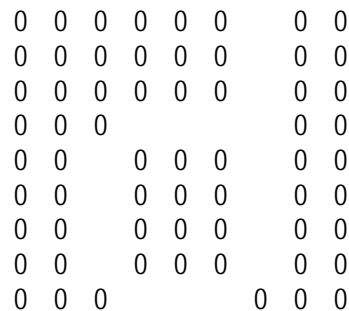
Figure 1.3.1 : Dot Matrix Character Formation.

Dot matrix printers are fast and cheap but their print quality is relatively poor. They are only really suitable for printing draft copies and documents, which are usually retained within an organisation. The printing also varies according to the type of matrix printer used. Most employ an ink ribbon, similar to conventional typewriter ribbons, to print documents. Although not of a high quality, when compared to letter quality printers, dot matrix printers do have the advantage of being able to print a much wider range and size of typeface and, in addition, can print graphs, illustrations and drawings. This type of printer can also be used to print colour.

Manufacturers of dot matrix printers include: Brother, Canon, Centronics, Commodore, Epson, Facit, General Electric, Hewlett Packard, Mannesheim Tally, NEC, OKI, Seikosha, Shinwa, Star, and TEC.

(ii) **Daisywheel Printers :** 'Daisywheel' printers work in a similar manner to an electronic typewriter. The major difference is that they use a new type of printing element called a 'daisywheel'. This is a molded metal or plastic disc-shaped printing element which looks very much like a daisy - hence the name. (See Figure 1.3.2) It is about 65 m.m. in diameter and has a number of stalks or petals which radiate from a central core. On the

end of each stalk is a type character set in a similar manner to the keys as on a typewriter. This type of printer works by rotating the print element until the required character is positioned in front of the sheet of paper at the point where it will be printed. A small hammer hits the back of the stalk forcing that character against an inked ribbon and through onto the paper. All this 'happens at anything from 10 to 80 characters per second, which is far faster than a typist can type. A similar device, shaped like and called a 'Thimble' printer is used by the Japanese company NEC on the 'Spinwriter " printer. There printers enable users to change the typeface elements very quickly giving far more scope to the typing of important documents.
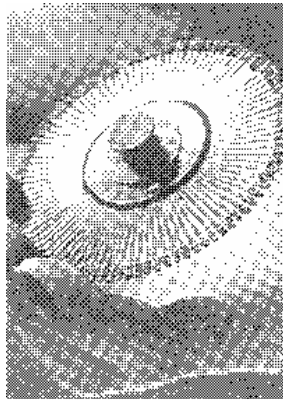
Figure 1.3.2 : The daisy wheel Printer

Quite recently cheaper daisywheel printers have appeared on the market. Major manufacturers of the daisywheel printers include: Brother, Data point, Diablo, Fujitsu, NEC, Olivetti, Olympia, TEC and Wang etc.

(b) Line Printers : A line printer operates at much higher speeds and prints what appears to be a full line at a time. Line printers are only used where high speed and volume is necessary and where quality is the lesser requirement. Two types of line printers are discussed belows :

 (i) **Chain Printers :** (Fig. 1.3.3) It has a chain that revolves at a constant speed in a horizontal plane. The complete chain has a complement of 48 numbers, alphabets and special symbols cast on 5 times over. It is confronted by a set of as many hammers as the number of print position say, 160. These hammers are magnetically controlled. The continuous stationery and ribbon are inter posed between a segment of the chain and the set of hammers. When a required character on the chain faces its print position, the corresponding hammer is actuated.

ONE SET OF 48 CHARACTERS

CHAIN

CHAIN MOVEMENT

CONTINUOUS STATIONERY & RIBBON

SET OF 132 HAMMERS

CHAIN PRINTER SCHEMATIC
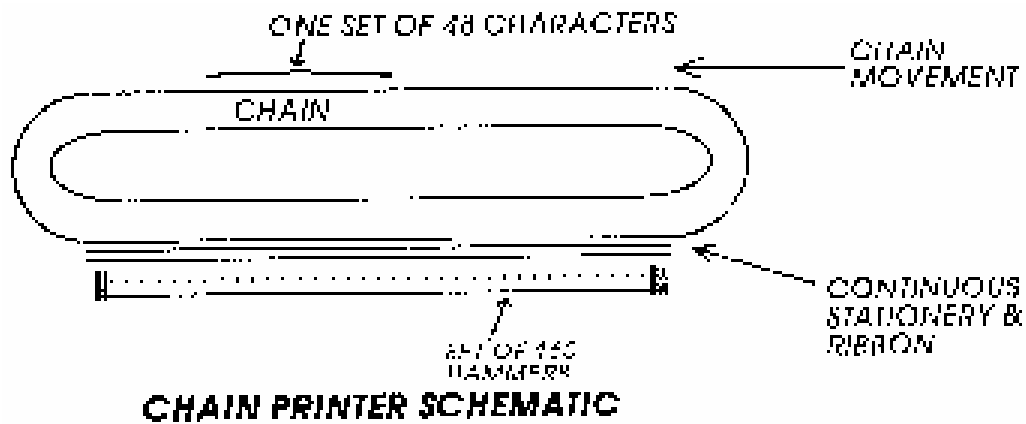
Fig. 1.3.3 : Chain Printer Schematic

DRUM PRINTER SCHEMATIC
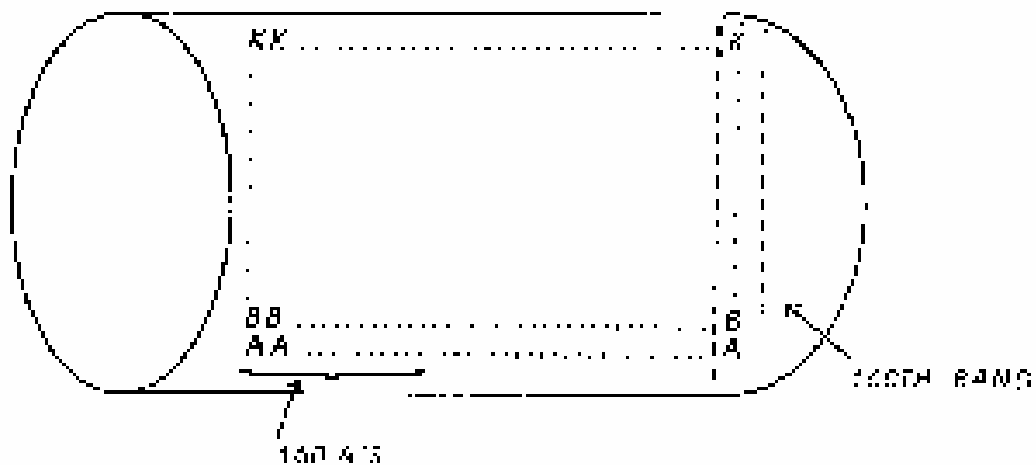
Fig. 1.3.4 : Drum printer schematic

(ii) Drum Printers : These printers use a solid cylinder. There are as many bands on it as the number of print positions. Each band has cast on it the complement of 48 numerals, alphabets and special characters. The drum rotates at a constant speed confronted by a set of as many hammers as the number of bands with the inked ribbon and continuous stationery interposed. In one rotation of the drum there would be appropriate strikes by the set of the hammers. In the first strike A's are printed in the appropriate print positions, followed by B,C,.......Z,0,1.........9 and special symbols one by one.

Various Characteristics of Printers

(i) *Speed* : The speed of a printer is measured in terms of cps (characters per second), lps (lines per second) or PPM (pages per minute) The speed of a dot-matrix printer is measured in CPS. While the speed can vary widely, it is generally 200 CPS. A line printer prints a line at a time. Its speed can be any where from 5 to 50 lps.

(ii) *Quality of output* : Depending on the type of characters formed, printers can be classified as draft, near letter quality (NLQ) or letter quality printers.

In a *draft quality printer,* a character is formed by arranging dots to resemble it. Although the characters can be distinguished, the output is not as good as that of near letter quality printouts. A dot-matrix printer is an example of a draft printer.

Near letter quality printers use a special character which resembles that of a typewriter. A daisy wheel printer is an example of a NLQ printer. Most dot-matrix printers can also be set to produce near - letter quality printouts.

Letter quality printers use a character set in which each letter or character is fully formed. The quality of output is the best in such printers. A *laser* printer discussed below is an example of a letter quality printer.

(iii) *Direction* : Printers can be unidirectional or bi-directional. In a unidirectional printer, printing takes place in one direction only. After printing a line from left to right, the print head returns to the left without printing. A bi-directional printer prints both ways.

1.3.1.2 Non-impact printers : A non-impact printer forms characters by chemical or electronic means. The non-impact printers are, however, not commonly used for the following reasons:-

(i)   Special and more expensive paper is required.

(ii)   Only one copy can be printed at a time.

(iii)   The print is not as sharp or clear as with the impact printer.

(iv)   Output is difficult to copy on office machines.

However, three types of non-impact printers are worth mentioning because they are expected to become more important in the future, as the technology becomes cheaper. These are *thermal printers, ink-jet printers* and *laser printers*. They are fast in operation, printing a page, or even more in a second but currently they are too expensive to be widely used. The laser printer produces very high quality prints from a wide selection of character fonts. Not many business organisations can justify the present high cost of laser printing but costs are falling sharply and laser printing is likely to become more common place. We have discussed below each of these briefly :

(i) **Thermal printers :** These printers use thermal printing facility i.e. the printer forms each character on the matrix printing head in the normal way but, instead of the printing head being impacted physically against an inked ribbon to print the character, the pins are heated by the electric element and then pressed against the paper. When the pins touch the paper, the area heated by the pins changes colour, usually to black or brown to form the character.

(ii) **Ink-Jet Printers :** This type of printers utilize the dot matrix principle but in stead of pins, set mechanically to form a character, it uses an array of nozzles which spray jets of ink onto the paper. When they first appeared; ink jet printers were very expensive but now a number of ink jet printers are beginning to find their way on to the market at fairly reasonable prices. An excellent example of such a printer is the Hewlett Packard″ Thinkjet″ originally developed for the Hewlett Packard HP 150 ″Touch-Screen″ microcomputer. HP 670C and HP 810C have now been made available for use with the IBM PC and other micro-computers.
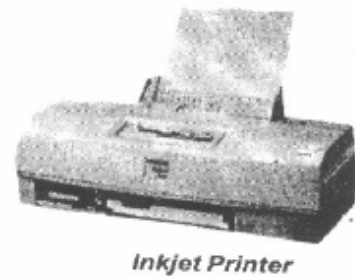
Fig. 1.3.5 : Inkjet Printer

Other examples include Canon′s PJ 1080 A, the Diablo C-150 and the Olivetti Spark Ink Jet Printer, which can operate at 50 lines per minute.

There are two types of inkjet printers:

Inkjet printers are very quiet and provide laser-like quality at a much lower cost although supplies are relatively expensive. Although one can print on regular paper, better results are obtained by using special paper that doesn′t allow the ink to soak in.

Liquid inkjet : Color inkjet printers use three separate inkjets, one for each of the primary colors (red, green, and blue)

Liquid inkjet printers use ink cartridges from which they spray ink onto the paper. A cartridge of ink attached to a print head with 50 or so nozzles, each thinner than a human hair, moves across the paper. The number of nozzles determines the printer′s resolution. A digital signal from the computer tells each nozzle when to propel a drop of ink onto the paper. On some printers, this is done with mechanical vibrations.

Solid inkjet : Solid inkjet printers use solid ink sticks that are melted into a reservoir and sprayed in precisely controlled drops onto the page where the ink immediately hardens. High- pressure rollers flatten and fuse the ink to the paper to prevent smearing. This

produces an exceptionally high-quality image with sharp edges and good colour reproduction. Solid inkjet printers are also the best for producing low-cost but high-quality transparencies. These printers are sometimes referred to as phase-change printers because the ink moves from a solid to a liquid phase to be printed then back to a solid phase on the page. As a final step, the paper moves between two rollers to cold-fuse the image and improves the surface texture.

(iii) Laser Printers : Laser printer uses a combined system which utilizes laser and Xerographic photocopying technology. In a laser printer, a beam from a small laser scans horizontally across a charged xerographic selenium drum to build up an invisible electrostatic image of a whole page of text. Using standard photocopier techniques, the formed image is then transferred to the paper being printed. Toner is attracted to the electrostatic image and it is then permanently fixed using heat. A wide variety of

Fig. 1.3.6 : Laser Printer

typefaces are available. Very competitively priced laser printers have been introduced by various companies such as Hewlett Packard. These printers, which can be used by most personal computers and the microcomputers, have an excellent print quality. Laser printer produces not only alphanumeric characters but also drawings, graphics and other requirements. Its output can be very close to professional printing quality. The dots making up the image are so closely spaced that they look like characters typed on a typewriter. The laser printer prints a page at a time. Its speed can be anywhere between 4 to 17 pages per minute (ppm) The resolution of laser printers is measured in dots per inch (DPI) The most common laser printers have resolutions of 600 DPI, both horizontally and vertically. Some laser printers have a resolution of 1200 DPI also.

Laser printer features : Even with the best printers, there are differences that affect their use. These include the number of sides the printer prints on, its memory, and its fonts.

Duplex printers print on both sides of a sheet of paper at the same time. This duplex printing is ideal for documents that will be stapled or bound.

Laser printers make up an entire page before printing it. The page is temporarily stored in the printer's memory while it is being processed and printed. If a page contains a graphics image, the memory required for it can be substantial. For example, it takes 1 megabyte to store a full-page black-and-white graphics image that is to be printed with a 300-dpi resolution. To fill the page, the printer has to address over 8 million dots (1 megabyte x 8 bits = 8 million bits) This is obviously a big chore.

All laser printers come with some built-in fonts; however thousands of others can be added. At one time, these were added using plug-in cartridges. Currently they are built-in or distributed on disks and installed onto the system's hard disk drive. From there they are fed to the printer when needed.

1.3.2 COMPUTER OUTPUT MICROFILM (MICROFICHE)

Computer output microfilm (COM) is an output technique that records output from a computer as microscopic images on roll or sheet film. The images stored on COM are the same as the images, which would be printed on paper. The COM recording process reduces characters 24, 42 or 48 times smaller than would be produced from a printer. The information is then recorded on sheet film called 16 mm, 35 mm microfilm or 105 mm microfiche.

The data to be recorded on the microfilm can come directly from the computer (online) or from magnetic tape, which is produced by the computer (off-line) The data is read into a recorder where, in most systems, it is displayed internally on a CRT. As the data is displayed on the CRT, a camera takes a picture of it and places it on the film. The film is then processed, either in the recorder unit or separately. After it is processed, it can be retrieved and viewed by the user.

COM has several advantages over printed reports or other storage media for certain applications. Some of these advantages are (1) Data can be recorded on the film at up to 30,000 lines per minute-faster than all except very high-speed printers: (2) Costs for recording the data are less. It is estimated that the cost for printing a 3-part 1,000 page report as quoted by "Shelly and Cashman" is approximately $28.00, whereas the cost to produce the same report on microfilm is estimated to be approximately $3.11; (3) Less space is required to store microfilm than printed materials. A microfilm that weighs an ounce can store the equivalent of 10 pounds of paper: (4) Microfilm provides a less expensive way to store data than other media provide. For example, it is estimated that the cost per million characters (megabyte) on a disk is $20.00, while the cost per megabyte on microfilm is $6.5.

To access data stored on microfilm, a variety of readers are available which utilize indexing techniques to provide a ready reference to data. Some microfilm readers can perform automatic data lookup, called computer-assisted retrieval, under the control of an attached minicomputer. With powerful indexing software and hardware now available, a user can usually locate any piece of data within a 200,000,000 characters data base in less than 10 seconds at a far lower cost per inquiry than using an on-line inquiry system consisting of a CRT, hard disk, and computer.

Though both microfilm and microfiche are created on a continuous negative film and one can make as many copies of the film as one desires, there are certain basic differences between the two. The Physical difference between a microfilm and microfiche is that a microfilm stays in a continuous form while a microfiche is cut into pieces. A microfilm is 16 millimeters (mm) or

35 mm roll of film contained in cartridges. Each roll can hold 2,000 to 5,000 pages of information. A microfiche, on the other hand, is 105-mm film cut in 4 × 6 inch sheet, each sheet capable of reproducing upto 270 page sized images. The operational difference between the two is that a microfilm has to be read sequentially until the desired record is retrieved whereas a microfiche allows direct access to data through hunt and storage procedure.

For certain applications, COM is a viable way to store and retrieves data.

1.3.3 MICROPHONES AND VOICE RECOGNITION

Now that sound capabilities are a standard part of computers, microphones are becoming increasingly important as input devices. Sound is used most often in multimedia, where the presentation can benefit from narration, music, or sound effects. In software, sounds are used to alert the user to a problem or to prompt the user for input.

For this type of sound input, basically a digitized recording is required. All that one needs to make such a recording are a microphone (or some other audio input device, such as a CD player) and a sound card that translates the electrical signal from the microphone into a digitized form that the computer can store and process. Sound cards can also translate digitized sounds back into analog signals that can then be sent to the speakers.

There is also a demand for translating spoken words into text, much as there is a demand for translating handwriting into text. Translating voice to text is a capability known as **voice recognition** (or speech recognition) With it, one can speak to the computer rather than having to type . The user can also control the computer with oral commands, such as "shut down" or "print status report".

Voice recognition software takes the smallest individual sounds in a language, called phonemes, and translates them into text or commands. Even though English uses only about 40 phonemes, a sound can have several different meanings ("two" versus "too," for example) making reliable translation difficult. The challenge for voice distinguish meaningful sounds from background noise.

Sound Systems : Just as microphones are now important input devices, speakers and their associated technology are key output systems. Today, when one buys a multimedia PC, one gets a machine that includes a CD-ROM drive, a high –quality video controller (with plenty of VRAM), speakers, and a sound card.

The speakers attached to these systems are similar to ones that are connected to a stereo. The only difference is that they are usually smaller and they contain their own small amplifiers. Otherwise, they do the same thing that any speaker does: they transfer a constantly changing electric current to a magnet, which pushes the speaker cone back and forth. The moving speaker cone creates pressure vibrations - in other words, sound.

The more complicated part of the sound output system is in the **sound card**. The sound card translates digital sounds into the electric current that is sent to the speakers. Sound is defined as air pressure varying over time. To digitize sound, the waves are converted to an electric current measured thousands of times per second and recorded as a number. When the sound is played back, the sound card reverses this process, translating the series of numbers into electric current that is sent to the speakers. The magnet moves back and fourth with the changing current, creating vibrations.

With the right software, one can do much more than simply record and play back digitized sound. Utilities that are built into Windows 95 provide a miniature sound studio, allowing the user to view the sound wave and edit it. In the editing one can cut bits of sound, copy them, amplify the parts one wants to hear louder, cut out static, and crate many exotic audio effects.

1.3.4 GRAPH PLOTTER

A graph plotter is a device capable of tracing out graphs, designs and maps into paper and even into plastic or metal plates. A high degree of accuracy can be achieved, even upto one thousandth of an inch. Plotters may be driven *on-line or off-line*. Computer systems dedicated to design work often operate plotter on-line but systems used for other applications as well as graphic applications operate them off-line.

There are two types of plotters, drum and flat-bed. A drum plotter plots on paper affixed to a drum. The drum revolves back and forth, and a pen suspended from a bar above moves from side-to-side taking up new plot positions or plotting as it moves. This device is suitable for routine graph plotting and also for fashion designs.

On a flat-bed plotter, the paper lies flat. The bar on which the pen is suspended itself moves on a gantry to provide the necessary two-way movement. Colour plotting is usually possible.

Plotters are now increasingly being used in application like CAD, which requires high quality graphics on paper. A plotter can be connected to a PC through the parallel port. A plotter is more software dependent than any other peripheral, and needs much more instructions than the printer for producing output.

Many of the plotters now available in the market are desktop models that can be used with PCs. Business generally use plotters to present an analysis in visual terms (bar charts, graphs, diagrams) etc. as well as for engineering drawings.
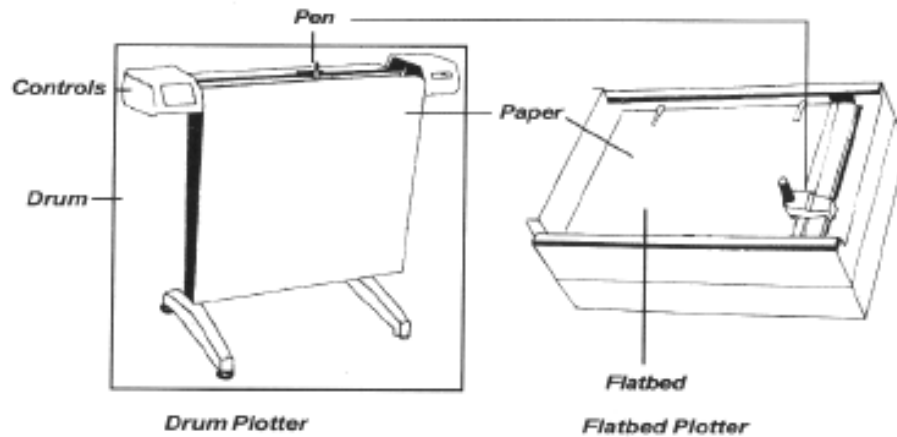
Fig. 1.3.7 : Graph Plotter

SELF-EXAMINATION QUESTIONS

1. Write short notes relating to computer input and data capture.

2. Write brief notes on the following techniques and describe the situation in which each technique would be used :—

    (i)   Optical Character recognition (OCR)

    (ii) Magnetic Ink Character Recognition (MICR)

    (iii) Optical Mark Reader (OMR)

    (iv) Image Scanners.

    (v)   Bar Codes

3. List the types of terminals which may be used for computer input.

4. What purpose do terminals serve ?

5. VDU (Visual display unit) and key-board-printer units are widely used as terminals to multiaccess systems. Give one example for each device where it is preferable to use it. Give reasons for your choice.

6 . Explain the differences between a dumb terminal and an intelligent terminal.

7. Summarise the different methods of producing computer output.

8. Distinguish between impact printers and non-Impact printers.

9. List the main features of a dot matrix and a daisy wheel printer.

10. Write short notes on laser printer and an ink-jet printer.

12. Write short notes on chain printer and a drum printer.

13. Explain the following terms:-

   (*i*) Computer Output Microfilm.

   (*ii*) Graph Plotter.

   (*iii*) Voice recognition.

UNIT 3 : SOFTWARE

WHAT IS SOFTWARE ?

The word "software" has been coined to differentiate between the computer equipment (*i.e.,* the hardware) and the means of controlling the equipment, the latter having been termed "Software". Although in early days of the computer only standard programs supplied by the computer manufacturers were called the software, the term, now-a-days, has a much wider meaning and is also inclusive of programs developed by the user or procured by him from an organisation dealing in software, and the associated policies and procedures.

There is a definite trade off relationship between the hardware represented by the CPU and the software represented by the programs. Whatever is programmed can also be directly embedded in the computer circuitry. For example, the computations of square root are ordinarily incorporated in the computer program. They could also be alternatively provided for in the CPU circuitry so that with just one instruction the square root of any number is got. But this alternative is highly expensive in terms of initial investment. It can only be justified if the square roots were to be derived in an enormously large number, in some scientific application perhaps as an example. As we shall see later only simple arithmetic/logic operations (like add, subtract, multiply, divide) are provided for in the CPU circuitry so that these are performed in just one instruction each as they are all too frequent in both business and scientific applications. Nevertheless, the trade-off relationship is of theoretical interest.

There are basically three types of software : Systems software, applications software and general-purpose software. We will now discuss each of these in detail.

1.1 SYSTEMS SOFTWARE

It comprises of those programs that control and support the computer system and its data processing applications. It includes the following:

- Programming languages.
- Operating systems.
- Subroutines.
- Utility programs.
- Diagnostic routines.
- Language translators.

A broad spectrum of the above software is usually available from the manufacturer, but some software is also available from software concerns. There is generally an extra charge for software but some manufacturers furnish software without extra cost for those who purchase or lease their equipment. We will now describe each of the aforesaid software in detail.

1.1.1 PROGRAMMING LANGUAGES

The programming languages are part of the software or programming aids provided by the manufacturer. A programming language is a language used in writing programs to direct processing steps to be carried out by a computer.

A wide variety of computer programming languages are available. The programmer must be familiar with one or more of them in order to write a computer program. Each programming language has very specific standards and rules of use, which the programmer must know and adhere to when developing a program. The programming languages can be hierarchically divided as follows.

Hierarchy of programming languages

(A) **Machine Language or First Generation Languages :** In the early days of computer, all programs were written in machine codes. Each particular computer model has a machine language, which is based on the internal engineering architecture of the equipment, and which is developed and provided to user by the computer manufacturer. Simply a machine level language is the language of the computer, the only language the computer understands without translation. If such a language is used in writing a program (say a user's payroll program), the programmer must be familiar with the specific machine-level language as well as with the details of the computer equipment to be used. Programs written in machine-level language can only be used on the computer model for which that language is written. That is why this language is called machine-oriented.

Writing programs in machine language is not only difficult for humans to do but is also subject to error. This will be more clear below. In attempt to facilitate human programming and to eliminate human errors, assembly language, which is very close to machine language was designed. As we shall see later, the assembly language assists the programmer in writing fairly error-free programs with far less labour and also as much suit the design of the machine on hand as its machine language. The procedural languages are completely oriented to ease up the programmer's task but disregard the machine design entirely.

The earlier machine language employed the binary code *i.e.,* the instructions were codified in series of 1's and 0's in accordance with the bit pattern of the instruction to be performed. The binary code is now being abandoned in favour of the decimal code which is far more easy for the programmer and therefore, we shall not pursue the binary code any more.

The computer manufacturer supplies a manual of the codes for the various operations which are unique to that computer.

An example on some of the codes for a computer and use of these codes to write instructions in its machine languages follows :

Operation Code

Add the contents of two locations	10	00
Add a constant to the contents of a location	10	01
Subtract contents of one location from those of another	11	00
Subtract a constant from the contents of a location	11	01
Multiply the contents of two locations	12	00
Multiply the contents of a locations by a constant	12	01
Divide the contents of a location by those of another	13	00
Divide the contents of a location by a constant	13	01
Transfer (copy) the contents of a location into another location	22	00
Transfer (copy) partially the contents of a location into another	22	10
Zeroise the contents of a location	23	00
Compare the contents of two locations and branch if...	21	00
Jump to such and such instruction	20	00
Print the contents of a location etc. etc.	33	00

Either the programmer should refer continually to such a chart or, as it happens with practice, should memorize these codes. Both of these are however, cumbersome and error-prone

(B) **Assembler Languages or Second Generation Languages :** *Assembler Languages* are at the next level in improvement over the machine languages. They are also known as symbolic languages because they employ symbols for both arithmetic and logical operations and even location addresses. The above instruction (033) may be written as ADDC 001 Counter 001 Counter. ADDC is add a constant. Such standard symbols for the various operations are supplied by the computer manufacturer who creates the assembly language for his computer. Counter is the name given to location 353 by the programmer.

Since mnemonic symbols are being used, this eases up the programmer's task greatly. But the computer follows its machine language only and the program written in the assembler language has to be translated. This is accomplished by a special program usually supplied by

the computer manufacturer and known as the *assembler.* The assembler simply translates each instruction in symbolic language to its machine language equivalent. Thus, there is a one-for-one correspondence between the two languages. Another advantage possessed by the assembly language is that of flexibility. Towards explanation of this, consider a program written in a machine language and consisting of 980 instructions. If the programmer, upon an after thought, wishes to insert another couple of instructions he would have to alter the entire program. Although it is possible to save a great deal on alterations by programming jugglery, it is not only cumbersome but also liable to errors. If a program is written in an assembler language the extra instructions can be inserted wherever desired without any reprogramming, on the existing instructions. Both the machine and assembler languages posses a definite advantage over the procedural languages discussed below.

Advantages and disadvantages of assembler language

The principal advantage of assembler language is that a program can be written which is very efficient in terms of execution time and main memory usage. This is so because nearly every instruction is written on a one-for-one basis with machine language. In addition, assembler language has a full range of computer instructions that allow a programmer to manipulate individual records, fields within records, characters within fields, and even bits, within bytes.

Further since programs written in assembly language are machine oriented, the programmer can write the programs that suit the capabilities of the computer at hand *i.e.,* the program would occupy the minimum storage and take less processing time as compared to the one in procedural languages.

There are several significant **disadvantages** of assembler language. First, because assembler language reflects the architecture of the computer on which it is used, there is little compatibility between the assembler languages used with various computers. Thus, a program coded in assembler language for one computer will not run on a computer of a different manufacturer unless the internal design is exactly the same.

Additionally, an assembler language programmer will normally have to write a large number of statements to solve a given problem than will a programmer using other high-level programming languages. Also, because of the concise symbolic notation used in assembler language, assembler language programs are often more difficult to write, read and maintain than programs written in high-level languages.

Assembler languages are not normally used to write programs for generalized business application software such as payroll, account receivable, billing, and similar applications. Other languages are available that are more appropriate for programming these types of applications. Assembler language is commonly used where fast execution is essential. For example, with personal computers the actual prewritten application software to generate graphics on a screen is commonly written in assembler language.

(C) Compiler languages (High-level-languages) or Third Generation Languages :
Compiler languages are also known as high level languages or procedural languages. They are procedure oriented (*viz.,* a business application oriented language COBOL and a scientific application oriented language FORTRAN. They employ plain English like and mathematical expressions. They are detached from the machine design and therefore the nomenclature 'High level' Languages. Since they are procedure oriented and detached from the machine design, instructions of these languages may be equivalent to more than one instructions in a machine language. An instruction in these languages is usually called a statement.

A computation X+Y=Z would be written as below in FORTRAN (Formula Translation and COBOL (Common Business Oriented Language) This example is intended to bring out the similarity between the statements of these languages to plain English and mathematical expressions.

FORTRAN :   Z = X + Y   X, Y, Z designate

COBOL :   COMPUTE   Z = X + Y   storage locations.

Whereas each computer has its own machine language and assembly language devised by its manufacturer, the compiler languages are universal.

Since these languages employ plain English and mathematical expressions, it is easy to learn and write relatively error free programs. This is further facilitated because of the fact that the programs written in them are much more compact than those in the low level (machine and assembly) languages. But they have to be translated to the machine language for the computer on hand which is accomplished by an especial program known as the **compiler**, written and provided by the computer manufacturer. It usually occupies more storage space and requires more processing time than the assembler. It however, also possesses the diagnostic capabilities. Thus, programs written in high-level language are cheaper than the low level languages in terms of learning and writing programs but this advantage is offset to an extent by more time on translation. Usually, therefore, an organisation would write frequently used programs in low level language and infrequently used programs in high level languages provided of course, they are not constrained to favour one of them in view of available programmers being skilled in only that one.

Besides FORTRAN and COBOL there are several more high-level languages such as BASIC, PASCAL and C-language etc.

(D) **The Fourth Generation Languages (4GLs)** : The trend in software development is toward using high level user friendly Fourth Generation Languages (4 GLs) There are two types of 4GLs :

(i) *Production Oriented 4GLs* - Production-Oriented 4GLs are designed primarily for computer professionals. They use 4GLs such as ADR's, Ideal, Software AG's Natural 2, and Cincoms Mantis to create information systems. Professional programmers who use 4GLs claim productivity improvements over Third Generation procedure oriented languages such as (COBOL, FORTRAN, BASIC and so on) of 200% to 1000%.

(ii) *User Oriented 4GLs* - This type of 4GLs is designed primarily for end users. Users write 4GL programs to query (extract information from) a database and to create personal or departmental information systems. User-oriented 4GLs include Mathematical Products Group's RAMIS-II and Information Builders' FOCUS.

Prior to Fourth Generation Languages, in case a person required access to computer based data, he had to describe his information needs to a professional programmer, who would then write a program in a procedure-oriented language like COBOL or PL/1 to produce the desired results.Fulfilling a typical user request would take at least a couple of days and as long as few weeks. By then the desired information might no longer be needed. With 4GLs, these *ad hoc* requests or queries can be completed in minutes. When 4GLs are available, many users elect to only handle their own needs without involving computer professionals at all. With a day or so of training and practice, a computer-competent user can learn to write programs, make enquiries and get reports in user oriented 4GLs. 4GLs use high level English like instructions to retrieve and format data for enquiries and reporting. Most of the procedure portion of 4GL program is generated automatically by the computer and the language software.

The features of a 4GL include English like instructions, limited mathematical manipulation of data, automatic report formatting, sequencing (sorting) and record selection by the user given criteria. However, 4GLs are less efficient than third generation languages. 4GLs require more computer capacity to perform a particular operation and users end up fitting their problems to the capabilities of the software. Large programs that support many simultaneous on-line users are better handled by a 3GL or an assembly language. When being executed, 4GL programs often consume significantly more machine cycles than 3GL program that perform the same task. This may result in slow response time. Faster and more powerful processors, along with 4GL product refinement, are likely to compensate for these deficiencies over time. However, managers should carefully consider both advantages and disadvantages of 4GL programs before deciding whether the organisation should adopt them on a wide scale.

Third-Generation Languages (3GLs)	Fourth-Generation Languages (4GLs)
Intended for use by professional programmer	May be used by a non-programming end- programmers end user as well as a professional programmer
Require specification of how to perform the task	Require specification of what task to perform (system determines how to perform the task
Require that all alternatives be specified	Have default alternatives built in; end user need not specify these alternatives
Require large number of procedural instructions	Require far fewer instructions (less than one-tenth in most cases)
Code may be difficult to read, understand and maintain	Code is easy to understand and maintain because of English-like commands
Language developed originally for batch operation	Language developed primarily for on-line use
Can be difficult to learn	Many features can be learned quickly
Difficult to debug	Errors easier to locate because of shorter programs, more structured code, and use of defaults and English-like language
Typically file-oriented	Typically data base oriented

(E) Object -Oriented Languages and Programming: With traditional programming approaches, developing a new program means writing entirely new code, one line at a time. The program may be hundreds of thousands of lines long and can take years to complete. Since each program is written from scratch, quality is often poor, productivity of programmers is low, and programs are usually behind schedule. When program modifications are needed, the code must be rewritten and tested. As programs become longer and more complex, achieving a reasonable quality level becomes a formidable task.

One solution to these problems is a new way of developing software using an object-oriented language (OOL) An object is a predefined set of program code that, after having been written and tested, will always behave the same way, so that it can be used for other applications. All

1.86

programs consist of specific tasks such as saving or retrieving data and calculating totals. In object-oriented programming, an object is written for each specific task and saved in a library so that anyone can use it.

Using object-oriented programming (OOP), objects are combined and the small amount of code necessary for finishing the program is written. Rather than writing a program line by line, programmers select objects by pointing to a representative icon and then linking these objects together. Objects can be modified, reused, copies, or created. When an object is updated, all programs using that object can be automatically updated as well.

These objects are then sent messages telling them what to do; the objects complete the task accordingly. For example, selecting an object that looks like a fax machine would mean that data are to be sent by fax. This programmer-machine interface is more natural, powerful, and easy to understand and use than more traditional methods.

The advantages of OOP are its graphical interface, ease of use, faster program development, and enhanced programmer productivity (up to tenfold increases) The programs produced by OOP are more reliable and contain fewer errors, since the modules being used have already been extensively tested. Its disadvantages are its steep initial development costs and a more extensive start-up time. OOP produced large programs are slower, and use more memory and other computer resources than traditional methods. As a result, it requires power PCs and workstations. Investing in OOP is cheaper than hiring additional programming staff, however, and the increase in productivity makes up for the additional costs. Many companies are moving to OOP. Adherents of OOP claim that the future software market will deal in objects rather than in software packages. In other words, software applications will be sold as collections of objects. Eventually a do-it-yourself software situation will result that has users purchasing the necessary objects from a computer store, assembling them, and adding a little coding to tie up loose ends. Some common object-oriented languages are small talk, C++ , Visual Basic, and Java.

1.2 OPERATING OR (EXECUTIVE) SYSTEMS

Considerable time is ordinarily wasted in computer set ups supervised by the operator. During compilation/assembly run time required to input the magnetic tape consisting of (the main program and sub-routines, etc.) is substantial and would naturally be pinching. Likewise several application programs (*viz.* inventory control, A/c receivables, etc.) would be read into the CPU in turn every day or so. This too, eats into the working time of the computer. Thus time reduction can be had by maintaining all the programs (including utility programs, assemblers, compiler, etc.) in the backing storage, which may be more commonly, of hard disk but inter-linked with main memory. The required program can be recalled into the CPU far more quickly than in ordinary systems where computer is especially set up for each application run or assembly/compilation run etc.-saving considerable time on set ups.

Besides, the operating systems work in multi-programming mode.

Operating Systems are devised to optimize the man-machine capabilities. Programs are held permanently in the computer memory freeing thereby the operator from inputting a program for each application. The operating systems are also known as "executive systems". "Control systems" and "monitor systems". Formally, an operating system may be defined as an integrated system of programs which supervises the operation of the CPU, controls the input/output functions of the computer system, translates the programming languages into the machine languages and provides various support services. The operating systems are based on the concept of modularity. The operating systems are usually the creation of the computer manufacturers who design these to suit the capabilities of the particular computer. It would be extremely difficult for the user to design, write and test operating system in view of the limited *brainware i.e.,* (systems analysts, programmers, etc.) These operating systems have acquired unique individualities and have their own names.

The CPM operating system was developed for 8-bit microprocessors. MS-DOS is a operating system for 16-bit developed by Microsoft and adopted by IBM for IBM-PC. However, of late many operating systems such as UNIX, Windows-95, Windows-98, Windows-2000, and OS/2 Wasp etc., have been developed which are portable. For example, versions of UNIX operating system can be used on personal computers, mini-computers and mainframes. Many more operating systems are coming into the market, which can be transported, from one system to another. It is a fact that the capabilities of the operating systems are far too numerous to be economically exploited by an average organisation. As a result, they tend to be white elephants. A great deal of memory remains occupied by the sophisticated programs.

There are six basic functions that an operating system can perform

(*i*) *Schedule Jobs:* They can determine the sequence in which jobs are executed, using priorities established by the organisation.

(*ii*) *Manage Hardware and Software Resources:* They can first cause the user's application program to be executed by loading it into primary storage and then cause the various hardware units to perform as specified by the application.

(*iii*) *Maintain System Security:* They may require users to enter a password - a group of characters that identifies users as being authorised to have access to the system.

(*iv*) *Enable Multiple User Resource Sharing:* They can handle the scheduling and execution of the application programs for many users at the same time, a feature called multiprogramming.

(*v*) *Handle Interrupts* : An interrupt is a technique used by the operating system to temporarily suspend the processing of one program in order to allow another program to be executed. Interrupts are issued when a program requests an operation that does not

require the CPU, such as input or output, or when the program exceeds some predetermined time limit.

(*vi*) *Maintain Usage Records* : They can keep track of the amount of time used by each user for each system unit - the CPU, secondary storage, and input and output devices. Such information is usually maintained for the purpose of charging users' departments for their use of the organisation's computing resources.

1.2.1 Locations & Functions

Location : The code which forms the OS of a computer is usually stored externally in a series of program files on the computer's hard disk/ external memory. However, because of their size (most modern computer OSs run into literally millions of lines of code), developers have found it necessary to structure OSs so they do not swamp the computers operating them. OSs are, therefore, usually engineered to operate in sections which page in and out of the computer's own memory/processors as and when needed.

The reason for this is practical economics. For example it would add greatly to the cost if a computer was designated so that its internal memory could accommodate the whole of the OS all at once, and it would also be a pointless exercise as many OS functions are only required on an occasional basis.

The type of OS routines that fall into this occasional category are sometimes called external OS procedure/file(s) A good example would be a file recovery program (basically a program which returns to 'situation normal' after complications) This type of routine is usually a sophisticated application which can take up a considerable part of the computer's internal memory. To maximize the efficiency of the computer, the file recovery routine is only loaded into the computer's internal memory as and when it is needed.

It should be noted that some parts of the OS must be loaded and running all the time. Programs falling into this category include instructions facilitating the transfer of keyboard commands or the relaying of information to the computer's peripheral devices. The files enabling these basic functions are usually called internal OS procedure/ file(s)

Functions : There is a wide range of Oss available for various computer systems providing a host of different services. However, there is a certain group of functions common to most modern Oss. These include function to control:

♦ User interface
♦ Peripheral devices
♦ File management
♦ Memory management
♦ Network facilities
♦ Program scheduling

♦ Fault monitoring

♦ Virus checking

1.2.2 Files and Directories : OSs function at two different levels, the hardware level and the user level. The interaction of the OS with the computer's hardware level is, for the most part, hidden from the user. For example, signals relayed from the keyboard to the computer's microprocessor are done automatically, under the control of the OS, and without further recourse to instructions from the user.

Even so, the user will, at some stage or another, wish to install programs/ applications, copy files, perform search routines or execute any one of a wide and ever-increasing range of tasks. In order to carry out these procedures, the user has to access and operate an appropriate user interface. However, before doing so, the user should have an appreciation of the significance of files and directories at the operating system level.

File names : A file is a collection of related data, saved on a specific area of the surface of whatever storage medium the system is using. To be accessed, the file must have a name which is recognised by the system. The name is also significant in that it is usually an indication of purpose of the file and the type of data stored in the file.(It should be pointed out that OSs such as Windows 95 and Windows NT place greater emphasis on small icons as a means of identifying the nature and type of a particular file.) For most OSs the file usually has two names. These are known as the prefix and the suffix/ extensions. The prefix is supplied by the user. The suffix is supplied by either the user or the computer application currently being used.

The prefix is frequently separated from the suffix by a full stop or a slash. For example, in a DOS or Windows environment, the file LETTER.TXT would suggest that it is a letter file containing text data. Below is a listing of some typical DOS/ Window file names with appropriate suffixes indicating their contents:

File Name	Data Type
PAY.BAS	Basic program (.BAS - Basic)
COMP.WKS	Spreadsheet data file (.WKS -Worksheet)
ACC.CBL	Cobol program(.CBL - Cobol)
FRED.DAT	Simple data file (.DAT-Data)
SAVE.BAT	Batch file (.BAT -Batch file)
NOTE.TXT	Text file (.TXT - Text)
LETTER.DOC	Document file (.DOC - Document)
MENU.EXE	Executable file (.EXE - Executable)
PROG.COM	Command file (.COM - Command)
REG.DBS	Database file (.DBS - Database)
PIC.IMG	Image file (.IMG - IMAGE)

Directories : A directory is like a drawer in a filing cabinet. It contains files. In addition, just as a filing cabinet usually consists of multiple drawers, similarly a computer disk usually contains multiple directories. A directory can, if necessary, also contain other directories. The purpose of directories is to enable the user to partition the computer's disk/storage devices in an organised and meaningful manner.

1.2.3 Graphical User Interfaces - Through the 1980s, micro computer's operating system was strictly text-based, command driven software *i.e.* the users were required to issue commands to the operating system by entering them on the key board, one character at a time. For example, to copy a word processing document from one disk to another, he might enter "copy c:myfile a:" via the key board.

Such operating system commands are syntax sensitive, so the user must follow the terms for constructing the command, otherwise an error message is displayed on the screen of the terminal.

The trend now-a-days is away from command-driven interfaces to an user-friendly graphics oriented environment called Graphical User Interfaces or GUI.

GUIs provide an alternative to cryptic text commands. With the GUI, the user can interact with operating system and other software packages by selecting options from menus that are temporarily super-imposed over whatever is currently on the screen by using mouse to position the graphics cursors over the appropriate icons. Graphical user interfaces have effectively eliminated the need for users to memorise and enter cumbersome commands.

When 386 and 486 — based computers were launched, these systems supported complex graphic displays, hence graphical user interface became necessary for almost all applications. Responding in a timely manner, Microsoft produced MS-Windows. This was actually not an operating system but an operating environment which internally exploited MS-DOS capabilities to execute various system calls. Officially introduced in November 1983, Windows provided an effective GUI cover for MS-DOS. In November 1985, Microsoft released Windows 2.0, but it met with a lukewarm response. Windows 3.0, which became widely popular, was launched in May 1990.

1.2.4 Various Operating Systems

MS/ PC-DOS : The origins of Microsoft's Disk Operating System (MS-DOS) lie in the prelaunch era of the IBM PC. As IBM was about to finalise the PC, it started to negotiate with other computer companies to secure a suitable OS for the product. Initial contracts between IBM and Digital Research, the company which happened to own the rights to CP/M (Control Program for a Micro computer) which was, at that time, the market leader in microcomputer OSs, proved unsuccessful.

In 1980, IBM and Microsoft started negotiations for the production of a suitable PC OS. For Microsoft, this was the big break. It had just purchased 86 DOS, an OS from Seattle Computer Products. As a result of a joint effort between IBM and Microsoft, 86 DOS was totally modified and upgraded to what was to become a new 16 bit OS called PC-DOS (Personal Computer Disk Operating System) When in 1981, IBM introduced its famed PC, it came equipped with PC-DOS. Because both companies shared in the ownership of the PC-DOS, Microsoft was able to retail an almost identical version of this OS under the title of MS-DOS. MS-DOS was usually the OS supplied with a PC comparable and PC-DOS was usually the OS which was supplied with an actual IBM PC.

Microsoft Windows: The first version of the Microsoft Windows OS was launched in 1983. Like Operating System 2 , the original release was not very successful. However, despite this initial setback. Microsoft continued to develop the program. Its persistence paid off when in 1990, it launched windows 3. The program became the world's best selling 16-bit GUI OS. By the end of 1996, it was estimated that Microsoft had sold more than 45 million copies.

Its success is often attributed to its overall design, which conveyed an effective and compact user interface, along-with the fact that it was a GUI OS specifically designed for the PC. In addition, Microsoft allowed developers to produce software applications to run on their Windows OS without the need to notify them and so encouraged a whole industry to work with their product.

Besides allowing users/applications to employ increased RAM, Windows 3 enabled true multitasking and allowed users to access programs written for MS/PC-DOS as well as those specifically written for a Windows environment. However, Windows 3 also resulted in a dramatic rise in the processing capabilities of the PC. To work effectively, the PC was required to have a minimum of 4 Mb of RAM along with a 386 Processor.

Windows 95 : Windows 95, a 32 bit OS was released in August 1995. It took Microsoft three and a half years to develop. It was a gigantic task as far as computer projects go and was estimated to have taken 75 million hours of testing prior to its release. It was greeted enthusiastically by the computer industry, which saw it as a significant launch platform which would enable it to sell even more sophisticated computers.

The significance of a 32-bit OS as opposed to a 16-bit OS can be measured by the amount of internal main memory that can be directly access by the user/program. For example, with a 16-bit version of MS-DOS, the maximum amount of directly accessible memory is 1 MB. However, with a 32 bit OS, the user has direct access to 4 GB of main memory. To run Windows 95 users need a computer equipped with a 386DX or higher processor with a minimum of 4 Mb of memory (8Mb is recommended) along with a hard disk of 50 Mb as well as 3.5 inch disk drive or a CD-ROM.

Windows 95 was designed to have certain critical features over and above what was already supplied by Windows 3.1 or Windows for Workgroups. These included:

(a)   A 32-bit architecture which provides for a multitasking environment allowing the user to run multiple programs or execute multiple tasks concurrently. This architecture also enables faster data / file access as well as an improvement in printing delivery.

(b)   A friendlier interface fitted with what is described as 'one click' access. One click access refers to the fact that users didn't have to double click on the mouse every time that they wanted to activate an application. Other congenial attributes include the ability to employ long file names, easy navigation routes and 'plug and play technology' enabling users to connect various peripheral devices or add-ons with the minimum of fuss.

(c)   Windows 95 is also network ready. In other words the OS is designed for easy access to network resources. The OS also facilitates gateways to e-mail and fax facilities and access to the Internet via the Microsoft Network. In addition Windows 95 is backwardly compatible with most 3.1 Windows / DOS applications so enabling users to migrate from previous systems / applications.

Windows NT: Unlike Windows 3 and Windows 95, Windows New Technology (NT) is what is known as an industry standard mission critical OS. As a 32 bit OS Windows NT represents the preferred platform for Intel's more powerful Pentium range of processors. Although not exactly the same, Windows NT 4.0 is, as might be expected, very similar in appearance to Windows 95. Critical features that allow the program to context the commercial OS market include:

♦   A stable multitasking environment
♦   Enhanced security features
♦   Increased memory
♦   Network utilities
♦   Portability: NT can operate on microprocessors other than those designed for the PC.

Windows NT is, as might be expected, more expensive than the other Windows Oss and makes greater processing demands. However, it should be pointed out that Windows NT is making massive inroads into the corporate computing market and is fully recognised as being a competent useful OS.

OS/2: In 1987 IBM and Microsoft announced a new PC OS called OS/2 (Operating System Two) Unfortunately, the original OS/2 was not very successful. Hindsight suggests that, as with the early versions of Windows, one of the reasons for the slow uptake of OS/2 was the then considerable hardware demand of this particular application.

Another more serious problem with the original OS/2 that it was unable to support many existing PC applications. So users faced problems due to lack of compatibility between their original applications and OS/2. Predictably, the initial lack of interest in the original OS/2

resulted in a considerable strain on the IBM - Microsoft alliance. Not long after the launch of OS/2, IBM and Microsoft began to go their separate ways. Microsoft effectively abandoned OS/2 to IBM and chose instead to concentrate on MS-DOS and Windows.

1.3 OPERATING SYSTEMS FOR LARGER SYSTEMS

Operating systems for mid-range and mainframe systems are often more complex than those for microcomputers. MVS is the most common operating system used on IBM mainframe. OS/400, an operating system for the IBM AS/400 line of midrange computers, is used at most of the sites where AS/400 is installed. VMS is the operating system used most frequently on DEC midrange and mainframe systems.

Interleaving Techniques : Large centralized systems often support multiple simultaneous users. The users' terminals may have limited processing capabilities and actual processing may be done entirely on the large computer that is connected to the terminals. Hence, this computing configuration requires an operating system that enables many users to concurrently share the central processor. To do this, the operating systems on large computer systems often combine (interleave) the processing work of multiple simultaneous users or applications in a manner that achieves the highest possible resource efficiency. Among the interleaving techniques commonly used are multiprogramming, foreground/background processing ,multi-tasking, virtual memory, and multi-processing.

1.3.1 Multiprogramming - The purpose of multiprogramming is to increase the utilization of the computer system as a whole. The reader must have noted when a program issues an input/output command, the program and hence the CPU is placed in a wait state until the execution of the command has been completed. When the transfer of data between main memory and the input/output devices has been completed, the device generates an *interrupt*, which is a signal that the data has been transferred. Till then the CPU remains idle and only after it receives the interrupt signal, it continues processing. Hence, in a way, the speed of the CPU is restricted by the speed of I/O devices and most of the time the CPU keeps waiting for the I/O operations to be completed. In order to utilize the computer more effectively, a technique known as *multiprogramming* has been developed. It is a module that is available in an operating system.

Multiprogramming is defined as execution of two or more programs that all reside in primary storage. Since the CPU can execute only one instruction at a time, it cannot simultaneously execute instructions from two or more programs. However, it can execute instructions from one program then from second program then from first again, and so on. This type of processing is referred to as "concurrent execution". Using the concept of concurrent execution, multiprogramming operates in the following way:

When processing is interrupted on one program, perhaps to attend an input or output transfer, the processor switches to another program. This enables all parts of the system, the

processor, input and output peripherals to be operated concurrently thereby utilizing the whole system more fully. When operating on one program at a time, the processor or peripherals would be idle for a large proportion of the total processing time even though this would be reduced to some extent by buffering. **Buffering** enables the processor to execute another instruction while input or output is taking place rather than being idle while transfer was completed. Even then, when one program is being executed at a time, basic input and output peripherals such as floppy disk drive and line printers are slow compared with the electronic speed of the processor and this causes an imbalance in the system as a whole. However, in a multi-programming environment, the CPU can execute one program's instructions while a second program is waiting for I/O operations to take place.

In a system of multiprogramming, storage is allocated for each program. The areas of primary storage allocated for individual programs are called "partitions". Each partition must have some form of storage protection and priority protection to ensure that a program in one portion will not accidentally write over and destroy the instructions of another partition and priority (when two or more programs are residing in primary storage) because both programs will need access to the CPU's facilities (*e.g.*, the arithmetic and logic section) A system of priority-a method that will determine which program will have first call on the computer's facilities-is normally determined by locating the programs in specific partitions.

1.3.2 Foreground/background processing: Usually, it is possible to partition main memory into logically separate areas. This enables, for instance, two different operating systems to work on the same machine because each will have its own memory to manage in its own way. Partitioning also allows separate "job streams" to be set up. A common procedure is to set up a partition for high-priority tasks (called a foreground partition) and one for low-priority tasks (called a background partition) With foreground/background processing, foreground jobs are usually handled first. When no foreground task awaits processing, the computer goes to the background partition and starts processing tasks there. As other foreground tasks come into the job queue, the computer leaves the background partition and resumes working in the foreground

1.3.3 Multi-tasking : Multi-tasking refers to the operating system's ability to execute two or more of a single user's tasks concurrently. Multitasking operating systems are often contrasted with single-user operating systems. *Single-user operating systems* have traditionally been the most common type of operating system for microcomputers. These only allow the user to work on one task at a time. For example, with many single-user operating systems for microcomputer systems, a word-processing user cannot effectively type in a document while another document is being printed out on an attached printer. For microcomputers, multi-tasking operating systems provide single users with multiprogramming capabilities. This is often accomplished through foreground/background processing. Multitasking operating systems for microcomputers-Such as Windows, OS/2, UNIX, Xenix, and

Macintosh System 7 – only run on the more powerful microprocessors that were developed; older machines with less powerful microprocessors typically have single-user operating systems.

1.3.4 Virtual Memory - A programmer has to take into account the size of the memory to fit all his instructions and the data to be operated in the primary storage. If the program is large, then the programmer has to use the concept of virtual memory. Virtual memory systems, sometimes called virtual storage systems, extend primary memory by treating disk storage as a logical extension of RAM. The technique works by dividing a program on disk into fixed-length pages or into logical, variable-length segments.

Virtual memory is typically implemented as follows. Programs stored on disk are broken up into fixed-length pages. When a program need to be processed, the first few pages of it are brought into primary memory. Then, the computer system starts processing the program. If the computer needs a page it does not have, it brings that page in from secondary storage and overwrites it onto the memory locations occupied by a page it no longer needs. Processing continues in this manner until the program finishes. This is known as *overlaying*

By allowing programs to be broken up into smaller parts, and by allowing only certain parts to be in main memory at any one time, virtual memory enables computers to get by with less main memory than usual. Of course, during page swapping in multiprogramming environments, the system may switch to other programs and tasks.

Thus, virtual memory is primary storage-that does not actually exist. It gives the programmers the illusion of a primary storage that is for all practical purposes never ending. It uses the hardware and software features, which provide for automatic segmentation of the program and for moving the segments from secondary storage to primary storage when needed. The segments of the program are thus spread through the primary and secondary (on-line) storage, and track of these segments is kept by using tables and indices. So far as the programmer is concerned, the virtual memory feature allows him to consider unlimited memory size, though not in physical term.

Virtual memory is tricky because writing software that determines which pages or segments are to be swapped in and out of real storage is a system programming art. A disadvantage of virtual memory systems is that time is lost when page swapping occurs. In some cases, the same pages will be brought in and out of primary memory and unusually large number of times, which is an undesirable condition known as thrashing. Machines that do not offer a virtual memory feature usually compensate for this by having larger primary memories.

1.3.5 Multiprocessing - The term multiprogramming is sometimes loosely interchanged with the term multiprocessing, but they are not the same. Multiprogramming involves concurrent execution of instructions from two or more programs sharing the CPU and controlled by one

supervisor. Multiprocessing (or parallel processing) refers to the use of two or more central processing units, linked together, to perform coordinated work simultaneously.

Instructions are executed simultaneously because the available CPUs can execute different instructions of the same program or of different programs at any given time.

Multiprocessing offers data-processing capabilities that are not present when only one CPU is used. Many complex operations can be performed at the same time. CPU can function on complementary units to provide data and control for one another. Multiprocessing is used for nation's major control applications such as rail road control, traffic control, or airways etc.

Although parallel processing is not widespread yet, multiprocessing should be the wave of the future. Because of the availability of cheaper but more powerful processors, many computer manufacturers are now designing hardware and software systems to do multiprocessing. Since several machines can work as a team and operate in parallel, jobs can be processed much more rapidly than on a single machine..

1.4 OTHER SYSTEMS SOFTWARE

1.4.1 Subroutines: A subroutine is a subset of instructions that appears over and again in the program or finds applications in several programs. It is obviously economical to write it once and for all. This would save time not only of writing it specifically or wherever it appears but also on debugging. In fact, it is not even necessary to repeat this subset over and again in the same program. This is sought to be depicted in figure 1.4.1 and explained below.

In two segments of the main program, a subroutine finds use. Instead of duplicating its instructions in the main program it is being used once only as shown in this diagram. This has been made possible by the following scheme. To make the explanation easy we assume that this subroutine consists of deriving the value of 2^N, N being a variable *i.e.,* at one segment of a program it may be desired to compute 2^5 and at another 2^{13} etc. Obviously, then before any entry into SR by the main program the value of N has to be supplied by the latter to the former. N, then is a parameter of S.R.

Instruction 516 "Set N = 5 in the entry instruction 901 of the S.R.".

Instruction 517 "Enter into instruction 901 of the S.R."

As such the SR would compute $2^5 = 32$ upto instruction 908 but there is an important point that has not been clarified. The SR must now return the control to the main program *i.e.,* after the execution of the SR instructions, the main program instruction 518 should be taken up for execution. We would avoid several complications here and roughly state that instruction 909, in plain English would read as "Go back to the next instructions to the one from which the program entered the "SR". The program entered the SR at instruction 517 and the control

would be returned at instruction 518 in the main program. Likewise, 2^{13} would be computed in the second segment of the program.
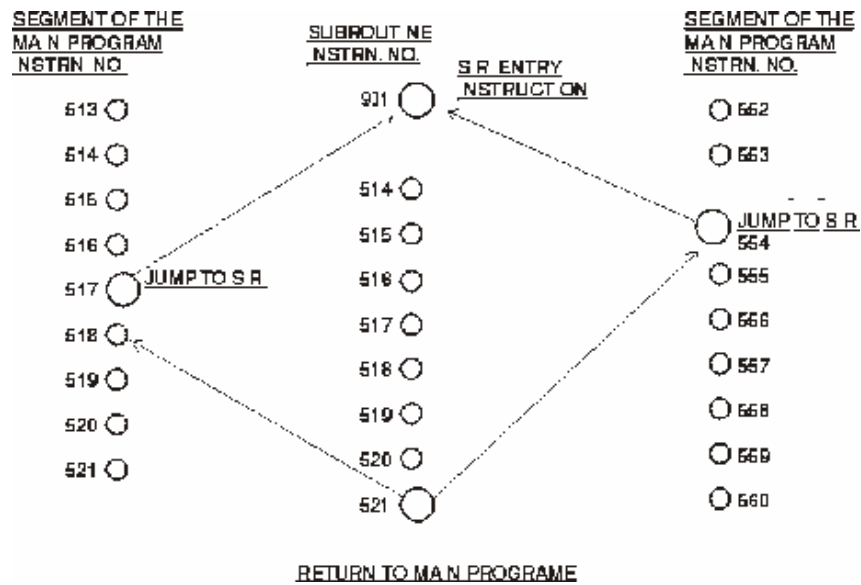
Fig. 1.4.1

Subroutines may be incorporated in the main program in the assembly run, the compilation run, or may be recalled by the main program from the library of subroutines in the backing storage. Both assembly/compilation run are explained later on.

1.4.2 Utility Programs or Service Programs: Utility programs are systems programs that perform general system –support tasks. These programs are provided by the computer manufacturers to perform tasks that are common to all data processing installations. Some of them may either be programs in their own right or subordinates to be assembled/compiled in the application programs. The following tasks are performed by the utility programs.

(i)   Sorting the data.

(ii)   Editing the output data.

(iii)   Converting data from one recording medium to another, viz., floppy disk to hard disc, tape to printer, etc.

(iv)   Dumping of data to disc or tape.

(v)   Tracing the operation of program.

In many instances, it is unclear what differentiates an operating system routine from a utility program. Some programs that one vendor bundles into an operating system might be offered by another vendor as separately priced and packaged utility programs.

A wide variety of utilities are available to carry out special tasks. Three types of utility programs found in most computer systems: sort utilities, spooling software, and text editors are discussed below:

(a) **Sort utilities:** Sort utility programs are those that sort data. For example, suppose we have a file of student records. We could declare "name" the *primary sort key* and arrange the file alphabetically on the name field. This would be useful for, perhaps, producing a student directory. Alternatively, we could sort the file by name, and then within name, by date-of-birth. Hence, we would declare name as the primary sort key and date-of-birth as the *secondary sort key*. Although the examples described here use only one or two sort keys, many sorting packages enable the user to identify 12 or more sort keys and to arrange outputted records in either ascending or descending order on each declared key.

Sort utilities are often found in mainframe and minicomputer environments. In the micro-computing world, it is typical for sort routines to be bundled into application packages; for example, sort routines are commonly found in spreadsheet and database management software.

(b) **Spooling software**: The purpose of spooling software is to compensate for the speed differences between the computer and its peripheral devices. Spooling software is usually encountered in large system and network computing environments. For instance, during the time it takes to type in or print out all the words on this page, the computer could begin and finish processing dozens of programs. The computer would be horribly bottlenecked if it had to wait for slow input and output devices before it could resume processing. It just does not make sense for a large computer, which may be worth lacs of rupees, to spend any time sitting idle because main memory is full of processed but unprinted jobs and the printer attached to the system cannot move fast enough.

To preclude the computer from being slowed down by input and output devices, many computer systems employ **spooling** software. These programs take the results of computer programs and move them from primary memory to disk. The area on the disk where the program results are sent is commonly called the output spooling area. Thus, the output device can be left to interact primarily with the disk unit, not the CPU. Spooling utilities can also be used on the input side, so that programs and data to be processed are temporarily stored in an input spooling area on disk.

Assume for example that a floppy disc, a line printer and a disk are used in a spooling operation on a computer system to process the pay-roll and prepare invoices by loading both programs into the main memory. While the line printer is printing an invoice line, the processor

switches to the pay roll application and transfers input data from floppy disc to magnetic disk. Afterwards the processor reverts back to the invoice application. As the printer is being used for printing invoices, pay roll application will be executed and output data would be recorded on the Magnetic disk for later conversion when the printer becomes available. As a result, the CPU can give the output at the maximum speed, while several relatively slow input and output units operate simultaneously to process it.

(c) **Text editors:** Text editors are programs that allow text in a file to be created and modified. These utilities are probably most useful to professional programmers, who constantly face the problems of cutting and pasting programs together, changing data files by eliminating certain data fields, changing the order of certain data fields, adding new data fields, and changing the format of data. Although text editors closely resemble word processors, they are not the same. Word processors are specifically designed to prepare such "document" materials as letters and reports, where text editors are specifically designed to manipulate "non-document" instructions in computer programs a or data in files. Text editors lack the extensive text-formatting and document-printing capabilities found on most word processors.

Some of the other commonly used utilities for a microcomputer operating systems are discussed below :

(i) *Disk copy program* - This program allows an user to copy the entire contents of one diskette to another diskette. It is generally used to make a backup or archive copy of a data diskette or an application program. The diskcopy program can also be used to transfer data stored from one size or capacity diskette to another. For example, it can be used to transfer data from a 360 KB diskette to a 1.2MB diskette or from a 5¼ inch diskette to a 3½ inch diskette.

(ii) *File copy program* - This program allows an user to copy just one file or a group of files, rather than the entire contents of the diskette, to be copied to another diskette. It has the same functions as a diskcopy utility except that it allows an individual file or group of files to be copied.

(iii) *Disk formatting program* - This program allows an user to prepare a new, blank diskette to receive data from the computer system. The data can not be stored on a diskette until it is formatted or initialized. The formatting process writes the sectors on the diskette so that the operating system is able to place data in these locations.

(iv) *File deletion program* - It allows an user to delete a file stored on a diskette.

(v) *File viewing program* - This program is used to view the contents of a file on the display screen of the microcomputer.

(vi) *Directory program* - This program allows an user to view the names of the data and program files which are stored on a disk/diskette. It will not only list the files, but also will show the amount of kilobytes of memory these files occupy, the time and day they were last revised and the amount of unused storage space available on the floppy.

1.4.3 Diagnostic Routines : These programs are usually written and provided by the computer manufacturers. They assist in program debugging. They usually trace the processing of the program being debugged. In personal computer, if an user wants to know anything regarding the processing equipments in his computers, he/she can consult the Microsoft Diagnostic Program, a utility built into the DOS version 6.0 operating system. Using the program, one can get answer to following questions *e.g.* :—

1. What type of processor does the computer use?
2. Is there a math coprocessor in the computer ?
3. Who is the BIOS manufacturer? (BIOS stands for Basic Input/Output System. It is a set of instructions, contained on a ROM chip, that are loaded in the computer memory before the operating system. The BIOS manufacturer is the maker of the ROM chip)
4. What is the total amount of conventional memory in the computer?
5. What type of keyboard is attached to the computer?
6. What is the display type?
7. If there is a mouse attached to the computer, what type is it and who made it?

The diagnostic routines are however also often treated as a category of the utility or service programs

1.4.4 Language translators : A language translator or language processor is a general term used for any assembler, compiler or other routine that accepts statements in one language and produces equivalent statements in another language. The language processor reads the source language statements one at a time and prepares a number of machine instructions to perform the operations specified or implied by each source statement. Most computer installations have several language processors available, one for each programming language the computer can accept.

The three most widely used types of language translators are compilers, interpreters, and assemblers.

Compilers : A compiler translates the entire program into machine language before the program is executed. Compilers are most commonly used to translate high-level languages such as COBOL, FORTRAN, and Pascal. Compilers typically result in programs that can be executed much more swiftly than those handled by interpreters. Since either a compiler or an interpreter can be developed to translate most languages, compilers would be preferred in environments where execution speed is important.
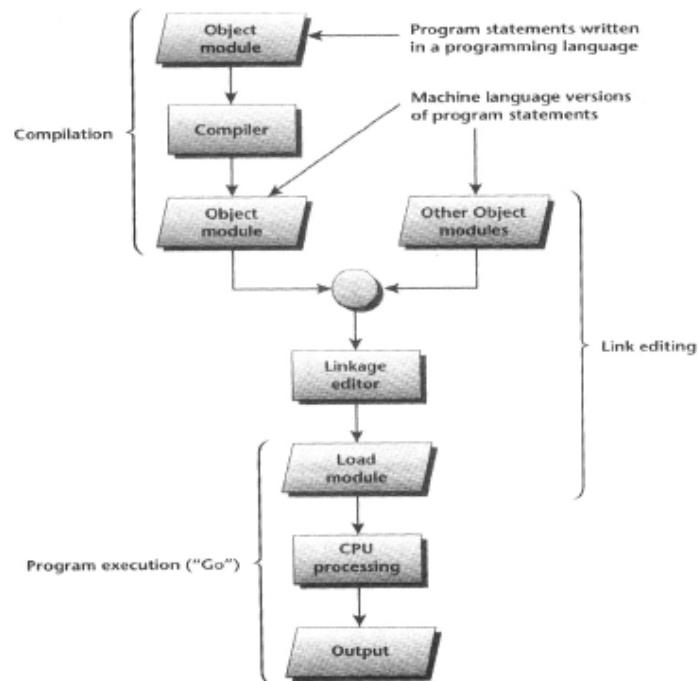
Fig. 1.4.2

Compilers work in the manner illustrated in Figure 1.4.2. Program is entered into the computer system and submitted to the appropriate compiler. For instance, A COBOL program is input to a COBOL compiler; a Pascal program, to a Pascal compiler. The program submitted for compilation is called a *source program* (or source module) The compiler then translates the program into machine language, producing *an object program* (or object module) Then, another software program called a **linkage editor** binds the object module of this program to object modules of any subprograms that must be used to complete processing. The resultant program, which is ready for computer execution, is called a *load program* (or load module) It is the load program that the computer actually executes.

The entire process is sometimes referred to as "compile/link-edit/go," corresponding to the compilation, link-editing, and execution stages that the user must go through to get a program processed. Programs can be saved on disk for processing in either source, object, or load-module form. Frequently run applications will often be saved in load module form to avoid repeated compilation and link-editing.

Interpreters: Whereas compilers translates programs into machine language all at once before programs are run, *interpreters* translate programs a line at a time as they are being run. For instance, if a user has a program in which a single statement is executed a thousand times during the course of the program's run, the interpreter would translate that statement a thousand different times into machine language. With an interpreter, each statement is translated into machine language just before it is executed. No object module or storable load module is ever produced.

Although interpreters have the glaring weakness of inefficiency because they translate statements over and over, they do have some advantages over compilers. First, they are usually easier and faster to use, since the user is not bothered with distinct and time-consuming compile, link-edit, and execution stages. Second, they typically provide users with superior error messages. When a program contains an error and "blows up," the interpreter knows exactly which statement triggered the error – the one it last translated. Because interpreters stop when errors are encountered, they help programmers debug their programs. This boosts programmer productivity and reduces program development time. Syntax errors encountered by compilers during the program translation process are counted, but the diagnostic routines and error messages associated with most compilers do not help programmers locate errors as readily as interpreters. Third, an interpreter for a 3GL typically requires less storage space in primary memory than a compiler for that language. So they may be ideal for programming environments in which main memory is limited, such as on low-end microcomputers. Fourth, interpreters are usually less expensive than compilers.

Programs written in simple languages such as BASIC are more likely to be interpreted than compiled because these programs are often developed on microcomputers. Although most microcomputer systems come equipped with a BASIC interpreter, few include a compiler. When BASIC is used in a commercial production environment, however, it is often advantageous to acquire a BASIC compiler. Ideally, program development is first performed using interpreters; then, using a compiler and linkage editor, the final version of the program is compiled and link-edited into directly executable code.

Assemblers : Assemblers are used exclusively with assembly languages. They work similarly to compilers, translating an assembly language program into object code. Because assembly language programs are usually more machine efficient than those written in high-level languages, a two-step translation process may take place. First, the high-level language is translated to assembly language; then, using an assembler, it is converted to machine language.

1.4.5 Firmware : Firmware or micro programs refer to a series of special program instructions. The most basic operations such as addition, multiplication etc. in a computer are carried out by hardwired circuits. These fundamental tasks are then combined in the form of micro programs to produce higher level operations such as move data, make comparisons etc.

These micro-programs are called firmware because they deal with very law-level machine operations and thus essentially substitute for additional hardware. Firmware are held in the CPU in a special control storage device.

1.5 GENERAL PURPOSE SOFTWARE/UTILITIES

This software provides the framework for a great number of business, scientific, and personal applications. Spreadsheet, data bases, Computer-Aided Design (CAD) and word processing software etc. fall into this category. Most general-purpose software is sold as a package. The software is accompanied by user-oriented documentation such as reference manuals, keyboard templates, and so on. It is then upto the user of the software to create the application. For example, an accountant can use spreadsheet software to create a template for preparing a balance sheet of a company. An aeronautical engineer can use CAD software to design an airplane or an airport. A personnel manager can use word processing software to create a letter and so on.

The three basic types of software are; commercial, shareware and open source software. Some software is also release into the public domain without a license. **Commercial** software comes prepackaged and is available from software stores and through the Internet. **Shareware** is software developed by individual and small companies that cannot afford to market their software world wide or by a company that wants to release a demonstration version of their commercial product. You will have an evaluation period in which you can decide whether to purchase the product or not. Shareware software often is disabled in some way and has a notice attached to explain the legal requirements for using the product. **Open Source software** is created by generous programmers and released into the public domain for public use. There is usually a copyright notice that must remain with the software product. Open Source software is not public domain in that the company or individual that develops the software retains ownership of the program but the software can be used freely. Many popular Open Source applications are being developed and upgraded regularly by individuals and companies that believe in the Open Source concept.

1.5.1 Word Processor : A **word processor** (more formally a **document preparation system**) is a computer application used for the production (including composition, editing, formatting, and possibly printing) of any sort of printable material.

Word processors are descended from early **text formatting** tools (sometimes called **text justification** tools, from their only real capability) Word processing was one of the earliest applications for the personal computer in office productivity.

Although early word processors used tag-based markup for document formatting, most modern word processors take advantage of a graphical user interface. Most are powerful systems consisting of one or more programs that can produce any arbitrary combination of images, graphics and text, the latter handled with type-setting capability.

Microsoft Word is the most widely used computer word processing system; Microsoft estimates over five million people use the Office suite. There are also many other commercial word processing applications, such as WordPerfect. Open-source applications such as OpenOffice's Writer and KWord are rapidly gaining in popularity.

1.5.2 Spreadsheet Program : A **spreadsheet** is a rectangular table (or grid) of information, often financial information. The word came from "spread" in its sense of a newspaper or magazine item (text and/or graphics) that covers two facing pages, extending across the center fold and treating the two pages as one large one. The compound word "spread-sheet" came to mean the format used to present bookkeeping ledgers -- with columns for categories of expenditures across the top, invoices listed down the left margin, and the amount of each payment in the cell where its row and column intersect -- which were traditionally a "spread" across facing pages of a bound ledger (book for keeping accounting records) or on oversized sheets of paper ruled into rows and columns in that format and approximately twice as wide as ordinary paper.

The generally recognized inventor of the spreadsheet as a commercial product for the personal computer is Dan Bricklinwho named it VisiCalc, the first application that turned the personal computer from a hobby for computer enthusiasts into a business tool.

The introduction of the IBM PC in 1982 was initially fairly unsuccessful, as most of the programs available for it were ports from other 8-bit platforms. Things changed dramatically with the introduction of Lotus 1-2-3, which became that platform's killer app, and drove widespread sales of the PC due to the massive improvements over the VisiCalc port on the same platform. Lotus 1-2-3 underwent an almost identical cycle with the introduction of Windows 3.x in the late 1980s. Microsoft had been developing Excel on the Macintosh platform for several years at this point, and it had developed into a fairly powerful system. A port to Windows 3.1 resulted in a fully-functional Windows spreadsheet which quickly took over from Lotus in the early 1990s. A number of companies have attempted to break into the spreadsheet market with programs based on very different paradigms. Lotus introduced what is likely the most successul example, Lotus Improv. Spreadsheet 2000 attempted to dramatically simplify formula construction.

1.5.3 Database Management System: A **database management system** (**DBMS**) is a system or software designed to manage a database, and run operations on the data requested by numerous clients. Typical examples of DBMS use include accounting, human resources and customer support systems. DBMSs have more recently emerged as a fairly standard part of any company back office.

1.5.4 Internet Browser : An Internet Browser or a **web browser** is a software application that enables a user to display and interact with text, images, and other information typically located on a web page at a website on the World Wide Web or a local area network. Text and images

on a web page can contain hyperlinks to other web pages at the same or different websites. Web browsers allow a user to quickly and easily access information provided on many web pages at many websites by traversing these links.

Web browsers available for personal computers include Microsoft Internet Explorer, Mozilla Firefox, Apple Safari, Netscape, and Opera, in order of descending popularity (July 2006) Web browsers are the most commonly used type of HTTP user agent. Although browsers are typically used to access the World Wide Web, they can also be used to access information provided by web servers in private networks or content in file systems.

1.5.5 Electronic mail, abbreviated as **e-mail** or **e-Mail** or **email**, is a method of composing, sending, storing, and receiving messages over electronic communication systems. The term e-mail applies both to the Internet e-mail system based on the Simple Mail Transfer Protocol (SMTP) and to intranet systems allowing users within one company to e-mail each other. Often these workgroup collaboration organizations may use the Internet protocols for internal e-mail service.

1.6 APPLICATION SOFTWARE

Application software is a loosely defined subclass of computer software that employs the capabilities of a computer directly to a task that the user wishes to perform. This should be contrasted with system software which is involved in integrating the computer's various capabilities, but typically does not directly apply them in the performance of tasks that benefit the user. The term application refers to both the application software and its implementation. A simple, if imperfect, analogy in the world of hardware would be the relationship of an electric light—an application—to an electric power generation plant—the system. The power plant merely generates electricity, itself not really of any use until harnessed to an application like the electric light which performs a service that the user desires.

The exact delineation between the operating system and application software is not precise, however, and is occasionally subject to controversy. For example, one of the key questions in the United States v. Microsoft antitrust trial was whether Microsoft's Internet Explorer web browser was part of its Windows operating system or a separable piece of application software.

Multiple applications bundled together as a package are sometimes referred to as an application suite.. The separate applications in a suite usually have a user interface that has some commonality making it easier for the user to learn and use each application. And often they may have some capability to interact with each other in ways beneficial to the user.

User-written software tailors systems to meet the user's specific needs. User-written software include spreadsheet templates, word processor macros, scientific simulations, graphics and animation scripts. Even email filters are a kind of user software. Users create this software themselves and often overlook how important it is.

The program usually solves a particular application or problem. Examples of such programs are payroll, General accounting, sales statistics and inventory control etc. Usually different organisations require different programs for similar application and hence it is difficult to write standardized programs. However, tailor-made application software can be written by software houses on *modular* design to cater to the needs of different users.

1.6.1 Enterprise Resource Planning systems (ERPs) integrate (or attempt to integrate) all data and processes of an organization into a single unified system. A typical ERP system will use multiple components of computer software and hardware to achieve the integration. A key ingredient of most ERP systems is the use of a single, unified database to store data for the various system modules.

The term ERP originally implied systems designed to plan the utilization of enterprise-wide resources. Although the acronym ERP originated in the manufacturing environment, today's use of the term ERP systems has much broader scope. ERP systems typically attempt to cover all basic functions of an organization, regardless of the organization's business or charter. Business, non-profit organizations, governments, and other large entities utilize ERP systems.

Additionally, it may be noted that to be considered an ERP system, a software package generally would only need to provide functionality in a single package that would normally be covered by two or more systems. Technically, a software package that provides both Payroll and Accounting functions (such as QuickBooks) would be considered an ERP software package.

However; the term is typically reserved for larger, more broadbased applications. The introduction of an ERP system to replace two or more independent applications eliminates the need for interfaces previously required between systems, and provides additional benefits that range from standardization and lower maintenance (one system instead of two or more) to easier and/or greater reporting capabilities (as all data is typically kept in one database)

Examples of modules in an ERP which formerly would have been stand-alone applications include: Manufacturing, Supply Chain, Financials, CRM, Human Resources, and Warehouse Management.

1.6.2 DECISION SUPPORT SYSTEMS

Decision support systems are information processing systems frequently used by accountants, managers, and auditors to assist them in the decision-making process. The concept of decision support systems evolved in the 1960s from studies of decision making in organisations. These studies noted that managers required flexible systems to respond to less well-defined questions than those addressed by operational employees. Advances in hardware technology, interactive computing design, graphics capabilities, and programming

languages contributed to this evolution. Decision support systems have achieved broad use in accounting and auditing today.

Characteristics of Decision Support Systems : Although decision support system applications vary widely in their level of sophistication and specific purpose, they possess several characteristics in common.

(1) Decision support system support management decision making – Although most heavily used for management planning decisions, operational managers can use them (e.g., to solve scheduling problems), as can top managers (e.g., to decide whether to drop a product line) Decision support systems enhance decision quality. While the system might point to a particular decision, it is the user who ultimately makes the final choice.

(2) Decision support systems solve relatively unstructured problems – problems that do not have easy solution procedures and therefore problems in which some managerial judgment is necessary in addition to structured analysis. Thus, in contrast to transaction processing systems, decision support systems typically use non-routine data as input. These data are not easy to gather and might require estimates. For example, imagine that the manager is selecting accounting software for his company's use. This problem is unstructured because there is no available listing of all the features that are desirable in accounting software for his particular company. Furthermore, he will need to use his judgment to determine what features are important.

Because managers must plan for future activities, they rely heavily on assumptions of future interest rates, inventory prices, consumer demand, and similar variables. But what if managers' assumptions are wrong? A key characteristic of many decision support systems is that they allow users to ask what-if questions and to examine the results of these questions. For instance, a manager may build an electronic spreadsheet model that attempts to forecast future departmental expenditures. The manager cannot know in advance how inflation rates might affect his or her projection figures, but can examine the consequences of alternate assumptions by changing the parameters (here, growth rates) influenced by these rates. Decision support systems are useful in supporting this type of analysis.

Although systems designers may develop decision support systems for one-time use, managers use them to solve a particular type of problem on a regular basis. The same is true of expert systems. However, decision support systems are much more flexible and may handle many different types of problems. Accountants might use a spreadsheet model developed to calculate depreciation only for depreciation problems, but many more general decision support system tools such as Expert Choice (discussed later as an example of a decision support system) are sufficiently flexible and adaptive for ongoing use. Another example is decision support systems that perform data mining tasks.

(3) Finally, a "friendly" computer interface is also a characteristic of a decision support system – Because managers and other decision makers who are non programmers frequently use decision support systems, these systems must be easy to use. The availability of nonprocedural modeling languages, eases communication between the user and the decision support system.

Components of Decision Support Systems : A decision support system has four basic components: (1) the user, (2) one or more databases, (3) a planning language, and (4) the model base (see Figure below)
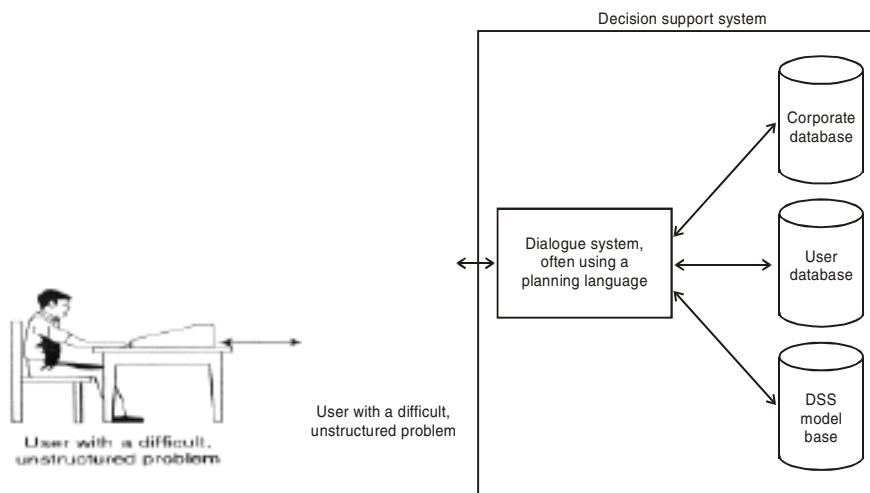
Fig. 1.6.1

The components of a decision support system

(i) The users : The user of a decision support system is usually a manager with an unstructured or semi-structured problem to solve. The manager may be at any level of authority in the organisation (e.g., either top management or operating management) Typically, users do not need a computer background to use a decision support system for problem solving. The most important knowledge is a thorough understanding of the problem and the factors to be considered in finding a solution. A user does not need extensive education in computer programming in part because a special planning language performs the communication function within the decision support system. Often, the planning language is nonprocedural, meaning that the user can concentrate on what should be accomplished rather than on how the computer should perform each step.

(ii) Databases : Decision support systems include one or more databases. These databases contain both routine and non-routine data from both internal and external sources. The data from external sources include data about the operating environment surrounding an organisation – for example, data about economic conditions, market demand for the organisation's goods or services, and industry competition.

Decision support system users may construct additional databases themselves. Some of the data may come from internal sources. An orgnaisation often generates this type of data in the normal course of operations – for example, data from the financial and managerial accounting systems such as account, transaction, and planning data. The database may also capture data from other subsystems such as marketing, production, and personnel. External data include assumptions about such variables as interest rates, vacancy rates, market prices, and levels of competition.

(iii) Planning languages : Two types of planning languages that are commonly used in decision support systems are: (1) general –purpose planning languages and (2) special-purpose planning languages. General-purpose planning languages allow users to perform many routine tasks – for example, retrieving various data from a database or performing statistical analyses. The languages in most electronic spreadsheets are good examples of general-purpose planning languages. These languages enable user to tackle a broad range of budgeting, forecasting, and other worksheet-oriented problems. Special-purpose planning languages are more limited in what they can do, but they usually do certain jobs better than the general-purpose planning languages. Some statistical languages, such as SAS, SPSS, and Minitab, are examples of special purpose planning languages.

(iv) Model base : The planning language in a decision support system allows the user to maintain a dialogue with the model base. **The model base** is the "brain" of the decision support system because it performs data manipulations and computations with the data provided to it by the user and the database. There are many types of model bases, but most of them are custom-developed models that do some types of mathematical functions-for example, cross tabulation, regression analysis, time series analysis, linear programming and financial computations. The analysis provided by the routines in the model base is the key to supporting the user's decision. The model base may dictate the type of data included in the database and the type of data provided by the user. Even where the quantitative analysis is simple, a system that requires users to concentrate on certain kinds of data can improve the effectiveness of decision making.

Examples of Decision Support Systems in Accounting : Decision support systems are widely used as part of an orgnaisation's AIS. The complexity and nature of decision support systems vary. Many are developed in-house using either a general type of decision support program or a spreadsheet program to solve specific problems. Below are several illustrations of these systems.

Cost Accounting system: The health care industry is well known for its cost complexity. Managing costs in this industry requires controlling costs of supplies, expensive machinery, technology, and a variety of personnel. Cost accounting applications help health care organisations calculate product costs for individual procedures or services. Decision support systems can accumulate these product costs to calculate total costs per patient. Health care managers many combine cost accounting decision support systems with other applications, such as productivity systems. Combining these applications allows managers to measure the effectiveness of specific operating processes. One health care organisation, for example, combines a variety of decision support system applications in productivity, cost accounting, case mix, and nursing staff scheduling to improve its management decision making.

Capital Budgeting System: Companies require new tools to evaluate high-technology investment decisions. Decision makers need to supplement analytical techniques, such as net present value and internal rate of return, with decision support tools that consider some benefits of new technology not captured in strict financial analysis. One decision support system designed to support decisions about investments in automated manufacturing technology is AutoMan, which allows decision makers to consider financial, nonfinancial, quantitative, and qualitative factors in their decision-making processes. Using this decision support system, accountants, managers, and engineers identify and prioritize these factors. They can then evaluate up to seven investment alternatives at once.

Budget Variance Analysis System: Financial institutions rely heavily on their budgeting systems for controlling costs and evaluating managerial performance. One institution uses a computerized decision support system to generate monthly variance reports for division comptrollers. The system allows these comptrollers to graph, view, analyse, and annotate budget variances, as well as create additional one-and five-year budget projections using the forecasting tools provided in the system. The decision support system thus helps the controllers create and control budgets for the cost-center managers reporting to them.

General Decision Support System: As mentioned earlier, some planning languages used in decision support systems are general purpose and therefore have the ability to analyze many different types of problems. In a sense, these types of decision support systems are a decision

maker's tools. The user needs to input data and answer questions about a specific problem domain to make use of this type of decision support system. An example is a program called **Expert Choice.** This program supports a variety of problems requiring decisions. The user works interactively with the computer to develop a hierarchical model of the decision problem. The decision support system then asks the user to compare decision variables with each other. For instance, the system might ask the user how important cash inflows are versus initial investment amount to a capital budgeting decision. The decision maker also makes judgments about which investment is best with respect to these cash flows and which requires the smallest initial investment. Expert Choice analyzes these judgments and presents the decision maker with the best alternative.

1.6.3 ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) is software that tries to emulate aspects of human behavior, such as reasoning, communicating, seeing, and hearing. AI software can use its accumulated knowledge to reason and, in some instances, learn from experience and thereby modify its subsequent reasoning. There are several types of AI, including natural language, voice and visual recognition, robotics, neural networks, and expert systems.

Natural language and voice and visual recognition both focus on enabling computers to interact more easily and naturally with users. Robotics focuses on teaching machines to replace human labour. Both neural networks and expert systems aim to improve decision-making.

1.6.4 EXPERT SYSTEMS

An expert system (ES) is a computerized information system that allows non-experts to make decisions comparable to those of an expert. Expert systems are used for complex or ill-structured tasks that require experience and specialised knowledge in narrow, specific subject areas, as shown in Figure 1.6.2 , expert systems typically contain the following components:

Major Components of an Expert System
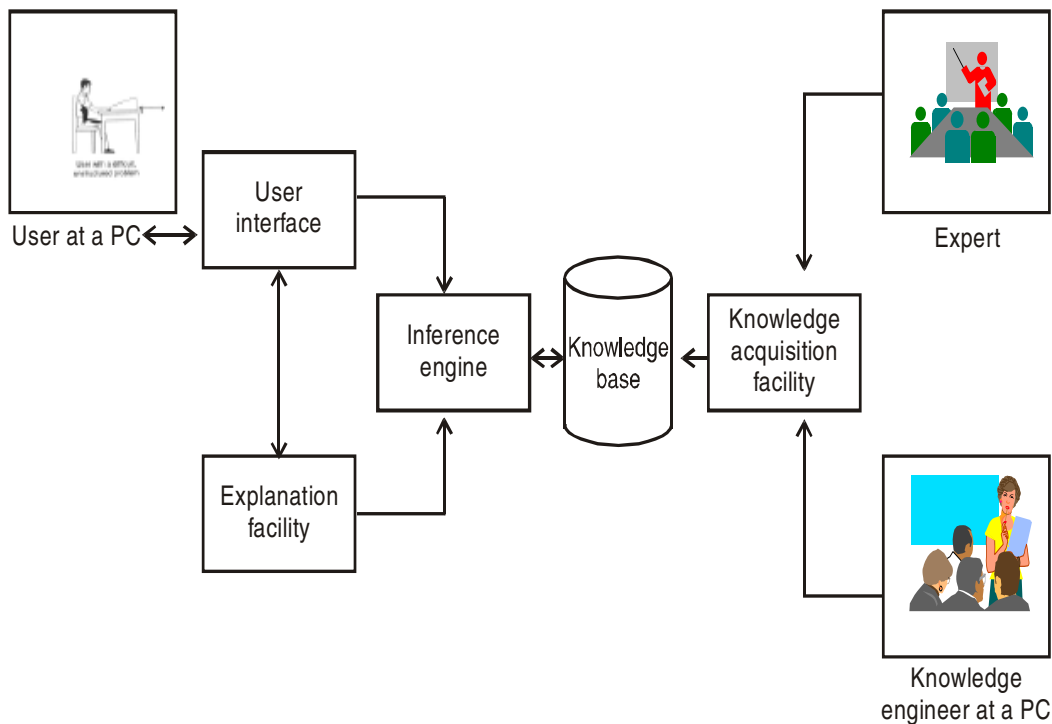
Fig 1.6.2

1. **Knowledge base** : This includes the data, knowledge, relationships, rules of thumb (heuristics), and decision rules used by experts to solve a particular type of problem. A knowledge base is the computer equivalent of all the knowledge and insight that an expert or a group of experts develop through years of experience in their field.

2. **Inference engine** : This program contains the logic and reasoning mechanisms that simulate the expert logic process and deliver advice. It uses data obtained from both the knowledge base and the user to make associations and inferences, form its conclusions, and recommend a course of action.

3. **User interface** : This program allows the user to design, create, update, use, and communicate with the expert system.

4. **Explanation facility :** This facility provides the user with an explanation of the logic the ES used to arrive at its conclusion.

5. **Knowledge acquisition facility :** Building a knowledge base, referred to as knowledge engineering, involves both a human expert and a knowledge engineer. The knowledge engineer is responsible for extracting an individual's expertise and using the knowledge acquisition facility to enter it into the knowledge base.

Expert systems can be example-based, rule based, or frame based. Using an example-based system, developers enter the case facts and results. Through induction the ES converts the examples to a decision tree that is used to match the case at hand with those previously entered in the knowledge base. Rule-based systems are created by storing data and decision rules as if- then -else rules. The systems asks the user questions and applied the if-then-else rules to the answers to draw conclusions and make recommendations. Rule -based systems are appropriate when a history of cases is unavailable or when a body of knowledge can be structured within a set of general rules. Frame -based systems organize all the information (data, descriptions, rules etc.) about a topic into logical units called frames, which are similar to linked records in data files. Rules are then established about how to assemble or interrelate the frames to meet the user's needs.

Expert systems provide several levels of expertise. Some function as assistants that perform routine analysis and call the user's attention to tasks that require human expertise. Others function as colleagues, and the user "discusses" a problem with the system until both agree on a solution. When a user can accept the system's solution without question, the expert system can be referred to as a true expert. Developers of expert systems are still striving to create a true expert; most current systems function at the assistant or colleague level.

Expert systems offer the following benefits:

♦ They provide a cost-effective alternative to human experts.

♦ They can outperform a single expert because their knowledge is representative of numerous experts. They are faster and more consistent and do not get distracted, overworked, or stressed out.

♦ They produce better-quality and more consistent decisions. Expert systems assist users in identifying potential decision making problems, which increases the probability that sound decisions will be made.

♦ They can increase productivity.

♦ They preserve the expertise of an expert leaving the organization.

Although expert systems have many advantages and great promise, they also have a significant number of limitations

♦ Development can be costly and time-consuming. Some large systems required upto 15 years and millions of dollars to develop.

♦ It can be difficult to obtain knowledge from experts who have difficulty specifying exactly how they make decisions.

♦ Designers have not been able to program what humans consider common sense into current systems. consequently, rule-based systems break down when presented with situations they are not programmed to handle.

♦ Until recently, developers encountered skepticism from businesses due to the poor quality of the early expert systems and the high expectations of users.

As technology advances, some of these problems will be overcome and expert systems will play an increasingly important role in accounting information systems. Here are specific examples of companies that have successful used expert systems:

♦ The IRS analyzes tax returns to determine which should be passed on to tax fraud investigators.

♦ IBM designs and evaluates internal controls in both new and existing applications.

♦ Americans Express authorizes credit card purchases to minimize fraud and credit losses. Its ES replaced 700 authorization clerks and saved tens of millions of dollars.

SELF-EXAMINATION QUESTIONS

1. What do you understand by the term "Software"? What are the various types of Software?

2. Define a Computer Operating System and describe its functions and development.

3. Briefly discuss various operating systems for microcomputers.

4. Define the following items :

    (i)   Language Translator   (ii)   Firmware

    (iii) Subroutine   (iv)   Utility Programs

    (v)   Debugging   (vi)   Diagnostic routines

5. Explain in brief, the various computer programming languages starting from machine language.

6. Explain the difference between :

    (i)   Hardware and Software. (ii)   Source program and Object program.

    (iii) Interpreter and Compiler. (iv)   System software and Application software.

    (v)   Multiprogramming and Multiprocessing

7. Write short note on :

    (i)   Foreground/background processing

    (ii)   Virtual memory

8. Write short notes on the following:

    (a)   General purpose software

    (b)   Application software

9. Briefly discuss the following

    (i)   Word Processor   (ii)   Spreadsheet

    (iii) DBMS   (iv)   Internet Browser

10. What is a decision support system ? Briefly discuss various characteristics of a decision support system.

11. Explain the components of a decision support system.

12. What do you understand by artificial intelligence ? Describe various types of artificial intelligence.

13. Discuss various components of an Expert systems. What benefits are offered by Expert systems.

CHAPTER 2

DATA STORAGE, RETRIEVAL AND

DATA BASE MANAGEMENT SYSTEMS

INTRODUCTION

We use the decimal numbers or the decimal number system for our day-to-day activities. As we all know, in the decimal number system there are ten digits – 0 through 9. But computers understand only 0s and 1s - the machine language. But using 0s and 1s to program a computer is a thing in the past. Now we can use the decimal numbers, the alphabets and special characters like +,-,*,?,/, etc. for programming the computer. Inside the computer, these decimal numbers, alphabets and the special characters are converted into 0s and 1s, so that the computer can understand what we are instructing it to do. To understand the working of a computer, the knowledge of binary, octal and hexadecimal number systems is essential.

2.1 DECIMAL NUMBER SYSTEM

The base or radix of a number system is defined as the number of digits it uses to represent the numbers in the system. Since decimal number system uses 10 digits - 0 through 9 - its base or radix is 10. The decimal number system is also called *base-10 number system.* The weight of each digit of a decimal number system depends on its relative position within the number. For example, consider the number 3256.

$3256 = 3000 + 200 + 50 + 6$

or, in other words,

$3256 = 3 \times 10^3 + 2 \times 10^2 + 5 \times 10^1 + 6 \times 10^0$

From the above example, we can see that the weight of the nth digit of the number from the right hand side is equal to *n th digit X* 10^{n-1} which is again equal to *nth digit x* $(base)^{n-1}$. The number system, in which the weight of each digit depends on its relative position within the numbers, is called the *positional number system.*

2.1.1 Binary Number System

The base or radix of the binary number system is 2. It uses only two digits - 0 and 1. Data is represented in a computer system by either the presence or absence of electronic or magnetic

signals in its circuitry or the media it uses. This is called a binary, or two-state representation of data since the computer is indicating only two possible states or conditions. For example, transistors and other semiconductor circuits are either in a conducting or non-conducting state. Media such as magnetic disks and tapes indicate these two states by having magnetized spots whose magnetic fields can have two different directions or polarities. These binary characteristics of computer circuitry and media are the primary reasons why the binary number system is the basis for data representation in computers. Thus, for electronic circuits, the conduction state (ON) represents a ONE and the non-conducting state (OFF) represents a ZERO.

Therefore, as mentioned earlier, the binary number system has only two symbols, 0 and 1. The binary symbol 0 or 1 is commonly called a bit, which is a contraction of the term binary digit. In the binary system, all numbers are expressed as groups of binary digits (bits), that is, as groups of 0s and 1s. Just as in any other number system, the value of a binary number depends on the position or place of each digit in a grouping of binary digits. The values are based on the right to left position of digits in a binary number, using the power of 2 as position values. For example, consider the binary number 10100.

$10100 = 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 0 \times 2^0 = 16 + 0 + 4 + 0 + 0 = 20$

Table 1 gives the binary equivalents of the decimal numbers from 0 to 20.

Table 1: Binary equivalents of the decimal numbers

Decimal	Binary	Decimal	Binary
0	0	11	1011
1	01	12	1100
2	10	13	1101
3	11	14	1110
4	100	15	1111
5	101	16	10000
6	110	17	10001
7	111	18	10010
8	1000	19	10011
9	1001	20	10100
10	1010		

Binary-decimal Conversion

To convert a binary number to its decimal equivalent, we use the following expression:

2.2

The weight of the nth bit of a number from the right hand side = n^{th} bit x 2^{n-1}

After calculating the weight of each bit, they are added to get the decimal value as shown in the following examples:

$101 = 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 4 + 0 + 1 = 5$

$1010 = 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 8 + 0 + 2 + 0 = 10$

$1111 = 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = 8 + 4 + 2 + 1 = 15$

$1.001 = 1 \times 2^0 + 0 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3} = 1 + 0 + 0 + .125 = 1.125$

2.1.2 Decimal-binary Conversion: Decimal numbers are converted into binary by a method called *Double Dabble Method.* In this method, the mantissa part of the number is repeatedly divided by two and noting the reminders, which will be either 0 or 1. This division is continued till the mantissa becomes zero. The remainders, which are noted down during the division is read in the reverse order to get the binary equivalent. This can be better illustrated using the following example.

2	14	Remainder
2	7	0
2	3	1
2	1	1
2	0	1
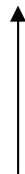
The number is written from below, that is 1110. So the binary equivalent of 14 is 1110

If the decimal number has a fractional part, then the fractional part is converted into binary by multiplying it with 2. Only the integer of the result is noted and the fraction is repeatedly multiplied by 2 until the fractional part becomes 0. This can be explained using the following example.

```
    0.125
    X 2
    ──────
    0.25    0
    X 2
    ──────
    0.5     0
    X 2
    ──────
    0       1
    ──────
```

Here the number is written from top - 0.001. So the binary equivalent of 0.125 is 0.001

2.1.3 Fixed-Point Representation of Number

In the fixed-point number representation system, all numbers are represented as integers or fractions. Signed integer or BCD numbers are referred to as fixed-point numbers because they contain no information regarding the location of the decimal point or the binary point. The binary or decimal point is assumed to be at the extreme right or left of the number.

If the binary or decimal point is at the extreme right of the computer word, then all numbers are positive or negative integers. If the radix point is assumed to be at the extreme left, then all numbers are positive or negative fractions.

Consider that you have to multiply 23.15 and 33.45. This will be represented a 2315 x 3345. The result will be 7743675. The decimal point has to be placed by the user to get the correct result, which is 774.3675. So in the fixed-point representation system, the user has to keep track of the radix point, which can be a tedious job.

2.1.4 Floating-Point Representation of Number

In most computing applications, fractions are used very frequently. So a system of number representation which automatically keeps track of the position of the binary or decimal point is better than the fixed-point representation. Such a system is the floating-point representation of numbers.

A number, which has both an integer part and a fractional part, is called a real number or a floating-point number. These numbers can be either positive or negative. Examples of real numbers (decimal) are 123.23, -56.899, 0.008, etc. The real number 123.23 can be written as 1.2323×10^2 or 0.12323×10^3. Similarly the numbers 0.008 and 1345.66 can be represented as 0.8×10^{-2} and 1.34566×10^3 respectively. This kind of representation is called the *scientific representation.* Using this scientific form, any number can be expressed as a combination of a mantissa and an exponent, or in other words, the number 'n' can be expressed as 'n = m re' where 'm' is the **mantissa, 'r' is the radix** of the number system and 'e' is the **exponent.**

In a computer also the real or floating-point number is represented by two parts mantissa and exponent. Mantissa is a signed fixed point number and the exponent indicates the position of the binary or decimal point. For example, the number 123.23 is represented in the floating-point system as:

Sign
0   .12323
Mantissa

Sign
0   03
Exponent

The zero in the leftmost position of the mantissa and exponent indicates the plus sign. The mantissa can be either a fraction or an integer, which is dependent on the computer

manufacturer. Most computers use the fractional system of representation for mantissa. The decimal point shown above is an assumed decimal point and is not stored in the register.

The exponent of the above example, +3, indicates that the actual decimal point is 3 digits to the right of the assumed one. In the above example, the mantissa is shown as a fraction. As mentioned, we can use an integer as **the mantissa.** The following example shows how it is done.

Sign
0   .12323
Mantissa

Sign
1   02
Exponent

In the above representation, the sign of the exponent is negative and it indicates that the actual decimal point lies 2 decimal positions to the left of the assumed point (in this case, the assumed decimal point is placed at the extreme right of the integer or 12323.)

A negative number say -123.23 can be expressed as follows.

Sign
1   .12323
Mantissa

Sign
0   03
Exponent

A negative fraction, say -0.0012323 can be represented as follows.

Sign
1   .12323
Mantissa

Sign
1   02
Exponent

2.1.5 Binary Coded Decimal (BCD)

The BCD is the simplest binary code that is used to represent a decimal number. In the BCD code, 4 bits represent a decimal number.

2.1.6 ASCII CODE

ASCII stands for American Standard Code for Information Interchange. ASCII code is used extensively in small computers, peripherals, instruments and communications devices. It has replaced many of the special codes that were previously used. It is a seven-bit code.

Microcomputers using 8-bit word length use 7 bits to represent the basic code. The 8th bit is used for parity or it may be permanently 1 or 0.

With 7 bits, up to 128 characters can be coded. A letter, digit or special symbol is called a

character. It includes upper and lower case alphabets, numbers, punctuation mark and special and control characters.

ASCII-8 Code: A newer version of ASCII is the ASCII-8 code, which is an 8-bit code. With 8 bits, the code capacity is extended to 256 characters.

2.1.7 EBCDIC Code

EBCDIC stands for Extended BCD Interchange Code. It is the standard character code for large computers. It is an 8-bit code without parity. A 9th bit can be used for parity. With 8 bits up to 256 characters can be coded.

In ASCII-8 and EBCDIC, the first 4 bits are known as zone bits and the remaining 4 bits represent digit values. In ASCII, the first 3 bits are zone bits and the remaining 4 bits represent digit values.

Some examples of ASCII and EBCDIC values are shown in the table 3.

Table 3: ASCII and EBCDIC Codes

Character	ASCII	EBCDIC
0	00110000	11110000
1	00110001	11110001
2	00110010	11110010
3	00110011	11110011
4	00110100	11110100
5	00110101	11110101
6	00110110	11110110
7	00110111	11110111
8	00111000	11111000
9	00111001	11111001
A	01000001	11000001
B	01000010	11000010
C	01000011	11000011
D	01000100	11000100
E	01000101	11000101

F	01000110	11000110
G	01000111	11000111
H	01001000	11001000
1	01001001	11001001
1	01001010	11010001
K	01001011	11010010
L	01001100	11010011
M	01001101	11010100
N	01001110	11010101
0	01001111	11010110
p	01010000	11010111
Q	01010001	11011000
R	01010010	11011001
S	01010011	11100010
T	01010100	11100011
U	01010101	11100100
V	01010110	11100101
w	01010111	11100110
x	01011000	11100111
Y	01011001	11101000
Z	01011010	11101001

2.2 BITS, BYTES AND WORDS

A **byte** is a basic grouping of bits (binary digits) that the computer operates on as a single unit. It consists of 8 bits and is used to represent a character by the ASCII and EBCDIC coding systems. For example, each storage location of computers using EBCDIC or ASCII-8 codes consist of electronic circuit elements or magnetic or optical media positions that can represent at least 8 bits. Thus each storage location can hold one character. The capacity of a computer's primary storage and its secondary storage devices is usually expressed in terms of bytes.

A word is a grouping of bits (usually larger than a byte) that is transferred as a unit between primary storage and the registers of the ALU and control unit. Thus, a computer with a 32-bit word length might have registers with a capacity of 32 bits, and transfer data and instructions within the CPU in groupings of 32 bits. It should process data faster than computers with a 16-bit or 8-bit word length.

However, processing speed also depends on the size of the CPU's data path or data bus, which are the circuits that interconnect the various **CPU components.** For example, a microprocessor like the Intel 80386 SX has 32-bit registers but only a 16-bit data bus. Thus, it only moves data and instructions 16 bits at a time. Hence, it is slower than Intel 80386 DX microprocessor, which has 32-bit registers and data **paths.**

Lots of Bites: When you start talking about lots of bytes, you get into **prefixes** like kilo, mega and giga, as in kilobyte, megabyte and gigabyte (also shortened to K, M and G, as in Kbytes, Mbytes and Gbytes or KB, MB and GB) The following table shows the multipliers:

Name	Abbr.	Size
Kilo	K	2^10 = 1,024
Mega	M	2^20 = 1,048,576
Giga	G	2^30 = 1,073,741,824
Tera	T	2^40 = 1,099,511,627,776
Peta	P	2^50 = 1,125,899,906,842,624
Exa	E	2^60 = 1,152,921,504,606,846,976
Zetta	Z	2^70 = 1,180,591,620,717,411,303,424
Yotta	Y	2^80 = 1,208,925,819,614,629,174,706,176

You can see in this chart that kilo is about a thousand, mega is about a million, giga is about a billion, and so on. So when someone says, "This computer has a 2 giga hard drive," what he or she means is that the hard drive stores 2 gigabytes, or approximately 2 billion bytes, or exactly 2,147,483,648 bytes. How could you possibly need 2 gigabytes of space? When you consider that one CD holds 650 megabytes, you can see that just three CDs worth of data will fill the whole thing! Terabyte databases are fairly common these days, and there are probably a few petabyte databases floating around the world by now.

2.8

2.3   CONCEPTS RELATED TO DATA

2.3.1 Double Precision: Real data values are commonly called single precision data because each real constant is stored in a single memory location. This usually gives seven significant digits for each real value. In many calculations, particularly those involving iteration or long sequences of calculations, single precision is not adequate to express the precision required. To overcome this limitation , many programming languages provide the double precision data type. Each double precision is stored in two memory locations, thus providing twice as many significant digits.

2.3.2 Logical Data Type: Use the Logical data type when you want an efficient way to store data that has only two values. Logical data is stored as true (.T.) or false (.F.)

Data Type	Description	Size	Range
Logical	Boolean value of true or false	1 byte	True (.T.) or False (.F.)

2.3.3 Characters: Choose the Character data type when you want to include letters, numbers, spaces, symbols, and punctuation. Character fields or variables store text information such as names, addresses, and numbers that are not used in mathematical calculations. For example, phone numbers or zip codes, though they include mostly numbers, are actually best used as Character values.

Data Type	Description	Size	Range
Character	1 byte per character to 254	1 byte	Any characters

2.3.4   Strings:A data type consisting of a sequence of contiguous characters that represent the characters themselves rather than their numeric values. A **String** can include letters, numbers, spaces, and punctuation. The **String** data type can store fixed-length strings ranging in length from 0 to approximately 63K characters and dynamic strings ranging in length from 0 to approximately 2 billion characters. The dollar sign (**$**) type-declaration character represents a **String.**

The codes for String characters range from 0–255. The first 128 characters (0–127) of the character set correspond to the letters and symbols on a standard U.S. keyboard. These first 128 characters are the same as those defined by the ASCII character set. The second 128 characters (128–255) represent special characters, such as letters in international alphabets, accents, currency symbols, and fractions.

2.3.5 Variables: A variable is something that may change in value. A variable might be the

number of words on different pages of this booklet, the air temperature each day, or the exam marks given to a class of school children.

2.3.6 Memo Data Type: Use the Memo data type if you need to store more than 255 characters. A Memo field can store up to 65,536 characters. If you want to store formatted text or long documents, you should create an OLE Object field instead of a Memo field.

2.4. KEY

The word "**key**" is much used and abused in the context of relational database design. In pre-relational databases (hierarchtical, networked) and file systems (ISAM, VSAM, *etc.*) "key" often referred to the specific structure and components of a linked list, chain of pointers, or other physical locator outside of the data. It is thus natural, but unfortunate, that today people often associate "key" with a RDBMS "index". We will explain what a key is and how it differs from an index.

A key is a set of one or more columns whose combined values are *unique* among all occurrences in a given table. **A key is the relational means of specifying uniqueness**.

There are only three types of relational keys.

2.4.1 Candidate Key: As stated above, a **candidate key** is any set of one or more columns whose combined values are unique among all occurrences (i.e., tuples or rows) Since a null value is not guaranteed to be unique, no component of a candidate key is allowed to be null.

There can be any number of candidate keys in a table. Relational pundits are not in agreement whether *zero* candidate keys is acceptable, since that would contradict the (debatable) requirement that there must be a primary key.

2.4.2 Primary Key: The **primary key** of any table is any candidate key of that table which the database designer arbitrarily designates as "primary". The primary key may be selected for convenience, comprehension, performance, or any other reasons. It is entirely proper to change the selection of primary key to another candidate key.

Enrollment	
student	class
PK	

Enrollment		
student	class	row id
		PK

As we will see below, there is no property of a primary key which is not shared by all other candidate keys of the table *except* this arbitrary designation. Unfortunately RDBMS products have come to rely on the primary key almost to the exclusion of the concept of candidate keys, which are rarely supported by software.

2.4.3 Alternate Key : The **alternate key**s of any table are simply those candidate keys which are not currently selected as the primary key. An alternate key is a *function* of all candidate keys *minus* the primary key.

Therefore it is completely incorrect and misleading that several data modeling products (e.g., ERwin, Silverrun, PowerDesigner) provide "alternate keys" which are selected arbitrarily by the designer, without qualifying the alternates as unused candidate keys, in fact without any mechanism to even designate candidate keys.

There is an insidious trap in the fallacy of not supporting candidate keys and providing arbitrary primary and alternate keys instead. Designers become accustomed to the fact the a primary key is unique and often assign a primary key just to obtain uniqueness. If this requirement of uniqueness *per se* is not recorded, then there is a danger that at some point someone else may eventually change the primary key (for example, to a system assigned number) and lose the original enforcement of uniqueness on what had been the primary key.

Let's look at this simple association or join table below which holds student class enrollment:

This is the default form, and often the only form taught or recommended for a join table. The primary key of each contribution table is inherited so that this table has a compound primary key. Since the Data Definition Language (DDL) will create a unique index on the two columns, the designer knows that each student-class pair will be unique; i.e., each student may enroll in each class only once.

Several years later a new Data Base Administrator (DBA) decides that it is inefficient to use two columns for the primary key where one would do. She adds a "row id" column and makes it the primary key by loading it with a system counter. This is fine as far as an identity for each row. But now nothing prevents a student from enrolling in the same class multiple times!

Enrollment			Enrollment		
student	class	row id	student	class	row id
CK	CK		AK		PK

This happened because the data model did not retain a candidate key property on the two original columns when the primary key was changed. Therefore the new DBA had no direct way of knowing (other than text notes somewhere) that these two columns must still remain unique, even though they are no longer part of the primary key.

Notice here how this could have been handled automatically by the model, if it had captured candidate keys in the first place and then generated alternate keys as a function of those candidates not in the primary key. The original two columns remain unique even after they are no longer primary.

2.4.4 Secondary Key: Secondary keys can be defined for each table to optimize the data access. They can refer to any column combination and they help to prevent sequential scans over the table. Like the primary key, the secondary key can consist of multiple columns.

A candidate key which is not selected as a primary key is known as Secondary Key.

2.4.5 Referential Integrity: A feature provided by relational database management systems (RDBMS's) that prevents users or applications from entering inconsistent data. Most RDBMS's have various referential integrity rules that you can apply when you create a relationship between two tables.

For example, suppose Table B has a *foreign key* that points to a field in Table A. Referential integrity would prevent you from adding a record to Table B that cannot be linked to Table A. In addition, the referential integrity rules might also specify that whenever you delete a record from Table A, any records in Table B that are linked to the deleted record will also be deleted. This is called *cascading delete.* Finally, the referential integrity rules could specify that whenever you modify the value of a linked field in Table A, all records in Table B that are linked to it will also be modified accordingly. This is called *cascading update.*

2.4.6 Index Fields: Index fields are used to store relevant information along with a document. The data input to an Index Field is used to find those documents when needed. The program provides up to twenty-five user-definable Index Fields in an Index Set.

An index field can be one of three types:

> Drop-Down Look-Up List,
>
> Standard,
>
> Auto-Complete History List.

2.4.7 Currency Fields – These automatically display the data entered as dollar amounts. They have a scroll bar attached to move the amount up or down in increments of one dollar.

2.4.8 Date Fields – These automatically display data entered in date format. Click on the arrow at the end of the field to display a Calendar Window to choose a date.

2.4.9 Integer Fields – These automatically display data as a whole number.

2.4.10 Text Fields – These display data as an alpha-numeric text string

2.5 WHAT IS DATA PROCESSING

Data are a collection of facts - unorganized but able to be organized into useful information. A collection of sales orders, time sheets, and class registration cards are a few examples. Data are manipulated to produce output, such as bills and pay cheques. When this output can be used to help people make decisions, it is called *information.*

Processing is a series of actions or operations that convert inputs into outputs. When we

speak of data processing, the input is data, and the output is useful information. Hence, data processing is defined as series of actions or operations that converts data into useful information. *The data processing* system is used to include the resources such as people, procedures, and devices that are used to accomplish the processing of data for producing desirable output.

Thus, data are the raw material for information and just as raw materials are transformed into finished products by a manufacturing process, raw data are transformed into information by data processing.

2.5.1 Data storage Hierarchy: The basic building block of data is a *character*, which consists of letters (A, B, C ... Z), numeric digits (0, 1, 2 ... 9) or special characters (+, -, /, *, .1 $ ...) These characters are put together to form a field (also called a fact, data item, or data element) A *field* is a meaningful collection of related characters. It is the smallest logical data entity that is treated as a single unit in data processing.

For example, if we are processing employees data of a company, we may have an employee code field, an employee name field, an hours worked field, a hourly-pay-rate field, a tax-rate-deduction field, etc. Fields are normally grouped together to form a record. *A record*, then, is a collection of related fields that are treated as a single unit. An employee record would be a collection of fields of one employee. These fields would include the employee's code, name, hours-worked, pay-rate, tax-rate-deduction, and so forth. Records are then grouped to form a file. A **file** is a number of related records that are treated as a unit. For example, a collection of all employee records for one company would be an employee file. Similarly, a collection of all inventory records for a particular company forms an inventory file. Figure 2.1 reveals these data relationships.

It is customary to set up a master file of permanent (and, usually, the latest) data, and to use *transaction files* containing data of a temporary nature. For example, the master payroll file will contain not only all the permanent details about each employee, his name and code, pay-rate, income tax rate and so forth, but it will also include the current gross-pay-to-date total and the tax paid-to-date total. The transaction payroll file will contain details of hours worked this week, normal and overtime, and, if piecework is involved, the quantity of goods made. When the payroll program is processed, both files will have to be consulted to generate this week's payslips, and the master file updated in readiness for the following week.

File of
Related
Records

Customer No. 4

Customer No. 3

Customer No. 2

Customer No. 1

Ref. No.
XXX

Amount
XXX

Item (field) in a Record

Record in a file

Character in an item
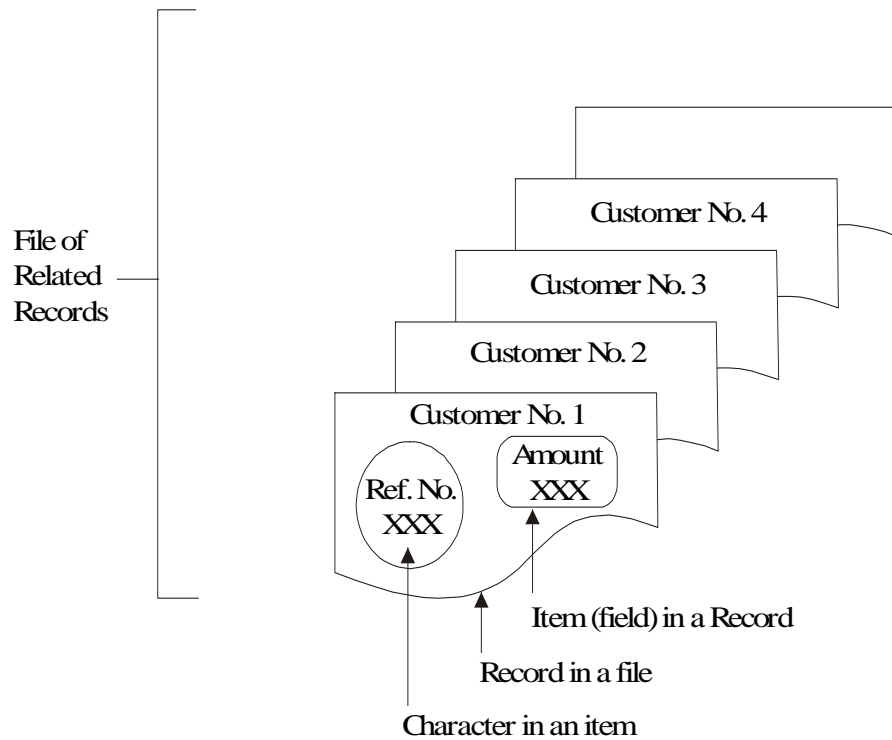
Figure 2.1. Relationship between character, field, record, and file.

A *data base* is a collection of integrated and related master files. It is a collection of logically related data elements that may be structured in various ways to meet the multiple processing and retrieval needs of organizations and individuals. Characters, fields, records, files, and data bases form a hierarchy of data storage. Figure 2.2 summarizes the data storage hierarchy used by computer based processing systems. Characters are combined to make a field, fields are combined to make a record, records are combined to make a file, and files are combined to make a data base.
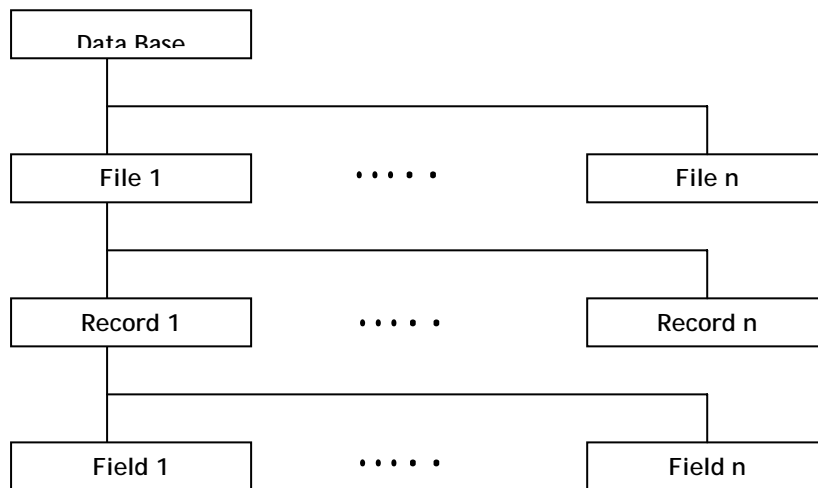
Figure 2.2 : A Data Storage hierarchy

2.6. FILE ORGANIZATIONS

System designers choose to organize, access, and process records and files in different ways depending on the type of application and the needs of users. The three commonly used file organizations used in business data processing applications are - sequential, direct and indexed sequential organizations. The selection of a particular file organization depends upon the type of application. The best organization to use in a given application is the one that happens to meet the user's needs in the most effective and economical manner. In making the choice for an application, designers must evaluate the distinct strengths and weaknesses of each file organization. File organization requires the use of some key field or unique identifying value that is found in every record in the file. The key value must be unique for each record of the file because duplications would cause serious problems. In the payroll example, the employee code field may be used as the key field.

2.6.1 Serial : The simplest organization scheme is serial. With serial organization, records are arranged one after another, in no particular order- other than, the chronological order in which records are added to the file. Serial organisation is commonly found with transaction data, where records are created in a file in the order in which transactions take place.

Records in a serially organized file are sometimes processed in the order in which they occur. For example, when such a file consists of daily purchase and payment transaction data, it is often used to update records in a master account file. Since transactions are in random order

by key field, in order to perform this update, records must be accessed randomly from the master file.

Transaction data is not the only type of data found in serially organized files. In many businesses, customer account numbers are issued in a serial manner. In this scheme, a new customer is given the next highest account number that has not been issued and the data about the new customer (such as name, address, and phone number) are placed at the end of the existing customer account file. When this approach is used, it is easy to distinguish the long-time customers from the new ones; the long-time customers have lower account numbers.

2.6.2 Sequential files: In a sequential file, records are stored one after another in an ascending or descending order determined by the key field of the records. In payroll example, the records of the employee file may be organized sequentially by employee code sequence. Sequentially organized files that are processed by computer systems are normally stored on storage media such as magnetic tape, punched paper tape, punched cards, or magnetic disks. To access these records, the computer must read the file in sequence from the beginning. The first record is read and processed first, then the second record in the file sequence, and so on. To locate a particular record, the computer program must read in each record in sequence and compare its key field to the one that is needed. The retrieval search ends only when the desired key matches with the key field of the currently read record. On an average, about half the file has to be searched to retrieve the desired record from a sequential file.

Advantages of sequential files

➢ Easy to organize, maintain, and understand.

➢ There is no overhead in address generation. Locating a particular record requires only the specification of the key field.

➢ Relatively inexpensive 1/0 media and devices can be used for the storage and processing of such files.

➢ It is the most efficient and economical file organization in case of applications in which there are a large number of file records to be updated at regularly scheduled intervals. That is, when the activity ratio (the ratio of the total number of records in transaction file and the total number of records in master file) is very high. Applications such as payroll processing, billing and statement preparation, and bank cheque processing meet these conditions.

Disadvantages of sequential Files

➢ It proves to be very inefficient and uneconomical for applications in which the activity ratio is very low.

2.16

➢ Since an entire sequential file may need to be read just to retrieve -and update few records, accumulation of transactions into batches is required before processing them.

➢ Transactions must be sorted and placed in sequence prior to processing.

➢ Timeliness of data in the file deteriorates while batches are being accumulated.

➢ Data redundancy is typically high since the same data may be stored in several files sequenced on different keys.

2.6.3 Direct Access File Organisation : Direct file organisation allows immediate direct access to individual records on the file. The most widely used direct access techniques are depicted in the chart below :-
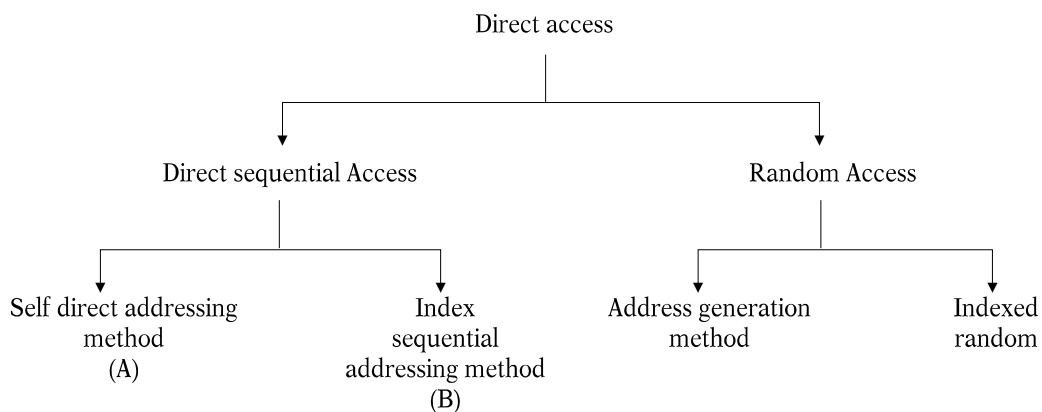
Fig. 2.3

The primary storage in a CPU truly provides for direct access. There are some devices outside the CPU which can provide the direct access feature, the direct access storage devices (DASD) have the capability of directly reaching any location. Although there are several types of direct storage devices including discs and other mass storage devices, discs are by far the most widely used direct access storage devices. We will now describe the methods A-B mentioned above to show how data are stored on magnetic disks using these methods.

2.6.4 Direct Sequential Access Methods

(A) Self (Direct) Addressing : Under self direct addressing, a record key is used as its relative address. Therefore, we can compute the record's address directly from the record key and the physical address of the first record in the file.

Thus, this method is suitable for determining the bucket address of fixed length records in a sequential file, and in which the keys are from a complete or almost complete range of consecutive numbers. Suppose we want to store 1,60,000 payroll records cylinder-wise in the magnetic disc pack of 6 discs. The first cylinder carries the first 800 records, the 2nd cylinder

carries the next 800 records, and so on. For periodic processing of the file, the read/write heads would move cylinder by cylinder in which the records have been sequentially arranged. For example, the ten faces in the first cylinder would carry the first 800 records as below :

$f_{1, 1}$ 1 to 80

$f_{1, 2}$ 81 to 160

:

:

:

$f_{1, 10}$ 721 to 800

How do we have direct access then in such a file organisation ? There are a total of 16,000 buckets. Let the bucket address range from 10,001 to 26,000. And the keys of the records range from 1 to 1,60,000. We wish to know where record of the key 1,49,892 is to be found *i.e.,* in which bucket it is stored. The following arithmetic computations would have to be performed towards this purpose.

1.   Divide the wanted record's key by the number of records per bucket.

2.   Add the first bucket number to the quotient to give the wanted record's bucket:

     14989 + 10001 = 24990.

3.   The remainder (2) is the record's position within the bucket. The remainder 0 would indicate that it is the last record of the preceding bucket. Thus, if a manager wishes to know the qualification of a particular employee (say, no 149892) i.e., makes a random inquiry, the above computations would be performed to derive the bucket number, command the read/write heads to move to that bucket and supply the wanted information.

But this method is highly impractical because files too have gaps in the keys and this would leave too many empty buckets *i.e.,* storage would not be compact.

The advantage of Self-addressing is that there is no need to store an index.

The disadvantages of Self-addressing are :

(i)   The records must be of fixed length.

(ii) If some records are deleted their storage space remains empty.

(B) Indexed-Sequential File Organisation : *The indexed sequential file organisation or indexed sequential access method* (ISAM), is a hybrid between sequential and direct access file organisations. The records within the file are stored sequentially but direct access to

individual records is possible through an index. This index is analogous to a card catalog in a library. Figure 2.4 illustrates a cylinder and track index for an ISAM file.

Cylinder Index

Cylinder	Highest Record key in the Cylinder
1	84
2	250
3	398
4	479
5	590

Cylinder 1 Track index		Cylinder 2 Track index		Cylinder 3 Track index	
Track	Highest record key in the Track	Track	Highest record key in the Track	Track	Highest record key in the Track
1	15	1	94	1	280
2	40	2	110	2	301
3	55	3	175	3	330
4	75	4	225	4	365
5	84	5	250	5	398

Fig. 2.4

To locate a record, the cylinder index is searched to find the cylinder address, and then the track index for the cylinder is searched to locate the track address of the desired record. Using Fig. 2.4 to illustrate, we assume that the desired record has a key value of 225. The cylinder address is 2, since 225 is greater than 84 but less than 250. Then, we search the track index for cylinder 2 and find that 225 is greater than 175 and equal to 225, therefore, the track address is 4. With the cylinder address, control unit can then search through the records on track 4 within cylinder 2 to retrieve the desired records.

Advantages of indexed sequential files

➢ Permits the efficient and economical use of sequential processing techniques when the activity ratio is high.

➢ Permits direct access processing of records in a relatively efficient way when the activity ratio is low.

Disadvantages of indexed sequential files

➤ These files must be stored on a direct-access storage device. Hence, relatively expensive hardware and software resources are required.

➤ Access to records may be slower than direct files.

➤ Less efficient in the use of storage space than some other alternatives.

2.6.5 Random Access Organisation : In this method, transactions can be processed in any order and written at any location through the stored file. To access a record, prior records need not be examined first. The CPU can go directly to the desired record using randomizing procedure without searching all the others in the file.

Randomizing Procedure is characterised by the fact that records are stored in such a way that there does not exist any simple relationship between the keys of the adjacent records. The technique provides for converting the record key number to a physical location represented by a disk address through a computational procedure.

Advantages of Direct Files

➤ The access to, and retrieval of a record is quick and direct. Any record can be located and retrieved directly in a fraction of a second without the need for a sequential search of the file.

➤ Transactions need not be sorted and placed in sequence prior to processing.

➤ Accumulation of transactions into batches is not required before processing them. They may be processed as and when generated.

➤ It can also provide up-to-the minute information in response to inquiries from simultaneously usable online stations.

➤ If required, it is also possible to process direct file records sequentially in a record key sequence.

➤ A direct file organization is most suitable for interactive online applications such as airline or railway reservation systems, teller facility in banking applications, etc.

Disadvantages of direct files

➤ These files must be stored on a direct-access storage device. Hence, relatively expensive hardware and software resources are required.

➤ File updation (addition and deletion of records) is more difficult as compared to sequential files.

➤ Address generation overhead is involved for accessing each record due to hashing function.

➢ May be less efficient in the use of storage space than sequentially organized files.

➢ Special security measures are necessary for online direct files that are accessible from several stations.

2.6.6 THE BEST FILE ORGANIZATION

Several factors must be considered in determining the best file organization for a particular application. These factors are file volatility, file activity, file size, and file interrogation requirements.

File volatility : It refers to the number of additions and deletions to the file in a given period of time. The payroll file for a construction company where the employee roster is constantly changing is a highly volatile file. An ISAM file would not be a good choice in this situation, since additions would have to be placed in the overflow area and constant reorganization of the file would have to occur. Other direct access methods would be better. Perhaps even sequential file organization would be appropriate if there were no interrogation requirements.

File activity : It is the proportion of master file records that are actually used or accessed in a given processing run. At one extreme is the real-time file where each transaction is processed immediately and hence at a time, only one master record is accessed. This situation obviously requires a direct access method. At the other extreme is a file, such as a payroll master file, where almost every record is accessed when the weekly payroll is processed. There, a sequentially ordered master file would be more efficient.

File interrogation : It refers to the retrieval of information from a file. If the retrieval of individual records must be fast to support a real-time operation such as airline reservation then some kind of direct organization is required. If, on the other hand, requirements for data can be delayed, then all the individual requests or information can be batched and run in a single processing run with a sequential file organization.

Large files that require many individual references to records with immediate response must be organized under some type of direct access method. On the other hand, with small files, it may be more efficient to search the entire file sequentially or, with a more efficient binary search, to find an individual record than to maintain complex indexes or complex direct addressing scheme.

2.7 DATA BASE MANAGEMENT SYSTEMS

Traditional sequential and random files are designed to meet specific information and data processing requirements of a particular department such as accounting, sales, or purchasing etc. Different files are created to support these functions, but many of the fields on each of these files are common. For example, each of these functional areas need to maintain customer data such as customer name, address and the person to be contracted at the

customer location etc. In a traditional file environment, when information relating to any of the fields change, each relevant file must be updated separately.

Through the early 1980s, most information systems were implemented in an environment with a single functional objective (such as accounts receivable, purchase accounting, payroll etc.) in mind. The integration of information systems was not a priority. As a result, today many companies are burdened with massive systems and data redundancies. These data redundancies cause inefficiencies and result in unnecessary expenses. Today companies are using database management systems software (DBMS) as a tool to integrate information flow within an organisation.

2.7.1 What is a DBMS? : A DBMS is the tool that computers use to achieve the processing and orderly storage of data. A data base is a repository for related collection of data. For example, an address book can be a data base where the names, address and telephone numbers of friends and business contacts are stored. A company data base might contain information about customers, vendors, employees, sales and inventory. Each piece of information can be added to a data base and extracted later in a meaningful way. DBMS is the program (or collection of programs) that allows users (and other programs) to access and work with a database.

Database programs for personal computers come in many shapes, sizes and variations. Some popular PC data base programs are developed by the same companies that make popular spreadsheets, word processors, and other software. These include dBase IV and Paradox from Borland International; Access and FoxPro from Microsoft; Q & A from Symantec; Lotus Approach, and File Maker Pro from Claris. For larger systems and Unix and OS/2 computers, Oracle Ingnes, Informix, and OS/2 Database Manager are some of the DBMS available. In this chapter, we will explore the world of DBMS.

2.7.2 An example of File Processing Approach : A simple example to illustrate why organisations started using database processing as an alternative to traditional file processing:

A firm might have a customer credit file containing data such as :

♦ Customer number

♦ Customer name and address

♦ Credit code

♦ Credit limit

Another file, called a customer master file, contains:

♦ Customer number

♦ Customer name and address

♦ Sales region number

♦ Salesperson number

♦ Customer class

♦ Shipping code

♦ Year to date sales this year

♦ Year to date sales last year

A third file, for accounts receivable, contains:

♦ Customer number

♦ Customer name and address

♦ First invoice data

  Invoice number

  Invoice date

  Invoice amount

♦ Second invoice data

  Invoice number

  Invoice date

  Invoice amount

♦ nth invoice data

  Invoice number

  Invoice date

  Invoice amount

Each of these files has one or more purposes. The customer credit file is used for approving customer orders, the customer master file is used for invoicing customers, and the accounts receivable file represents the money which is to be recovered from customers on account of sales by the firm. All are master files.

Some redundancies are found in the data elements contained within the files. All three files include customer number, and customer name and address. This redundancy is necessary since each file is designed to provide all of the data needed by a particular program.

Let us assume that the sales manager wants a report showing the amount of receivables by a salesperson. The firm's customers have not been paying their bills promptly, and the sales manager wants to know which sales persons have neglected to follow up on past due receivables. He wants the report to include the data listed in Table . It can be seen that this special report will require data from four files. A salesperson master file is needed to provide the sales person name.

Table 1 : Integration of report data from several files

Report Data	Customer Credit File	Customer Master File	Accounts Receivable File	Salesperson Master File
Salesperson number		X		
Sales person Name				X
Customer Data				
Customer number		X		
Customer name		X		
Credit code	X			
Year to date sales this year		X		
Total accounts receivable			X	

The report will list each customer by salesperson, following the process illustrated in Figure 2.5. In step 1 a program selects data from the three customer files that are maintained in customer number sequence. An intermediate file is created with the selected data (all the data elements listed in Table 1 except salesperson name) This intermediate file is stored into salesperson sequence in step 2. A sort is necessary since the salesperson master file is maintained in salesperson sequence. A second intermediate file is created and used with the salesperson master file to prepare the report in step 3. The programs for step 1 and step 3 would have to be specially written to satisfy this request.

Similarly a manager may require ad hoc reports for management information. For example, a manager might request a report showing sales for sales person 23. Assume that the firm assigns certain customers in a territory to a salesperson and that a customer file contains a record for each customer. The task is to select records for salesperson 23 only and print data on the report. Since the customer file is in sequence by customer, each record will have to be examined to determine if the sales person field contains a 23. This could be a time consuming process.
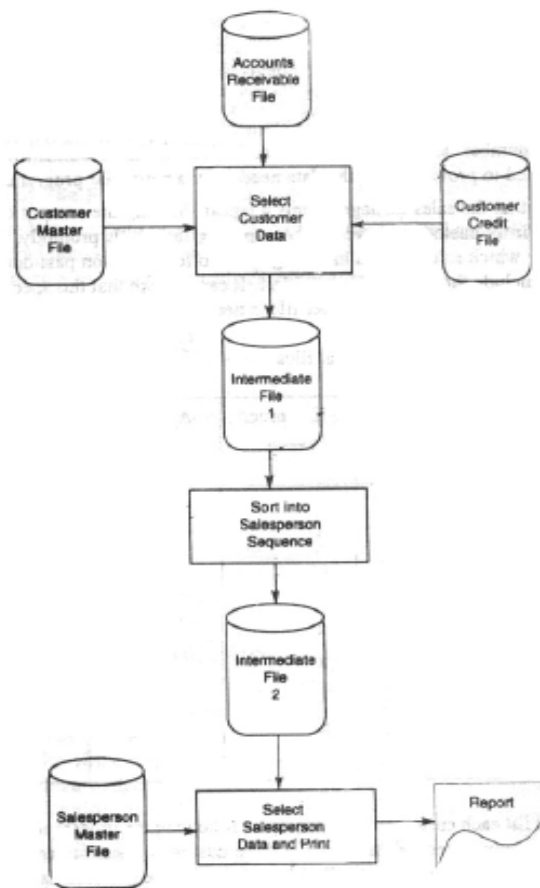
Fig. 2.5

2.7.3 Management Problems of File Processing : For many years, information systems had a file processing orientation, as illustrated in the previous example. Data needed for each user application was stored in independent data files. Processing consisted of using separate computer programs that updated these independent data files and used them to produce the documents and reports required by each separate user application. This file processing approach is still being used, but it has several problems that limit its efficiency and effectiveness for end user applications.

1. Data Duplication: Independent data files include a lot of duplicated data; the same data (such as a customer's name and address) is recorded and stored in several files. This data

redundancy causes problems when data has to be updated, since separate file maintenance programs have to be developed and coordinated to ensure that each file is properly updated. Of course, this proves difficult in practice, so a lot of inconsistency occurs among data stored in separate files.

2. Lack of Data Integration: Having data in independent files makes it difficult to provide end users with information for ad hoc requests that require accessing data stored in several different files. Special computer programs have to be written to retrieve data from each independent file. This is difficult, time consuming, and expensive for the organisations.

3. Data Dependence: In file processing systems, major components of a system i.e., the organisation of files, their physical locations on storage, hardware and the application software used to access those files depend on one another in significant ways. For example, application programs typically contain references to the specific format of the data stored in the various files they use. Thus, if changes are made in the format and structure of data and records in a file, changes have to be made in all the programs that use this file. This program maintenance effort is a major burden of file processing systems. It is difficult to do it properly, and it results in a lot of inconsistency in the data files.

4. Other Problems: In file processing systems, data elements such as stock numbers and customer addresses are generally defined differently by different end users and applications. This causes serious inconsistency in the development of programs which access such data. In addition, the integrity (i.e. the accuracy and completeness) of the data is suspected because there is no control over their use and maintenance by authorized end users.

2.7.4 The Database Management Solution : The concepts of databases and database management were, therefore, developed to solve the problems of file processing systems. A database is an integrated collection of logically related records and files. It consolidates records previously stored in independent files so that it serves as a common pool of data to be accessed by many different application programs. The data stored in a database is independent of the computer programs using it and of the type of secondary storage devices on which it is stored. Database management involves the control of how a database is created, interrogated, and maintained to provide information needed by end users and the organisation.

2.8 WHAT IS A DATABASE ?

Regardless of its file organisation, a data base system includes several components that collectively give it certain distinct, specific characteristics. The following is a precise definition of data base as given by "G"M.Scott"."

A data base is a computer file system that uses a particular *file organisation* to facilitate *rapid updating of individual records, simultaneous updating of related records, easy access to all*

records, by all applications programs, and rapid access to all stored data which must be brought together for a particular *routine report* or *inquiry* or a *special purpose report* or *inquiry*.

Each of the italicized phrases in the preceding definition has a special meaning that helps define a database. *"File organisation"* indicates that the database has one of the three file structures (discussed in the next section) that enable programs to establish associations between the records in the database.

A database facilities *"rapid updating of individual records"* and *"simultaneously updating of related records"* that is a data base permits the entry of an individual transaction to update all records affected by that transaction simultaneously. For example, consider a Rs.100,000 credit sale. In a data base system, the following accounts, along with others could be updated simultaneously with the input of one transaction.

♦ Sales record

♦ Salesperson's commissions record

♦ Division sales record

♦ Inventory item record

♦ Accounts receivable customer record

♦ Cost of sales of individual item record

If transactions are entered as they occur, records that are simultaneously updated are continuously up to date for managerial inquiry purposes. Simultaneous updating also means that the records have consistent contents. For example, the total of the sales record would be consistent with the salesperson's commissions record because the latter is based on the former and both are updated at the same time.

"Easy access to all records by all applications programs" means that the standard data definitions and record formats permit, for example, a payroll applications program to access the employee number, and data about them from the personnel section of the data base. It also implies that work force planning programs can access pay rates from the payroll section and employees skills from the personnel section of the database. Without a database, each application program would be able to access data only from its own file.

With respect to *"rapid access"* to all stored data needed of a "routine report or inquiry", routine reports can be provided quickly after the end of the accounting period and often whenever requested during the period if the processing of transactions in kept up to date. This is possible because transfer file processing is not required at the end of the period and because data summarisation of reports can be fully automated within a database. In other words, little period end processing is required. Similarly, inquiries can be routinely made into the files, for example, to see whether a particular product is available for immediately shipment.

Rapid access with respect to a *"special purpose report or inquiry"* means that records are kept continuously up to date for unanticipated inquiries into the files by managers and that the structure of the data base files facilitates the rapid development of special programs to prepare reports about unanticipated problems.

2.8.1 Architecture of a Database : It follows a three level architecture –

(i)   External or user view in different ways to say, the chairman, or the operation manager or the data entry operator,

(ii)   Conceptual or global view,

(iii)   Physical or internal view.

External or user view encircles the following –

(i)   It is at the highest level of the database abstraction,

(ii)   It includes only those portion of database or application programs which is of concern to the users,

(iii)   It is described by means of a scheme, called the external schema,

(iv)   It is defined by the users or written by the programmers.

For example an external view in its Logical Record 1 may indicate employee name, employee address and in its Logical Record 2 may indicate employee name, employee address and employee code and employee salary.

Global or conceptual view, which is viewed by the Data Base Administrator, encompasses the following –

(i)   All database entities and relationships among them are included,

(ii)   Single view represents the entire database,

(iii)   It is defined by the conceptual schema,

(iv)   It describes all records, relationships and constraints or boundaries,

(v)   Data description to render it independent of the physical representation.

For example a conceptual view may define employee code as a string of characters, employee address also as a string, employee code as a key and employee salary as an integer.

The physical or internal view contains the following –

(i)   It is at the lowest level of database abstraction,

(ii)   It is closest to the physical storage method,

(iii)   It indicates how data will be stored,

(iv) It describes data structure,

(v) It describes access methods,

(vi) It is expressed by internal schema.

The internal view instead, may define employee name is comprised of 30 characters, employee address is also comprised of 30 characters, employee code is comprised of 5 characters and employee salary is comprised of 12 numbers.
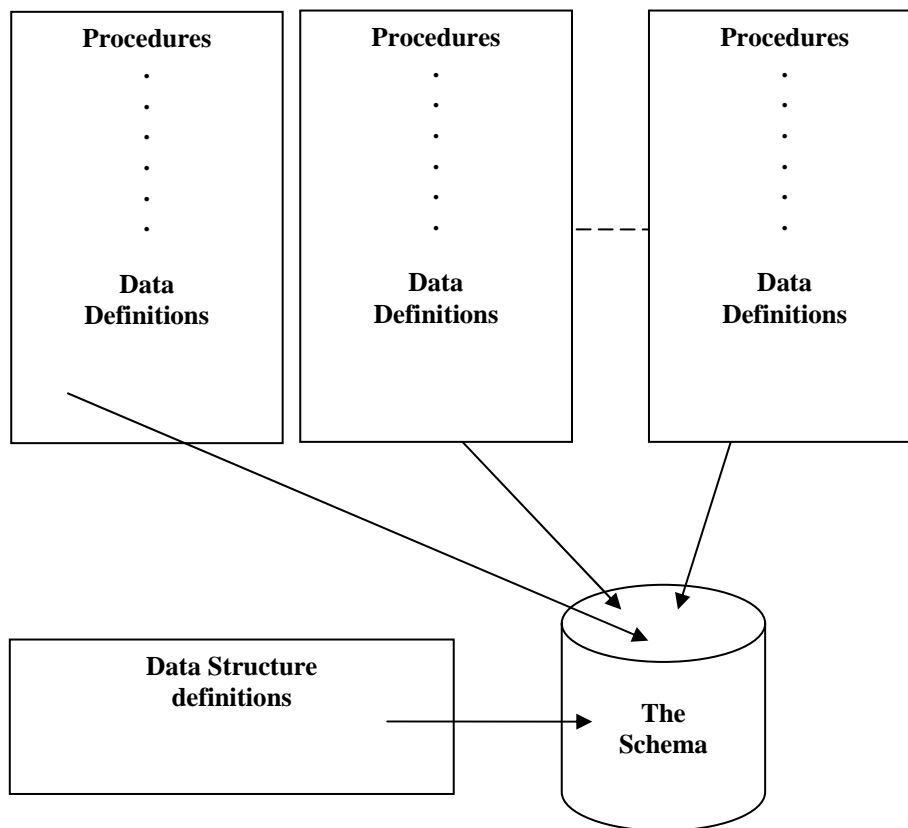
The first step in moving from ordinary file management to a data base system is to separate all data definitions from the applications programs and to consolidate them into a separate entity called a **schema**, as illustrated in the figure. In addition to data definition, the schema also includes an indication of the logical relationships between various components of the data base.

The schema then becomes a component of the overall data base itself. From the schema, the installation can generate dictionaries containing a complete description of the data base. These will, in turn, be used by systems analysts in defining new applications.

Database systems have several schemas, partitioned according to the levels of abstraction that we have discussed. At the lowest level is the **physical schema**; at the intermediate level is the **logical schema**; and at the highest level is a **subschema**.

2.8.2 Data independence:

(i) In a database an ability to modify a schema definition at one level is done without affecting a schema in the next higher level,

(ii) It facilitates logical data independence,

(iii) It assures physical data independence.

2.8.3 Classification of DBMS users:

(i) Naive users who are not aware of the presence of the database system supporting the usage,

(ii) Online users who may communicate with database either directly through online terminal or indirectly through user interface or application programs. Usually they acquire at least some skill and experience in communicating with the database,

(iii) Application programmers who are responsible for developing the application programs and user interfaces,

(iv) Data Base Administrator who can execute centralized control and is responsible for maintaining the database. He is most familiar with the database.

We will now discuss, how data is stored in a database.

2.8.4 File pointers:
File pointers establish linkage between records and are a basic part of the file organisation of all the database models except the relational model. A pointer is placed in the last field of a record, if more than one pointer is used, then in the last fields. A pointer is the address of another, related record that is "pointed to" and the pointer directs the computer system to that related record. File pointers are used with many database organisations.

Linked List : A linked List is a group of data records arranged in an order, which is based on embedded pointers. An embedded pointer is a special data field that links one record to another by referring to the other record. The field is embedded in the first record, i.e. it is a data element within the record.

Linked lists often have a head, which is a pointer to the first record. It has a tail, which points to the last record. One can start at the head and follow the list to the tail, or one can start in the middle and follow the list to the tail. The user cannot, however, start in the middle and go back to the head. In another words, the linked list is a one way street.

<p align="center">Embedded pointer</p>

Customer	Sales person number	Sales person link
22504		
23694	23	25410
24782		
25409		
25410	23	30102
26713		
28914		
30004		
30102	23	30111
30111	23	
30417		
31715		

<p align="center">Fig. 2.6</p>

Figure 2.6 shows a linked list of customer records. Each row is a record (only relevant fields are shown) The records are arranged sequentially using customer number as the key. Each record includes a data element, which identifies assigned salesperson. In the right most field of the record there is a pointer (a link) that chains together all customer records for a particular salesperson in the example it is salesperson 23. It can be assumed that customer 23694 is at the head of the list. The pointer links this record to a record for customer 25410 and so on until the tail for customer 30111 is encountered. The asterisk in the link field indicates the tail of the list.

This chaining feature is very powerful. The application program can initiate a search at the beginning of the file looking for the first customer assigned to salesperson 23. When that record is found, the salesperson links enable the program to follow the chain and process records only for salesperson 23. It is a more convenient method than searching through the entire file.

2.8.5 Record relationship in Database : Organising a large database logically into records and identifying the relationships among those records are complex and time-consuming tasks. There are large number of different records that are likely to be part of a corporate database and the numerous data elements constituting those records. Further, there can be several general types of record relationships that can be represented in a database. These are briefly discussed below:

1. *One –to-one relationships*, as in a single parent record to a single child record or as in a husband record and wife record in a monogamous society [see. figures 2.7(a)].

2. *One-to-many relationships,* as in a single parent record to two or more child records – for example, a teacher who teaches three single-section courses [see figure 2.7(b)].

3. *Many-to-one relationships*, as in two or more parent records to a single child record-for example, when three administrators in a small town share one minister [see figure 2.7(c)].

4. *Many-to-many relationships*, as in two or more parent records to two or more child records – for example, when two or more students are enrolled in two or more courses [See figures 2.7(d)].

2.9 DATABASE STRUCTURES

Three traditional approaches have been implemented commercially to organize records and their relationships logically. These logical organisational approaches are known as database structures. The three traditional database structures are the

1.   Hierarchical database structure

2.   Network database structure

3.   Relational database structure

These models differ in the manner in which data elements (fields) can be logically related and accessed. Hierarchical models are often considered to be the most restrictive and relational models are the most flexible.

(a) One-to-one relationship

```
Husband
  |
 Wife
```

(b) One-to-many relationship

```
          Teacher
   ┌─────────┼─────────┐
Course 1  Course 2  Course 3
```

(c) Many-to-one relationship

```
Fire Chief  Police Chief  Mayor
   └──────────┼──────────┘
          Minister
```

(d) Many-to-many relationship

```
Student 1   Student 2   Student 3
Course 1    Course 2    Course 3
```
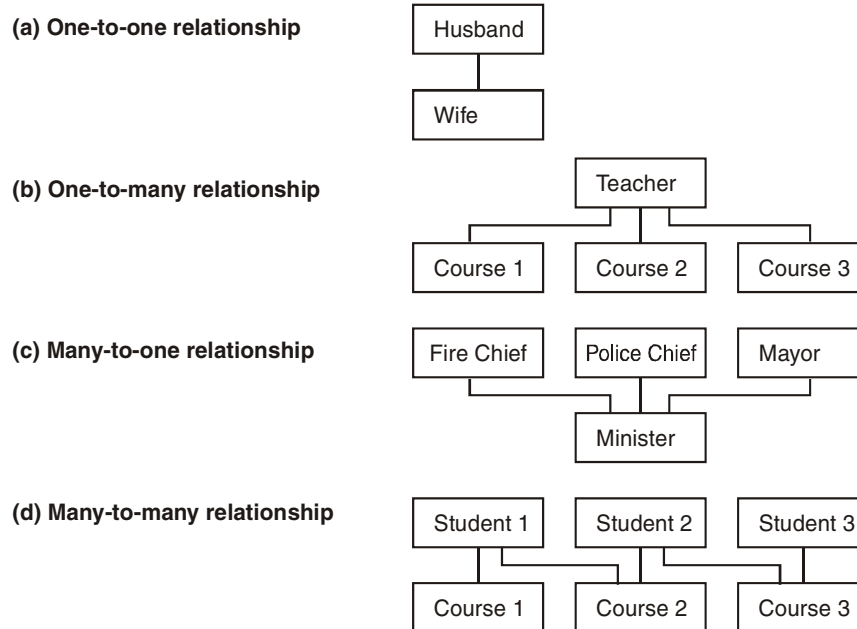
Fig. 2.7

2.9.1 Hierarchical Database Structure : In a hierarchical database structure, records are logically organised into a hierarchy of relationships. A hierarchically structured database is arranged logically in an inverted tree pattern. For example, an equipment database, diagrammed in Figure 2.8, may have building records, room records, equipment records, and repair records. The database structure reflects the fact that repairs are made to equipment located in rooms that are part of buildings.

All records in hierarchy are called **nodes**. Each node is related to the others in a parent-child relationship. Each parent record may have one or more child records, but no child record may have more than one parent record. Thus, the hierarchical data structure implements one-to-one and one-to-many relationships.

The top parent record in the hierarchy is called the *root record*. In this example, building records are the root to any sequence of room, equipment, and repair records. Entrance to this hierarchy by the database management system is made through the root record i.e., building. Records that "own" other records are called *parent records*. For example, room records are the parents of equipment records. Room records are also children of the parent record, building. There can be many levels of node records in a database.
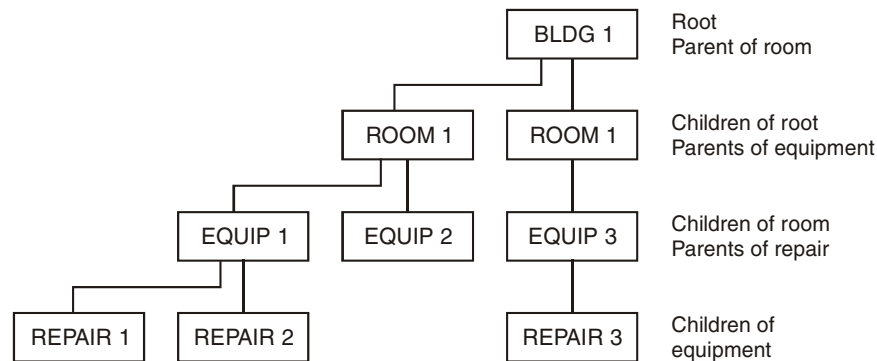
Fig. 2.8

Features of Hierarchical Database

♦ Hierarchically structured database are less flexible than other database structures because the hierarchy of records must be determined and implemented before a search can be conducted. In other words, the relationships between records are relatively fixed by the structure.

♦ Ad hoc queries made by managers that require different relationships other than that are already implemented in the database may be difficult or time consuming to accomplish. For example, a manager may wish to identify vendors of equipment with a high frequency of repair. If the equipment record contain the name of the original vendor, such a query could be performed fairly directly. However, data describing the original vendor may be contained in a record that is a part of another hierarchy. As a result, there may not be any established relationship between vendor records and repair records. Providing reports based on this relationship in a large database is not a minor task and is not likely to be undertaken by the data processing staff for a one-time management query.

♦ Managerial use of query language to solve the problem may require multiple searches and prove to very time consuming. Thus, analysis and planning activities, which frequently involve ad hoc management queries of the database, may not be supported as effectively by a hierarchical DBMS as they are by other database structures.

♦ On the plus side, a hierarchical database management system usually processes structured, day-to-day operational data rapidly. In fact, the hierarchy of records is usually specifically organised to maximise the speed with which large batch operations such as payroll or sales invoices are processed.

♦ Any group of records with a natural, hierarchical relationship to one another fits nicely within the structure. However, many records have relationships that are not hierarchical. For example, many records relationships require that the logical data structure permit a

child record to have more than one parent record. The query to isolate vendors of equipment with extensive repairs might be completed more easily if the equipment records were the children of both the room records and the vendor records

♦ Though a hierarchical database structure does not permit such a structure conceptually, a commercial hierarchical database management system must have ways to cope with these relationships. Unfortunately, they may not always be easy to implement.

2.9.2 Network Database Structure : A network database structure views all records in sets. Each set is composed of an owner record and one or more member records. This is analogous to the hierarchy's parent-children relationship. Thus, the network model implements the one-to-one and the one-to –many record structures. However, unlike the hierarchical mode, the network model also permits a record to be a member of more than one set at one time. The network model would permit the equipment records to be the children of both the room records and the vendor records. This feature allows the network model to implement the many-to-one and the many-to-many relationship types.

For example, suppose that in our database, it is decided to have the following records: repair vendor records for the companies that repair the equipment, equipment records for the various machines we have, and repair invoice records for the repair bills for the equipment. Suppose further that recently four repair vendors have completed repairs on equipment items 1,2,3,4,5, 7 and 8. These records might be logically organized into the sets shown in Figure 2.9.
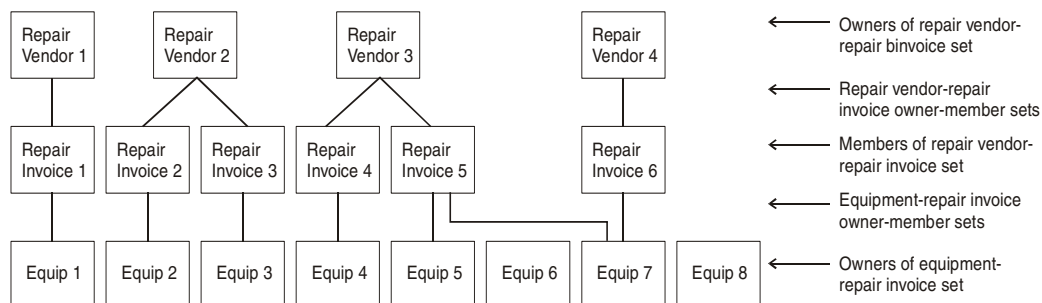
Fig. 2.9

Notice these relationships in the above:

1. Repair Vendor 1 record is the owner of the Repair Invoice 1 record. This is a one-to-one relationship.

2. Repair Vendor 2 record is the owner of the Repair Invoice 2 and 3 records. This is a one-to-many relationship.

3. Repair Vendor 3 record is the owner of Repair Invoice 4 and 5 records, and the Equipment 7 record owns both the Repair Invoice 5 and 6 records because it was fixed twice by different vendors. Because many equipment records can own many Repair Invoice records, these database records represent a many-to-many relationship.

4. Equipment 6 record does not own any records at this time because it is not required to be fixed yet.

5. Equipment 7 and 8 own Repair Invoice 6 because the repairs to both machines were listed on the same invoice by Repair Vendor 4. This illustrates the many-to-one relationship.

Thus, all the repair records are members of more than one owner-member set: the repair vendor-repair invoice set and the equipment-repair invoice set. The network model allows us to represent one-to-one, one-to-many and many-to-many relationships. The network model also allows us to create owner records without member records. Thus, we can create and store a record about a new piece of equipment even though no repairs have been made on the equipment yet.

Unlike hierarchical data structures that require specific entrance points to find records in a hierarchy, network data structures can be entered and traversed more flexibly. Access to repair records, for example, may be made through either the equipment record or the repair vendor record. However, like the hierarchical data model, the network model requires that record relationships be established in advance because these relationships are physically implemented by the DBMS when allocating storage space on disk. The requirement of established sets means that record processing for regular reports is likely to be swift. Record relationships are usually structured to fit the processing needs of large batch reports. However, ad hoc requests for data, requiring record relationships not established in the data model, may not be very swift at all, and in some cases, they may not be possible.

2.9.3 Relational Database Model : A third database structure is the relational database mode. Both the hierarchical and network data structures require explicit relationships, or links, between records in the database. Both structures also require that data be processed one record at a time. The relational database structure departs from both these requirements.

A relational database is structured into a series of two-dimensional tables. Because many managers often work with tabular financial data, it is easy for most of them to understand the structure used in a relational database. For example, consider the repair vendor relationship. The repair vendor table consists of the repair vendor master records, which contain the repair shown, in figure 2.9 as network structure. This can be represented in a tabular form as shown in figure 2.10. The repair vendor table consists of the repair vendor master records, which contain the repair vendor number, name and address. The table itself is really a file. Each row in the table is really a record and each column represents one type of data element.

Repair Vendors Records

Column 1	Column 2	Column 3
Repair Vendor Number	Repair Vendor Name	Repair Vendor Address
43623	Telo, Inc.	15 Parliament Street
42890	A-Repair Company	25 G.B.Road
43118	Beeline, Ltd.	498 Old Street
43079	Aspen, Inc.	12 Rouse Avenue
43920	Calso, Inc.	5 Janpath Road

Fig. 2.10

A similar table for equipment could look like the one in Figure 2.11. The table contains the records for each piece of equipment in the firm. Each record also contains the number of the repair vendor who has a contract to repair that piece of equipment.

Equipment Records

Column 1	Column 2	Column 3	Column 4
Equipment Number	Equipment Name	Date Purchased	Repair Vendor No.
10893	Typewriter	12/02/1999	43623
49178	Microcomputer	01/31/2000	43920
10719	Telephone	03/12/2000	43079
18572	Copier	11/06/1998	43890
60875	Calculator	08/01/1997	43118

Fig. 2.11

If the manager wished to create a report, showing the names of each repair vendor and the pieces of equipment that each vendor repairs, he could combine both tables into a third table. The manager might joint the two tables with a query statement such as this: JOIN REPAIR VENDOR AND EQUIPMENT ON REPAIR VENDOR NUMBER.

This would create a new table with six columns: Repair Vendor Number, Repair Vendor Name, Repair Vendor Address, Equipment Number, Equipment Name and Date Purchases. Now the manager could print out only the columns for vendor name and equipment name. Such as a report might look like the one shown in figure – 2.12.

Equipment Repairs 1999	
Repair Vendor	Equipment
Modern Insurance	Telephone
B-line Ltd.	Calculator
Telco India	Type writer

Fig. 2.12

The manager might also produce a report by selecting from both tables only the rows for specific equipment types or for equipment purchased in specific years. The important things to notice are that the relationships, or links, do not need to be specified in advance and that whole tables or files are manipulated.

Relational databases allow the manager flexibility in conducting database queries and creating reports. Queries can be made and new tables created using all or part of the data from one or more tables. The links between data elements in a relational database do not need to be made explicit at the time the database is created since new links can be structured at any time. The relational database structure is more flexible than hierarchical or network database structures and provides the manager with a rich opportunity for ad hoc reports and queries. However, because they do not specify the relationships among data elements in advance, relational databases do not process large batch applications with the speed of hierarchical or network databases.

Many relational database management system products are available. For example, Oracle and IBM offer commercial relational database management systems, Oracle and DB2 respectively.

2.10 Database Components

(i) **Data Definition Language (DDL)** that defines the conceptual schema providing a link between the logical (the way the user views the data) and physical (the way in which the data is stored physically) structures of the database. As discussed earlier, the logical structure of a database is a schema. A sub schema is the way a specific application views the data from the database.

Following are the functions of Data Definition Language (DDL) –

(a) They define the physical characteristics of each record, field in the record, field's data type, field's length, field's logical name and also specify relationships among the records,

2.38

(b) They describe the schema and subschema,

(c) They indicate the keys of the record,

(d) They provide means for associating related records or fields,

(e) They provide for data security measures,

(f) They provide for logical and physical data independence.

(ii) **Data Manipulation Language (DML): –**

(a) They provide the data manipulation techniques like deletion, modification, insertion, replacement, retrieval, sorting and display of data or records,

(b) They facilitate use of relationships between the records,

(c) They enable the user and application program to be independent of the physical data structures and database structures maintenance by allowing to process data on a logical and symbolic basis rather than on a physical location basis,

(d) They provide for independence of programming languages by supporting several high-level procedural languages like, COBOL, PL/1 and C++.
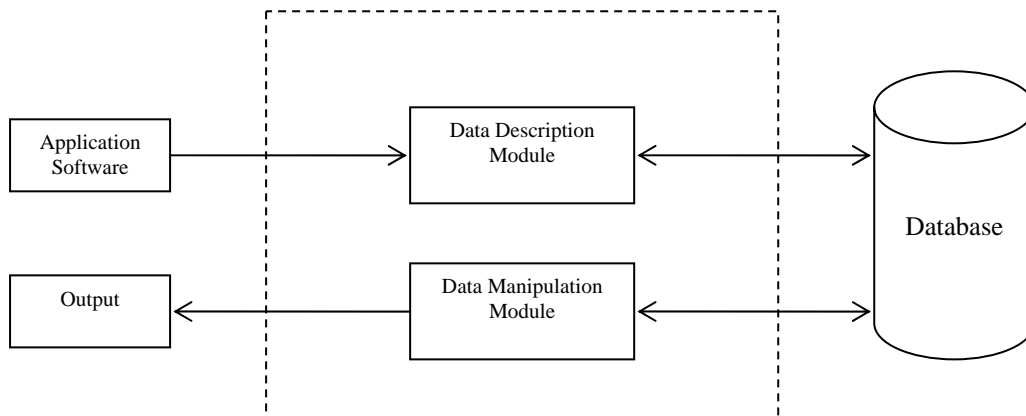
Figure 2.13: Data Base Management Systems Components

2.11 Structure of DBMS: –

(i) **DDL Compiler** –

   a. It converts data definition statements into a set of tables,

   b. Tables contain meta data (data about the data) concerning the database,

   c. It gives rise to a format that can be used by other components of database.

(ii) Data Manager –

    a. It is the central software component,

    b. It is referred to as the database control system,

    c. It converts operations in users' queries to physical file system.

(iii) File Manager –

    a. It is responsible for file structure,

    b. It is responsible for managing the space,

    c. It is responsible for locating block containing required record,

    d. It is responsible for requesting block from disk manager,

    e. It is responsible for transmitting required record to data manager.

(iv) Disk Manager –

    a. It is a part of the Operating System,

    b. It carries out all physical input / output operations,

    c. It transfers block / page requested by file manager.

(v) Query Manager –

    a. It interprets user's online query,

    b. It converts to an efficient series of operations,

    c. In a form it is capable of being sent to data manager,

    d. It uses data dictionary to find structure of relevant portion of database,

    e. It uses information to modify query,

    f. It prepares an optimal plan to access database for efficient data retrieval.

(vi) Data Dictionary –

    a. It maintains information pertaining to structure and usage of data and meta data,

    b. It is consulted by the database users to learn what each piece of data and various synonyms of data field means.

Data base administrator As mentioned earlier data base systems are typically installed and coordinated by an individual called the **data base administrator**. He has the overall authority to establish and control data definitions and standards. He is responsible for determining the relationships among data elements, and for designing the data base security system to guard against unauthorised use. He also trains and assists applications programmers in the use of

data base. A data dictionary is developed and used in a data base to document and maintain the data definitions.

To design the database, the data base administrator must have a discussion with users to determine their data requirement. He can then decide the schedule and accuracy requirements, the way and frequency of data access, search strategies, physical storage requirements of data, level of security needed and the response time requirements. He may also identify the source of data and the person responsible for originating and updation of data. The database administrator then converts these requirements into a physical design that specifies hardware resources required for the purpose.

Defining the contents of the data base is an important part of data base creation and maintenance. The process of describing formats, relationships among various data elements and their usage is called data definition and the DBA uses data definiton language (DDL) for this purpose.

Maintaining standards and controlling access to data base are two other important functions that are handled by the DBA using DDL. The DBA specifies various rules which must be adhered to while describing data for a database. Data description not meeting these rules are rejected and not placed in the data dictionary. Invalid data values entered by users are also rejected. The DBA uses access controls to allow only specified users to access certain paths into the data base and thus prevent unauthorised access. For example, in an airline reservation system, an airline agent should be prevented from offering an expired rate to a passenger.

The DBA also prepares documentation which includes recording the procedures, standards guidelines and data descriptions necessary for the efficient and continued use of the data base environment. Documentation should be helpful to end users, application programmers, operating staff and data administration personnel. The DBA also educates these personnel about their duties.

It is also a duty of the DBA to ensure that the operating staff performs its database processing related responsibilities which include loading the database, following maintenance and security procedures, taking backups, scheduling the database for use and following restart and recovery procedures after some hardware or software failure, in a proper way.

The DBA also monitors the data base environments. He ensures that the standards for database performance are being met and the accuracy, integrity and security of data is being maintained. He also sets up procedures for identifying and correcting violation of standards, documents and corrects errors. This is accomplished by carrying out a periodic audit of the database environment.

The DBA is also responsible for incorporating any enhancements into the database environment which may include new utility programs or new systems releases, and changes into internal procedures for using data base etc.

2.12 TYPES OF DATABASES

The growth of distributed processing, end user computing, decision support and executive information systems has caused the development of several types of databases. Figure 2.14 illustrates six of the main databases that may be found in computer using organisations.
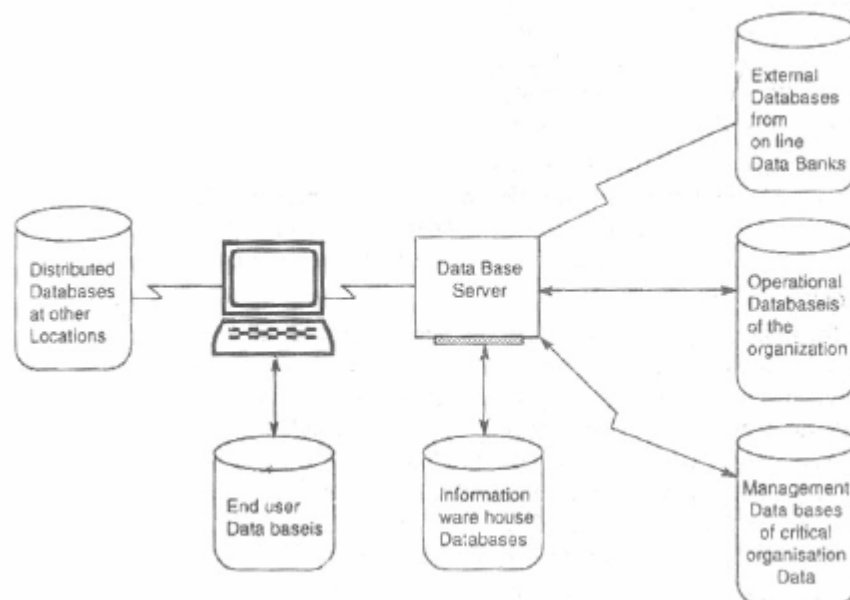
Fig. 2.14

Operational databases: These databases store detailed data needed to support the operations of the entire organisation . They are also called subject area databases (SADB), transaction databases, and production databases. Examples are a customer database, personnel database, inventory database, and other databases containing data generated by business operations.

Management Database: These databases store data and information extracted from selected operational and external database. They consist of summarized data and information most needed by the organisation's managers and other end users. Management databases are also

called information databases. These are the databases accessed by executive end-users as part of decision support systems and executive information systems to support managerial decision making.

Information Warehouse Databases: An information warehouse stores data from current and previous years. This is usually data that has been extracted from the various operational and management databases of an organisation. It is a central source of data that has been standardized and integrated so that it can be used by managers and other end-user professionals throughout an organisation. For example, an important use of information warehouse databases is pattern processing, where operational data is processed to identify key factors and trends in historical patterns of the business activity.

End User Databases: These databases consist of a variety of data files developed by end users at their workstations. For example, users may have their own electronic copies of documents they generated with word processing packages or received by electronic mail. Or they may have their own data files generated from spreadsheet and DBMS packages.

External Databases: Access to external, privately owned online databases or data banks is available, for a fee, to end users and organizations from commercial information services. Data is available in the form of statistics on economic and demographic activity from statistical data banks. One can receive abstracts from hundreds of newspapers, magazines, and other periodicals from bibliographic data banks.

Text Databases: Text databases are natural outgrowth of the use of computers to create and store documents electronically. Thus, online database services store bibliographic information such as publications in larger text databases. Text databases are also available on CD-ROM optical disks for use with microcomputer systems. Big corporations and government agencies have developed large text databases containing documents of all kinds. They use text database management systems software to help create, store, search, retrieve, modify, and assemble documents and other information stored as text data in such databases. Microcomputer versions of this software have been developed to help users manage their own text databases on CD-ROM disks.

Image Databases: Up to this point, we have discussed databases, which hold data in traditional alphanumeric records, and files or as documents in text databases. But a wide variety of images can also be stored electronically in image databases. For example, electronic encyclopedia are available on CD-ROM disks which store thousands of photographs

and many animated video sequences as digitized images, along with thousands of pages of text. The main appeal of image database for business users are in document image processing. Thousands of pages of business documents, such as customer correspondence, purchase orders and invoices, as well as sales catalogues and service manuals, can be optically scanned and stored as document images on a single optical disk. Image database management software allows employees to hold millions of pages of document images. Workers can view and modify documents at their own workstations and electronically transfer them to the workstations of other end users in the organisation.

2.12.1 Other Database models

(i) **Distributed Database:** When an organization follows a centralized system, its database is confined to a single location under the management of a single group. Sometimes an organization may require decentralizing its database by scattering it with computing resources to several locations so that running of applications programs and data processing are performed at more than one site. This is known distributed data processing to facilitate savings in time and costs by concurrent running of application programs and data processing at various sites. When processing is distributed since the data to be processed should be located at the processing site, the database needs to be distributed fully or partly, depending on the organizational requirements. There are two methodologies of distribution of a database. In a *replicated database* duplicates of data are provided to the sites so that the sites can have frequent access to the same data concurrently. But this method of replication is costly in terms of system resources and also maintaining the consistency of the data elements. In a *partitioned database* the database is divided into parts or segments that are required and appropriate for the respective sites so that only those segments are distributed without costly replication of the entire data. A database can be partitioned along *functional lines* or *geographical lines* or *hierarchically*.

(ii) **Object Oriented Database***:* It is based on the concept that the world can be modeled in terms of objects and their interactions. Objects are entities conveying some meaning for us and possess certain attributes to characterize them and interacting with each other. In the figure, the light rectangle indicates that 'engineer' is an object possessing attributes like 'date of birth', 'address', etc. which is interacting with another object known as 'civil jobs'. When a civil job is commenced, it updates the 'current job' attribute of the object known as 'engineer', because 'civil job' sends a message to the latter object.

```
                    ┌─────────────┐
                    │  Civil Job  │
                    │    Team     │
                    ├─────────────┤
                    │             │
                    ├─────────────┤
                    │             │
                    └──────┬──────┘
                           ┆ Part of structure
                    ┌──────┴──────────────┐
                    │  ┌───────────────┐  │          ┌─────────────┐
                    │  │   Engineer    │  │          │ Civil Jobs  │
                    │  ├───────────────┤  │          ├─────────────┤
                    │  │Engineer ID No.│  │          │             │
                    │  │Date of Birth  │  │◄─────────├─────────────┤
                    │  │Address        │  │          │             │
                    │  │Employment Date│  │          └─────────────┘
                    │  │Current Job    │  │
                    │  ├───────────────┤  │
                    │  │  Experience   │  │
                    │  └───────────────┘  │
                    └──────────┬──────────┘
                               │ Class of structure
                   ┌───────────┴───────────┐
          ┌────────┴────────┐      ┌───────┴─────────┐
          │     Civil       │      │   Architect     │
          │    Engineer     │      ├─────────────────┤
          ├─────────────────┤      │                 │
          │                 │      ├─────────────────┤
          ├─────────────────┤      │                 │
          │                 │      └─────────────────┘
          └─────────────────┘
```
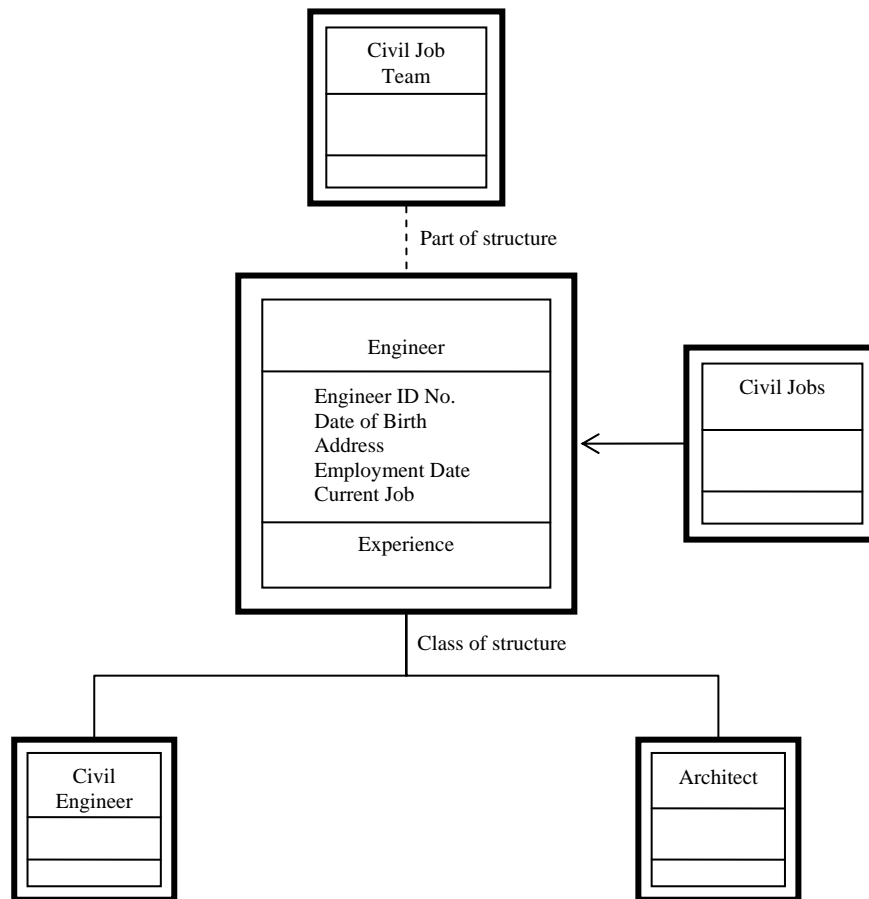
Figure 2.15: An object-oriented database design

Objects can be organized by first identifying them as a member of a class / subclass. Different objects of a particular class should possess at least one common attribute. In the figure the dark rectangles indicate 'Engineer' as a class and 'Civil Engineer' and also 'Architect' as both subclasses of 'Engineer'. These subclasses possess all the attributes of 'Engineer' over and above each possessing at least one attribute not possessed by 'Engineer'. The line intersecting particular object classes represents the class of structure. Secondly, objects can be identified as a component of some other object. In the figure 'Engineers' are components of a 'Civil Job Team' which may have one to more than one number of member(s) An 'Engineer' may not be a member of the 'Civil Job Team' and may not be a member of more than one

team. The dotted line intersecting particular object classes represents the part of structure. Apart from possessing attributes, objects as well as possess methods or services that are responsible for changing their states. In the figure for example, the service 'Experience' as a Civil Engineer or Architect for the object 'Engineer' calculates how much experience the engineers of these particular two subclasses have as professionals.

The motivation for development of object-oriented analysis and design of database are encapsulation and inheritance. Encapsulation indicates that the particulars of an object are hidden in capsule to keep it apart from the other objects. In the figure for example, only minimum details about the attributes and services of an 'Engineer' is exposed to other objects. But the hiding technique weakens the coupling between the objects resulting in having fewer effects when there is a change to the system. Inheritance indicates that the object in a subclass automatically acquire or inherit the attributes and services of their class. In the figure for example, the 'Civil Engineers' and the 'Architects' possess all the attributes and services of the class 'Engineers'. In fact inheritance develops reuse of objects and higher system reliability.

Now a day the database system is used increasingly to store –

(i) Data about manufacturing designs in which focus is given to design objects that can be composed or decomposed into other design objects (like Telco resorts to CAD-CAM techniques),

(ii) Images, graphics, audio, video which can be used to support multimedia applications.

(iii) **Client-server Database:** It is designed in a structure in which one system can connect to another system to ask it question or instruct it to perform job. The system that asks the questions and issues the instructions is the client and the system answering the queries and responding to the instructions is the server. The client machine contains the user interface logic, business logic and the database logic and the server machine contains the database. Both are coupled with a network of high bandwidth.
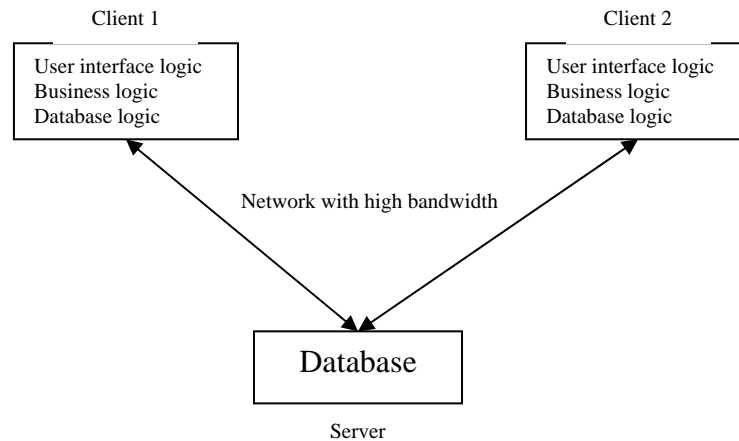
Figure 2.16: A Client-server Database Design (2-tier)

Whereas the user interface program or front end program is called the client, a back end program is called a server which interacts with share resources in a environment which can be based on heterogeneous hardware / software (Operating System) platforms of the client and the server and multi-vendor. The computational functions are shared in such a way that the server does all such higher level functions which it alone can do leaving the client to perform low level functions. The system scaleable in as much as clients may be added or removed and the shared resources may be relocated to a larger and faster server or to multiple servers.

The above is a 2-tier model implying a complicated software distribution procedure. Since all the application logic is executed on the personal computers, all these personal computers have to be updated in case of a new software release, which is bound to be very costly, time consuming, complicated and error prone. Once it reaches one of the users, the software first has to be installed and then tested for correct execution. Due to distributed character of such a procedure, it is not assured whether all clients work on the correct copy of the program.

3-tier and n-tier client-server database designs try to solve these problems by simply transferring the application logic from the client back to the server. This is accomplished by inserting an application server tier between the data server tier and the client tier. Client tier is responsible for data presentation, receiving user events and controlling the user interface. The actual business logic is not handled by the client tier; instead it is handled by the application server tier. In the light of object-oriented analysis (OOA), business objects which implement the business rules, reside in application server tier which forms the central key to solve the 2-tier problems and protects the data from direct access by the clients. Data server tier is responsible for data storage. Besides, the relational database structure, legacy system structure is often used.

(iv) **Knowledge Database:** A database system provides functions to define, create, modify, delete and read data in a system. The type data maintained in a database system historically has been *declarative data* describing the static aspects of the real world objects and their associations. A pay roll file and a personnel file can share data about pay rates for each and every employee, their positions, names, etc.

A database system can also be used to maintain *procedural data* describing the dynamic aspects of the real world objects and their associations. The database can contain for example, several amended versions of enactments in the field of labour laws to facilitate management decisions in pay negotiations. When both the declarative and procedural data are stored in a database it constitutes a knowledge database with more *powerful* data maintenance.

The emergence of voluminous databases and higher use of decision support systems (DSS) and executive information systems (EIS) have led to increased interest regarding database structures which allow recognition of patterns among data and facilitate knowledge discovery by the decision makers.

A voluminous database which contains integrated data, detailed data, summarized data, historical data and metadata (data about data) is called a ***data warehouse***. A database which contains selective data from a data warehouse meant for a specific function or department is called a ***data mart***. The process of recognizing patterns among data contained in a data warehouse or a data mart is called a process of *data mining.*

2.13 STRUCTURED QUERY LANGUAGE AND OTHER QUERY LANGUAGES

A query language is a set of commands to create, update and access data from a database allowing users to raise adhoc queries / questions interactively without the help of programmers. A structured query language (SQL) is a set of thirty (30) English like commands which has since become an adoptable standard. The structured query language syntax use some set of commands regardless of the database management system software like 'Select', 'From', 'Where'. For example, after 'Select' a user lists the fields, after 'From' the names of the files/group of records containing these fields are listed, after 'Where' conditions for search of the records are listed. A user can therefore desire to 'Select' all the names of the employees 'From' employee records where the country in which the employees live is India and enter the following command for report generation: -

Select name, address, city, state, country, Pin; *From* employee; *Where* country is equal to India.

Some query languages have been designed in such a way that the command used is as close to Standard English text as possible. Query languages in a user-friendly way allow users to retrieve data from database without exposure to -

(i)   file / record structure,

(ii)   processes that the system performs,

(iii) Languages like Common Business Oriented Language (COBOL), Beginner's All-purpose Symbolic Instruction Code (BASIC) or such other standard programming languages. Data retrieving efficiency may be improved by gaining knowledge about query shortcuts, query strategies and the types of data used in the database. A training and development program for this purpose may prove useful for the end users.

2.13.1   Natural Language: It is difficult for a system to understand natural language due to its ambiguity in sentence structure, syntax, construction and meaning. Accordingly it is not possible to design an interface given this problem. However systems can be designed to understand a subset of a language which implies the use of natural language in a restricted domain.

2.14 STORAGE

The storage structure design entails the decisions, which must be made on how to make it linear and to partition the data structure so that it can be stored on some device. The file library functions as an aspect of Operations Management Controls, takes responsibility of machine readable storage media for the management. In this context four functions must be undertaken: –

(i)   Ensuring that removable storage media are stored in a secure and clean environment,

(ii)   Ensuring that storage media are used for authorized purposes only,

(iii) Ensuring maintenance of storage media in good working condition and

(iv)   Ensuring location of storage media at on-site / off-site facilities.

A storage media can contain critical files and hence should be housed securely. In case of mainframe operations, a separate room may be required just adjacent to computer room to house storage media required during daily operations, restricting access to the room and fixing the responsibility in the hands of a file librarian. Similar arrangements may be followed in the case of an off-site backup storage. Both on-site and off-site facilities should be maintained in a constant temperature, dust free environment. For managing a bulk of removable storage media effectively an automated library system is needed which records the following –

(i)   An identifier of each storage medium,

(ii)   Location where each storage medium is at present placed,

(iii) Identity of the person responsible for storage medium,

(iv)   Identity of the present custodian of the storage medium,

(v)   List of files stored on each medium,

(vi)   List of authorized persons to access,

(vii)   Date of purchase and history of use with history of difficulties in using the storage medium,

(viii) Date of expiry when contents of the storage medium can be deleted,

(ix)   Date of last release from and date last return to the file library,

Use of storage media is controlled with grate care. In mainframe environments, file librarians issue removable storage media as per authorized production schedule by transporting the required media themselves to computer room and collecting it after the production runs. In other cases file librarians issue it on the basis of an authorized requisition only, side by side recording the use of removable storage media. In micro computer environments, the extent of control over its use is dependent on the criticality of the data maintained on it. At an off-site location asset safeguarding and data integrity objectives can be seriously compromised. Off-site personnel usually works for a vendor who may specialize in providing backup facilities and the off-site personnel may not have the knowledge of the customer organizations to determine who is authorized to access the storage media. Care should also be taken when multiple files are assigned to a single medium, for an application system reading one file may also read another file containing sensitive data. Actually, sensitive files should exist alone or separately on a medium. Otherwise the Operating System should be designed to exercise control over an application system to restrict access to authorized files only. To reduce the chance of exposure of sensitive data at some point of time, file should be expunged out of storage media as soon as their retention dates expire. Such media can then be reused to store other files, thereby reducing the inventory requirement.

Reliability of storage media should be monitored, especially which are used to store critical files, since the reliability decreases with age. For example, an increasing number of read / write errors are crept in the magnetic tapes and diskettes as these become older and used more. Storage media should not be kept unused for longs, otherwise the possibility of read / writes error occurring with the media increases. With a magnetic tape for example, pressure builds up towards its center on its hub as it grows older. The pressure causes bonding and compacting of the ferromagnetic material from which the magnetic tape is made resulting in unread ability of the tape. Keeping this in view, a backup storage media need to be managed. Even if the backup has to be stored for long periods, it should be retrieved at regular intervals and backup files re-written to another fresh medium.

When storage media becomes unreliable, it is best to discard it; after ensuring that all sensitive data is removed from the discarded media. Simply deleting the files on the media does not serve the purpose. It may be necessary to carry out bulk erasure followed by writing random bits to the media followed by carrying out of bulk erasure once again. In some cases,

unreliable storage media can be repaired. For example magnetic tapes can be cleaned to improve its reliability and to enhance its life. If storage media is required to be sent out side the organization for cleaning or repair, care should be taken to erase any sensitive data contained. The data on magnetic tapes for example, can be erased by degaussing or demagnetization.

Removable storage media should be located on-site when these are needed to support production running of application systems and should be located off-site when intended for backup and recovery. In a mainframe environment, it is the responsibility of the file librarian to manage transport of removable storage media to and from off-site locations. These movements should have compliance with the backup schedules. Backup schedules are prepared by a team comprised of security administrator, data administrator, application project manager, system development manager, operations manager and the file librarian. In a mini computer / micro computer environment, a person still performs file librarian duties for both on-site and off-site movements. Backup is prepared for minicomputer disk storage, local area network file server storage and critical microcomputer files. Good control is assured if these responsibilities are vested for example, in the file librarian who takes responsibility for backup of the mainframe. One operation staff dealing with minicomputers and local area networks and the other operations staff dealing with microcomputer can provide backup to mainframe file librarian for transport to off-site storage. If the mainframe file librarian does not perform the above mentioned functions, the other two operation staff may perform it themselves, provided management formulates standards on it and propagates it in that way.

2.15 DOCUMENTATION AND PROGRAM LIBRARY

The documentations that are needed to support a system in an organization are–

(i)   Strategic and operational plans,

(ii)   Application systems and program documentation,

(iii)   System software and utility program documentation,

(iv)   Database documentation,

(v)   Operations manuals,

(vi)   User manuals,

(vii) Standard manuals.

Besides, ancillary documents like memoranda, books and journals are also the required documents to support a system. These are kept in automated form for example, computer aided systems engineering (CASE) tools are used to provide machine readable formats of dataflow diagrams or entity relationship diagrams or some software that can provide

documentation on optical disks (CD-ROM) However much of the documentation is still kept in hard copy formats since it has still some advantages over online documentation.

The difficulties in the management of systems documentation are as follows –

(i)   Responsibility for documentation is dispersed throughout the organization. For example, a librarian may be responsible for documentation supporting mainframe and mini computer systems, whereas documentation supporting micro computer system may be the responsibility of its users,

(ii) Documentation is maintained in multiple forms and in multiple locations. For example, some part may exist in magnetic form, some other part in hard copy form and the remaining part in the micro form,

(iii) Given the density and dispersion of documentation, proper updating, accessibility and adequate backup are not ensured.

The responsibilities of documentation librarians are ensuring that –

(i)   Documentation is stored securely,

(ii) Only authorized user can have access to it,

(iii) It is updated,

(iv) Adequate backup exists for it,

Many organizations acquire a large number of software packages to support its microcomputers operations. In case the inventory of software is not managed by the documentation librarians properly, it may lead to problems like –

(i)   Purchase of too many copies of the software,

(ii) Loss or theft of the software,

(iii) Loss or theft of the documentation,

(iv) Illegal copying of the software,

(v)   Use of software not complying with the terms and conditions of the software license,

(vi) Absence of the software backup or improper backup.

Various types of software are available to mitigate the above hardship by taking the responsibility for maintaining the records of purchases, distributions and uses of the software and its related documentation and ensuring compliance with terms and conditions of the licensing agreements by the users. Some local area network Operation Systems for example, can provide a utility which generates a report listing all software located at workstations or file servers in the network, for review.

2.15.1   Program Library Management System Software:

(i)   It provides several functional capabilities to effectively and efficiently manage data center software inventory which includes –

   a.   Application Program Code,

   b.   System Software Code,

   c.   Job Control Statements

(ii)   It possesses integrity capabilities such that –

   a.   Each source program is assigned,

   b.   A modification number is assigned,

   c.   A version number is assigned,

   d.   It is associated with a creation date

(iii)   It uses –

   a.   Password,

   b.   Encryption,

   c.   Data Compression,

   d.   Automatic backup

(iv)   It possesses update capabilities with the facilities of –

   a.   Addition,

   b.   Modification,

   c.   Deletion,

   d.   Re-sequencing library numbers

(v)   It possesses reporting capabilities for being reviewed by the management and the end users by preparing lists of –

   a.   Additions,

   b.   Deletions,

   c.   Modifications,

   d.   Library catalogue,

   e.   Library members attributes

(vi)   It possesses interface capabilities with the –

a.   Operating System,

b.   Job scheduling system,

c.   Access control system,

d.   Online program management

(vii) It controls movement of program from test to production status

(viii) At last, it changes controls to application programs.

2.15.2   Design of User Interfaces: After discussing about storage media, we now turn to design of user interface. It is important since it involves the ways in which the users will interact with the system. Elements which have to considered in designing of user interface are as follows –

(i)   Source documents to capture data,

(ii)   Hard copy output reports,

(iii) Screen layout for source document input,

(iv)   Inquiry screens for database queries,

(v)   Command languages for decision support systems,

(vi)   Query languages for the database,

(vii) Graphic display and color or non-monochromatic display,

(viii) Voice output to answer users or answer queries,

(ix)   Screen layout manipulation by mouse or light pen,

(x)   Icons for representation of the output.

The interface design is developed as follows –

(i)   Identifying system users and classifying them into homogeneous groups,

(ii)   The user group characteristics are understood like whether the system will be handled by novices or experts,

(iii) Eliciting the tasks which the users wish to perform using the system,

(iv)   Commencing a preliminary design of the form of interaction that will support these tasks. Prototyping tools are usually employed to refine the design aspect with the users.

2.16 BACKUP, AND RECOVERY

Generally 'backup and recovery' is treated as one topic and 'disaster recovery' as another. 'Backup' is a utility program used to make a copy of the contents of database files and log

files. The database files consist of a database root file, log file, mirror log file, and other database files called dbspaces.

'Recovery' is a sequence of tasks performed to restore a database to some point-in-time. Recovery is performed when either a hardware or media failure occurs. Hardware failure is a physical component failure in the machine, such as, a disk drive, controller card, or power supply. Media failure is the result of unexpected database error when processing data.

Before one begins recovery, it is a good practice to back up the failing database. Backing up the failing database preserves the situation, provides a safe location so files are not accidentally overridden, and if unexpected errors occur during the recovery process, database Technical Support may request these files be forwarded to them.

'Disaster recovery' *differs from a database recovery scenario because the operating system and all related software must be recovered before any database recovery can begin.*

2.16.1   Database files that make up a database : Databases consist of disk files that store data. When you create a database either using ant database software command-line utility , a main database file or root file is created.. This main database file contains database tables, system tables, and indexes. Additional database files expand the size of the database and are called dbspaces. A dbspace contains tables and indexes, but not system tables.

A **transaction log** is a file that records database modifications. Database modifications consist of inserts, updates, deletes, commits, rollbacks, and database schema changes. A transaction log is not required but is recommended. The database engine uses a transaction log to apply any changes made between the most recent checkpoint and the system failure. The checkpoint ensures that all committed transactions are written to disk. During recovery the database engine must find the log file at specified location. When the transaction log file is not specifically identified then the database engine presumes that the log file is in the same directory as the database file.

A **mirror log** is an optional file and has a file extension of **.mlg**. It is a copy of a transaction log and provides additional protection against the loss of data in the event the transaction log becomes unusable.

2.16.2   Online backup, offline backup, and live backup : Database backups can be performed while the database is being actively accessed (online) or when the database is shutdown (offline) When a database goes through a normal shutdown process (the process is not being cancelled) the database engine commits the data to the database files.

An online database backup is performed by executing the command-line or from the 'Backup Database' utility. When an online backup process begins the database engine externalizes all cached data pages kept in memory to the database file(s) on disk. This process is called a checkpoint. The database engine continues recording activity in the transaction log file while

the database is being backed up. The log file is backed up after the backup utility finishes backing up the database. The log file contains all of the transactions recorded since the last database backup. For this reason the log file from an online full backup must be 'applied' to the database during recovery. The log file from an offline backup does not have to participate in recovery but it may be used in recovery if a prior database backup is used.

A **live backup** is carried out by using the BACKUP utility with the command-line option. A live backup provides a redundant copy of the transaction log for restart of your system on a secondary machine in the event the primary database server machine becomes unusable.

Full and incremental database backup : A database backup is either a full or incremental backup. For a full backup, the database backup utility copies the database and log. An incremental backup uses the DBBACKUP utility to copy the transaction log file since the most recent full backup. When you perform an incremental backup the mirror log is not backed up. When you backup and rename the log files the transaction and mirror log file is renamed and new log files are created. You must plan to manually back up the mirror log. Be aware of this when planning out your backup and recovery strategy.

2.16.3   Developing a backup and recovery strategy : The steps suggested in the development of a backup and recovery strategy consist of the following:

- Understand what backup and recovery means to your business

- Management commits time and resources for the project

- Develop, test, time, document, health check, deploy, and monitor

- Beware of any external factors that affect recovery

- Address secondary backup issues.

(i)   Understand what backup and recovery means to your business : How long can my business survive without access to the corporate data?Express your answer in terms of minutes, hours, or days.

If your recovery time is in minutes then database backup and recovery is critical to your business needs and it is paramount that you implement some kind of backup and recovery strategy. If recovery can take hours then you have more time to perform the tasks. If recovery can be expressed in terms of days then the urgency to recover the database still exists, but time appears to be less of a factor.

(ii)   Management commits time and resources for the project : Management must decide to commit financial resources towards the development and implementation of a backup and recovery strategy. The strategy can be basic or quite extensive depending upon the business needs of the company. After developing a backup and recovery strategy management should be informed of the expected backup and recovery times. Anticipate management countering

2.56

the timings by preparing alternative solutions. These alternative solutions could be requesting additional hardware, improved backup medium, altering backup schedule, accepting a longer recovery time versus backup time. Then it will be up to management to decide what solution fits their corporate needs.

(iii) Develop, test, time, document, health check, deploy, and monitor : These phases are the core in developing a backup and recovery strategy:

- Create backup and recovery commands. Verify these commands work as designed. Does your full or incremental online backup work? Verify that your commands product the desired results.

- Time estimates from executing backup and recovery commands help to get a feel for how long will these tasks take. Use this information to identify what commands will be executed and when.

- Document the backup commands and create written procedures outlining where your backups are kept and identify the naming convention used as well as the kind of backups performed. This information can be very important when an individual must check the backups or perform a database recovery and the data base administrator (DBA) is not available.

- Incorporate health checks into the backup procedures. You should check the database to ensure the database is not corrupt. You can perform a database health check prior to backing up a database or on a copy of the database from your backup.

- Deployment of your backup and recovery consists of setting up your backup procedures on the production server. Verify the necessary hardware is in place and any other supporting software necessary to perform these tasks. Modify procedures to reflect the change in environment. Change user id, password, server and database name to reflect the change in environment.

- Monitor backup procedures to avoid unexpected errors. Make sure any changes in the process are reflected in the documentation.

(iv) Beware of external factors that affect recovery : External factors that effect database recovery are time, hardware, and software. Allow additional recovery time for entering miscellaneous tasks that must be performed. These tasks could be as simple as entering recovery commands or retrieving and loading tapes. Factors that influence time are the size of database files, recovery medium, disk space, and unexpected errors The more files you add into the recovery scenario, it increases the places where recovery can fail.. As the backup and recovery strategy develops it may be necessary to check the performance of the equipment and software ensuring it meets your expectations.

(v) Protect database backups by performing health checks : Database health checks are run against the database and log files to ensure they are not corrupt. The database validity utility is used to scan every record in every table and looks up each record in each index on

the table. If the database file is corrupt, you need to recovery from your previous database backup. A database can be validated before being backed up or against a copy of the database from your backup.

2.17 Data warehouse : A **Data warehouse** is a computer database that collects, integrates and stores an organization's data with the aim of producing accurate and timely management information and supporting data analysis. Data Warehouses became a distinct type of computer database during the late 1980's and early 1990's. They developed to meet a growing demand for management information and analysis that could not be met by operational systems. Operational systems were unable to meet this need for a range of reasons:

- The processing load of reporting reduced the response time of the operational systems,

- The database designs of operational systems were not optimised for information analysis and reporting,

- Most organizations had more than one operational system, so company-wide reporting could not be supported from a single system, and

- Development of reports in operational systems often required writing specific computer programs which was slow and expensive

As a result, separate computer databases began to be built that were specifically designed to support management information and analysis purposes. These data warehouses were able to bring in data from a range of different data sources, such as mainframe computers, minicomputers, as well as personal computers and office automation software such as spreadsheets and integrate this information in a single place. This capability, coupled with user-friendly reporting tools, and freedom from operational impacts has led to a growth of this type of computer system. As technology improved (lower cost for more performance) and user requirements increased (faster data load cycle times and more functionality), data warehouses have evolved through several fundamental stages:

- **Offline Operational Databases** - Data warehouses in this initial stage are developed by simply copying the database of an operational system to an off-line server where the processing load of reporting does not impact on the operational system's performance.

- **Offline Data Warehouse** - Data warehouses in this stage of evolution are updated on a regular time cycle (usually daily, weekly or monthly) from the operational systems and the data is stored in an integrated reporting-oriented data structure

- **Real Time Data Warehouse** - Data warehouses at this stage are updated on a transaction or event basis, every time an operational system performs a transaction (e.g. an order or a delivery or a booking etc.)

- **Integrated Data Warehouse** - Data warehouses at this stage are used to generate activity or transactions that are passed back into the operational systems for use in the daily activity of the organization.

2.17.1 Components of a data warehouse : The primary components of the majority of data warehouses are shown in the attached diagram and described in more detail below:

Data Sources : Data sources refers to any electronic repository of information that contains data of interest for management use or analytics. This definition covers mainframe databases (eg IBM DB2, ISAM, Adabas, Teradata, etc.), client-server databases (eg Oracle database, Informix, Microsoft SQL Server etc.), PC databases (eg Microsoft Access), spreadsheets (eg Microsoft Excel) and any other electronic store of data. Data needs to be passed from these systems to the data warehouse either on a transaction-by-transaction basis for real-time data warehouses or on a regular cycle (e.g. daily or weekly) for offline data warehouses.
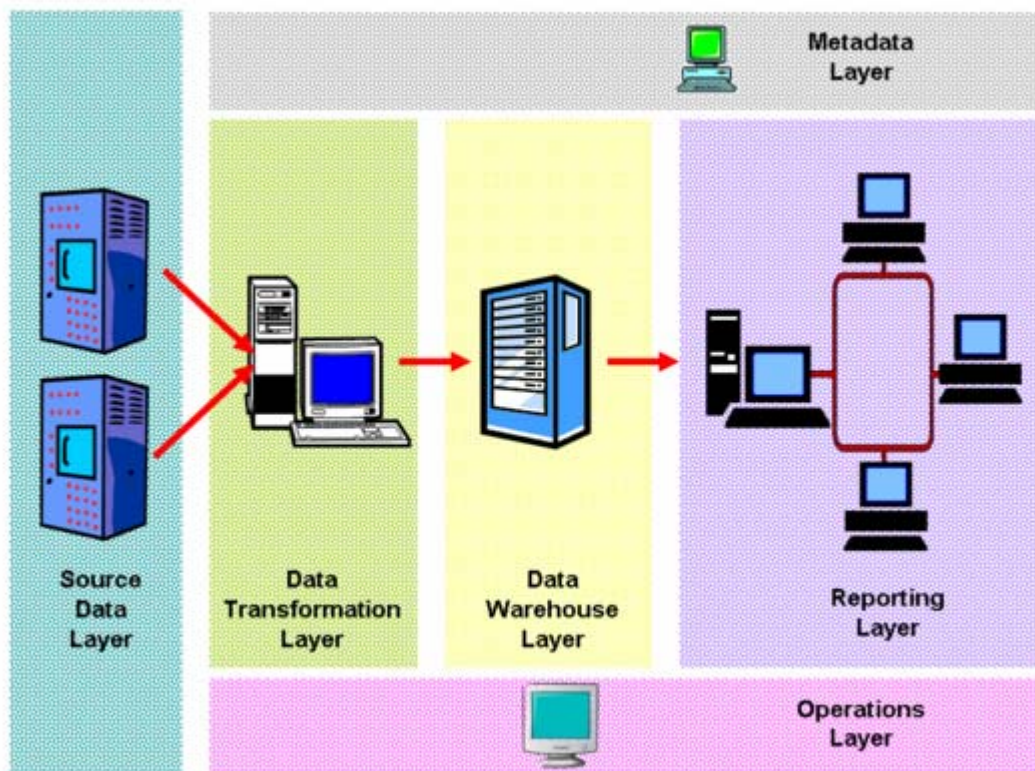
Data Transformation : The Data Transformation layer receives data from the data sources, cleans and standardises it, and loads it into the data repository. This is often called "staging" data as data often passes through a temporary database whilst it is being transformed. This activity of transforming data can be performed either by manually created code or a specific type of software could be used called an ETL tool. Regardless of the nature of the software used, the following types of activities occur during data transformation:

- comparing data from different systems to improve data quality (e.g. Date of birth for a customer may be blank in one system but contain valid data in a second system. In this instance, the data warehouse would retain the date of birth field from the second system)

- standardising data and codes (e.g. If one system refers to "Male" and "Female", but a second refers to only "M" and "F", these codes sets would need to be standardised)

- integrating data from different systems (e.g. if one system keeps orders and another stores customers, these data elements need to be linked)

- performing other system housekeeping functions such as determining change (or "delta") files to reduce data load times, generating or finding surrogate keys for data etc.

Data Warehouse : The data warehouse is a relational database organised to hold information in a structure that best supports reporting and analysis. Most data warehouses hold information for at least 1 year. As a result these databases can become very large.

Reporting : The data in the data warehouse must be available to the organisation's staff if the data warehouse is to be useful. There are a very large number of software applications that perform this function, or reporting can be custom-developed. Examples of types of reporting tools include:

- Business intelligence tools: These are software applications that simplify the process of development and production of business reports based on data warehouse data.

- Executive information systems: These are software applications that are used to display complex business metrics and information in a graphical way to allow rapid understanding.

- OLAP Tools: OLAP tools form data into logical multi-dimensional structures and allow users to select which dimensions to view data by.

- Data Mining: Data mining tools are software that allows users to perform detailed mathematical and statistical calculations on detailed data warehouse data to detect trends, identify patterns and analyse data.

Metadata : Metadata, or "data about data", is used to inform operators and users of the data warehouse about its status and the information held within the data warehouse. Examples of

data warehouse metadata include the most recent data load date, the business meaning of a data item and the number of users that are logged in currently.

Operations : Data warehouse operations comprises of the processes of loading, manipulating and extracting data from the data warehouse. Operations also covers user management, security, capacity management and related functions.

Optional Components : In addition, the following components also exist in some data warehouses:

1. Dependent Data Marts: A dependent data mart is a physical database (either on the same hardware as the data warehouse or on a separate hardware platform) that receives all its information from the data warehouse. The purpose of a Data Mart is to provide a sub-set of the data warehouse's data for a specific purpose or to a specific sub-group of the organisation.

2. Logical Data Marts: A logical data mart is a filtered view of the main data warehouse but does not physically exist as a separate data copy. This approach to data marts delivers the same benefits but has the additional advantages of not requiring additional (costly) disk space and it is always as current with data as the main data warehouse.

3. Operational Data Store: An ODS is an integrated database of operational data. Its sources include legacy systems and it contains current or near term data. An ODS may contain 30 to 60 days of information, while a data warehouse typically contains years of data. ODS's are used in some data warehouse architectures to provide near real time reporting capability in the event that the Data Warehouse's loading time or architecture prevents it being able to provide near real time reporting capability.

2.17.2   Different methods of storing data in a data warehouse : All data warehouses store their data grouped together by subject areas that reflect the general usage of the data (Customer, Product, Finance etc.) The general principle used in the majority of data warehouses is that data is stored at its most elemental level for use in reporting and information analysis. Within this generic intent, there are two primary approaches to organising the data in a data warehouse.

The first is using a "dimensional" approach. In this style, information is stored as "facts" which are numeric or text data that capture specific data about a single transaction or event, and "dimensions" which contain reference information that allows each transaction or event to be classified in various ways. As an example, a sales transaction would be broken up into facts such as the number of products ordered, and the price paid, and dimensions such as date, customer, product, geographical location and sales person. The main advantages of a dimensional approach is that the Data Warehouse is easy for business staff with limited information technology experience to understand and use. Also, because the data is pre-processed into the dimensional form, the Data Warehouse tends to operate very quickly. The

main disadvantage of the dimensional approach is that it is quite difficult to add or change later if the company changes the way in which it does business.

The second approach uses database normalisation. In this style, the data in the data warehouse is stored in third normal form. The main advantage of this approach is that it is quite straightforward to add new information into the database, whilst the primary disadvantage of this approach is that it can be quite slow to produce information and reports.

2.17.3   Advantages of using data warehouse : There are many advantages to using a data warehouse, some of them are:

- Enhances end-user access to a wide variety of data.

- Increases data consistency.

- Increases productivity and decreases computing costs.

- Is able to combine data from different sources, in one place.

- It provides an infrastructure that could support changes to data and replication of the changed data back into the operational systems.

2.17.4   Concerns in using data warehouse

- Extracting, cleaning and loading data could be time consuming.

- Data warehousing project scope might increase.

- Problems with compatibility with systems already in place e.g. transaction processing system.

- Providing training to end-users, who end up not using the data warehouse.

- Security could develop into a serious issue, especially if the data warehouse is web accessible.

- A data warehouse is a HIGH maintenance system.

2.18 DATA MINING

Data mining is concerned with the analysis of data and the use of software techniques for finding patterns and regularities in sets of data. It is the computer, which is responsible for finding the patterns by identifying the underlying rules and features in the data. The idea is that it is possible to strike gold in unexpected places as the data mining software extracts patterns not previously discernable or so obvious that no-one has noticed them before.

Data mining analysis tends to work from the data up and the best techniques are those developed with an orientation towards large volumes of data, making use of as much of the collected data as possible to arrive at reliable conclusions and decisions. The analysis process starts with a set of data, uses a methodology to develop an optimal representation of

the structure of the data during which time knowledge is acquired. Once knowledge has been acquired this can be extended to larger sets of data working on the assumption that the larger data set has a structure similar to the sample data. Again this is analogous to a mining operation where large amounts of low grade materials are sifted through in order to find something of value.

The following diagram summarises the some of the stages/processes identified in data mining and knowledge discovery by Usama Fayyad & Evangelos Simoudis, two of leading exponents of this area.
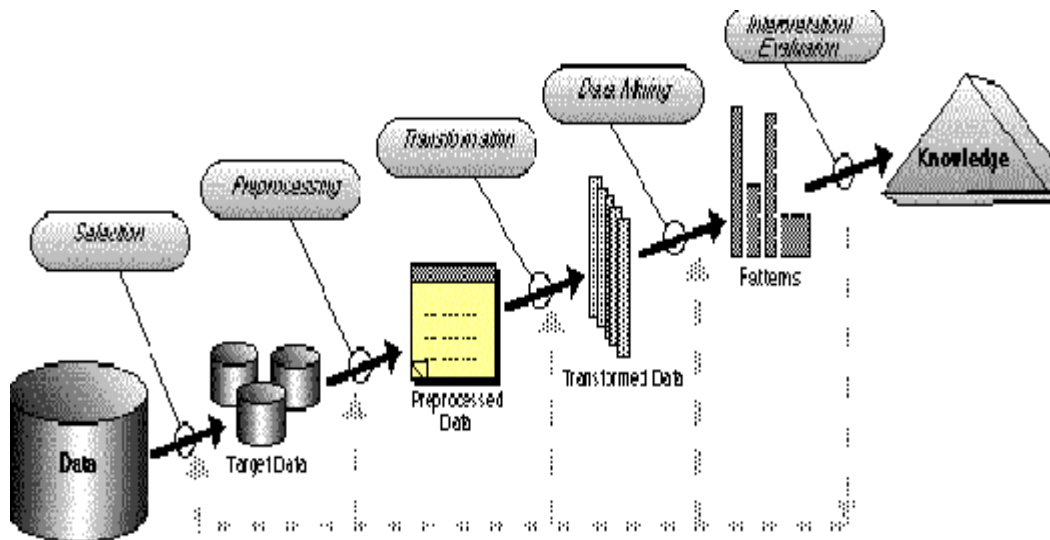
The phases depicted start with the raw data and finish with the extracted knowledge which was acquired as a result of the following stages:

- **Selection** - selecting or segmenting the data according to some criteria e.g. all those people who own a car, in this way subsets of the data can be determined.

- **Preprocessing** - this is the data cleansing stage where certain information is removed which is deemed unnecessary and may slow down queries for example unnecessary to note the sex of a patient when studying pregnancy. Also the data is reconfigured to ensure a consistent format as there is a possibility of inconsistent formats because the data is drawn from several sources e.g. sex may recorded as f or m and also as 1 or 0.

- **Transformation** - the data is not merely transferred across but transformed in that overlays may added such as the demographic overlays commonly used in market research. The data is made useable and navigable.

- **Data mining** - this stage is concerned with the extraction of patterns from the data. A pattern can be defined as given a set of facts(data) F, a language L, and some measure of certainty C a pattern is a statement S in L that describes relationships among a subset Fs of F with a certainty c such that S is simpler in some sense than the enumeration of all the facts in Fs.

- **Interpretation and evaluation** - the patterns identified by the system are interpreted into knowledge which can then be used to support human decision-making e.g. prediction and classification tasks, summarizing the contents of a database or explaining observed phenomena.

Self Examination Questions

1. Explain the following systems: -

   (a) Decimal,   (b) Binary   (c) BCD,

   (d) EBCDIC,   (e) ASCII

2. Define the following: –

   (a) Records,   (b) Fields,

   (c) Date Field,   (d) Integer Filed,

   (e) Double Precision Data,   (f) Logical Data,   (g) Primary Key,

   (h) Secondary Key,   (i) Foreign Key,   (j) Referential Integrity

3. In a database management system, describe the 3 level architecture with the following views: –

   (i)   External or User View,

   (ii)   Conceptual or Global View,

   (iii)   Physical or Internal View,

4. Define –

   (a) External Schema,   (b) Conceptual Schema,   (c) Internal Schema,

5. In a database management system, there are two components –

   (a)   Data Definition Language and   (b)   Data Manipulation Language

   Do you agree? If yes, discuss the above two database management system facilities.

6. Elucidate the functions of the following which are parts of structure of a database management system: –

   (i)   Data Definition Language Compiler,   (ii)   Data Manager,

   (iii) File Manager,   (iv)   Disk Manager,

   (v)   Query Manager,   (vi)   Data Dictionary.

7. Discuss the comparative advantages and disadvantages of the following models of a database management system: –

   (i) Hierarchical Model,   (ii)   Network Model,   (iii)   Relational Model.

8. Define the following models of Database: –

   (i)   Distributed database (both replicated and partitioned)

   (ii)   Client-server database (2-tier architecture and 3-tier architecture)

   (iii) Object-oriented database   (iv) Knowledge database.

9. Define the following high level languages and their functions: –

   (a)   Structured Query Language   (b) Natural Language

10. The file Library function as an aspect of Operations Management Controls, takes responsibility of the machine readable storage media for the management by undertaking four functions. Discuss.

11. Describe how the use of storage media is controlled? How the reliability of storage media is monitored?

12. What are the documents that are needed to support a system in an organization?

13. What are the difficulties in management of systems documentation? What are the responsibilities of documentation librarians?

14. Discuss the features of Program Library Management System Software.

15. What are the elements that are required to be considered in designing of user interface? How the interface design is developed?

CHAPTER **3**

COMPUTER NETWORKS & NETWORK SECURITY

3.1 INTRODUCTION

Many organisations have multiple users of computers; some of these users are geographically remote from the organization's headquarter offices. Even within an office building, there may be hundreds or thousands of employees who use a particular computer. Users have several options to choose from in communicating data to and in receiving data from the computer. These include the following:

♦ People may have to depend on mail delivery or messenger service to bring data to and from the computer. This usually involves delays and dependency on intermediaries. Also, the cost of such delivery service has risen rapidly.

♦ Each unit of the organization can be supplied with its own computer. However, it is not frequently economically feasible to do this for all units.

♦ Data may be transmitted, via communications links, between remote locations and the computer. Just as the telephone and telegraph services have speeded up oral and written messages between people, so data transmission can speed up the flow of data messages.
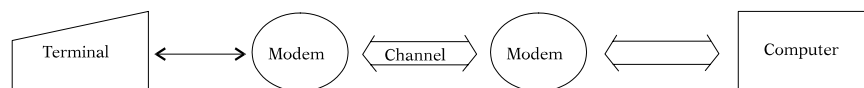
Fig 3.1

Fig. 3.1 shows the basic data communications schematic. This is the simplest form of computer communication. A single terminal is linked to a computer. The terminal can be the sender and the computer can be the receiver, or vice versa.
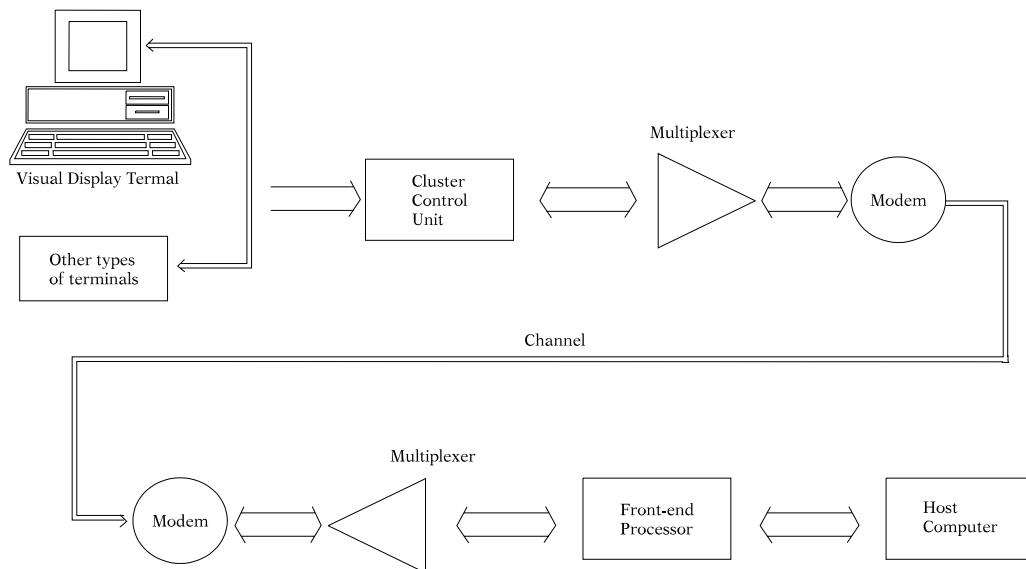
Fig 3.2

Fig. 3.2 illustrates an expanded data communication network. These are not all of the hardware devices that can be included, but they provide a good idea of how a network might appear in a business organisation.

3.2 COMPUTER NETWORKS

A computer network is a collection of computers and terminal devices connected together by a communication system. The set of computers may include large-scale computers, medium scale computers, mini computers and microprocessors. The set of terminal devices may include intelligent terminals, "dumb" terminals, workstations of various kinds and miscellaneous devices such as the commonly used telephone instruments.

Many computer people feel that a computer network must include more than one computer system-otherwise, it is an ordinary on-line system. Others feel that the use of telecommunication facilities is of primary importance. Thus, there is no specific definition of a computer network. Computer networks, however, not only increase the reliability of computer resources and facilitate overall system developments, but also satisfy the primary objective of resource sharing which include device sharing, file sharing, program sharing and program segmentation.

3.2.1 Need and scope of Networks : Here are some of the ways a computer network can help the business:

(i) File Sharing : File sharing is the most common function provided by networks and consists of grouping all data files together on a server or servers. When all data files in an organization are concentrated in one place, it is much easier for staff to share documents and other data. It is also an excellent way for the entire office to keep files organized according to a consistent scheme. Network operating systems such as Windows 2000 allow the administrator to grant or deny groups of users access to certain files.

(ii) Print Sharing : When printers are made available over the network, multiple users can print to the same printer. This can reduce the number of printers the organization must purchase, maintain and supply. Network printers are often faster and more capable than those connected directly to individual workstations, and often have accessories such as envelope feeders or multiple paper trays.

(iii) E-Mail: Internal or "group" email enables staff in the office to communicate with each other quickly and effectively. Group email applications also provide capabilities for contact management, scheduling and task assignment. Designated contact lists can be shared by the whole organization instead of duplicated on each person's own rolodex; group events can be scheduled on shared calendars accessible by the entire staff or appropriate groups. Equally important is a network's ability to provide a simple organization-wide conduit for Internet email, so that the staff can send and receive email with recipients outside of the organization as easily as they do with fellow staff members. Where appropriate, attaching documents to Internet email is dramatically faster, cheaper and easier than faxing them.

(iv) Fax Sharing : Through the use of a shared modem(s) connected directly to the network server, fax sharing permits users to fax documents directly from their computers without ever having to print them out on paper. This reduces paper consumption and printer usage and is more convenient for staff. Network faxing applications can be integrated with email contact lists, and faxes can be sent to groups of recipients. Specialized hardware is available for high-volume faxing to large groups. Incoming faxes can also be handled by the network and forwarded directly to users' computers via email, again eliminating the need to print a hard copy of every fax - and leaving the fax machine free for jobs that require it.

(v) Remote Access: In our increasingly mobile world, staff often require access to their email, documents or other data from locations outside of the office. A highly desirable network function, remote access allows users to dial in to your organization's network via telephone and access all of the same network resources they can access when they're in the office. Through the use of Virtual Private Networking (VPN), which uses the Internet to provide remote access to your network, even the cost of long-distance telephone calls can be avoided.

(vi) Shared Databases: Shared databases are an important subset of file sharing. If the organization maintains an extensive database - for example, a membership, client, grants or financial accounting database - a network is the only effective way to make the database

available to multiple users at the same time. Sophisticated database server software ensures the integrity of the data while multiple users access it at the same time.

(vi) Fault Tolerance : Establishing Fault Tolerance is the process of making sure that there are several lines of defense against accidental data loss. An example of accidental data loss might be a hard drive failing, or someone deleting a file by mistake. Usually, the first line of defense is having redundant hardware, especially hard drives, so that if one fails, another can take its place without losing data. Tape backup should always be a secondary line of defense (never primary) While today's backup systems are good, they are not fail-safe. Additional measures include having the server attached to an uninterruptible power supply, so that power problems and blackouts do not unnecessarily harm the equipment.

(viii) Internet Access and Security : When computers are connected via a network, they can share a common, network connection to the Internet. This facilitates email, document transfer and access to the resources available on the World Wide Web. Various levels of Internet service are available, depending on your organization's requirements. These range from a single dial-up connection (as you might have from your home computer) to 128K ISDN to 768K DSL or up to high-volume T-1 service. A.I. Technology Group strongly recommends the use of a firewall to any organization with any type of broadband Internet connection.

(ix) Communication and collaboration: It's hard for people to work together if no one knows what anyone else is doing. A network allows employees to share files, view other people's work, and exchange ideas more efficiently. In a larger office, one can use e-mail and instant messaging tools to communicate quickly and to store messages for future reference.

(x) Organization: A variety of network scheduling software is available that makes it possible to arrange meetings without constantly checking everyone's schedules. This software usually includes other helpful features, such as shared address books and to-do lists.

3.2.2 Benefits of using networks : As the business grows, good communication between employees is needed. The organisations can improve efficiency by sharing information such as common files, databases and business application software over a computer network.

With improvements in network capacity and the ability to work wirelessly or remotely, successful businesses should regularly re-evaluate their needs and their IT infrastructure.

(i) Organisations can **improve communication** by connecting theirr computers and working on standardised systems, so that:

- Staff, suppliers and customers are able to share information and get in touch more easily

- More information sharing can make the business more efficient - eg networked access to a common database can avoid the same data being keyed multiple times, which would waste time and could result in errors

- as staff are better equipped to deal with queries and deliver a better standard of service as they can share information about customers

(ii) Organisation can **reduce costs and improve efficiency** - by storing information in one centralised database and streamlining working practices, so that:

- staff can deal with more customers at the same time by accessing customer and product databases

- network administration can be centralised, less IT support is required

- costs are cut through sharing of peripherals such as printers, scanners, external discs, tape drives and Internet access

(iii) Organisations can **reduce errors** and improve consistency - by having all staff work from a single source of information, so that standard versions of manuals and directories can be made available, and data can be backed up from a single point on a scheduled basis, ensuring consistency.

3.3 CLASSIFICATIONS OF NETWORKS

All of the interconnected data communication devices can form a wide area network, a local area network, or a metropolitan area network.

(i) Local Area Networks (LAN) : A LAN covers a limited area. This distinction, however, is changing as the scope of LAN coverage becomes increasingly broad. A typical LAN connects as many as hundred or so microcomputers that are located in a relatively small area, such as a building or several adjacent buildings. Organizations have been attracted to LANs because they enable multiple users to share software, data, and devices. Unlike WAN which use point-to-point links between systems, LANs use a shared physical media which is routed in the whole campus to connect various systems. LANs use high-speed media (1 Mbps to 30 Mbps or more) and are mostly privately owned and operated.

Following are the salient features of LAN:

- Multiple user computers connected together

- Machines are spread over a small geographic region

- Communication channels between the machines are usually privately owned. Channels are relatively high capacity (measuring throughput in mega bits per second, Mbits/s)

- Channels are relatively error free (for example, a bit error rate of 1 in 10^9 bits transmitted)

(ii) Metropolitan Area Networks (MAN) : A metropolitan area network (MAN) is some where between a LAN and a WAN. The terms MAN is sometimes used to refer to networks which connect systems or local area networks within a metropolitan area (roughly 40 kms in length

from one point to another) MANs are based on fiber optic transmission technology and provide high speed (10 Mbps or so), interconnection between sites.

A MAN can support both data and voice, cable television networks are examples of MANs that distribute television signals. A MAN just has one or two cables and does not contain switching elements.

(iii) Wide Area Networks (WAN): A WAN covers a large geographic area with various communication facilities such as long distance telephone service, satellite transmission, and under-sea cables. The WAN typically involves best computers and many different types of communication hardware and software. Examples of WANs are interstate banking networks and airline reservation systems. Wide area networks typically operate at lower link speeds (about 1 Mbps) Following are the salient features of WAN:

- Multiple user computers connected together.

- Machines are spread over a wide geographic region

- Communications channels between the machines are usually furnished by a third party (for example, the Telephone Company, a public data network, a satellite carrier)

- Channels are of relatively low capacity (measuring through put in kilobits per second, k bits)

- Channels are relatively error-prone (for example, a bit error rate of 1 in 10^5 bits transmitted)

(iv) VPN: A VPN is a private network that uses a public network (usually the Internet) to connect remote sites or users together. Instead of using a dedicated, real-world connection such as leased line, a VPN uses "virtual" connections routed through the Internet from the company's private network to the remote site or employee. There are two common types of VPN.

 (a) Remote-access, also called a **virtual private dial-up network** (**VPDN**), is a user-to-LAN connection used by a company that has employees who need to connect to the private network from various remote locations. Typically, a corporation that wishes to set up a large remote-access VPN will outsource to an **enterprise service provider** (**ESP**) The ESP sets up a **network access server** (**NAS**) and provides the remote users with desktop client software for their computers. The telecommuters can then dial a toll-free number to reach the NAS and use their VPN client software to access the corporate network.

A good example of a company that needs a remote-access VPN would be a large firm with hundreds of sales people in the field. Remote-access VPNs permit secure, encrypted connections between a company's private network and remote users through a third-party service provider.

(b)   Site-to-Site VPN : Through the use of dedicated equipment and large-scale encryption, a company can connect multiple fixed sites over a public network such as the Internet. Site-to-site VPNs can be one of two types:

- **Intranet-based** - If a company has one or more remote locations that they wish to join in a single private network, they can create an intranet VPN to connect LAN to LAN.

- **Extranet-based** - When a company has a close relationship with another company (for example, a partner, supplier or customer), they can build an extranet VPN that connects LAN to LAN, and that allows all of the various companies to work in a shared environment.
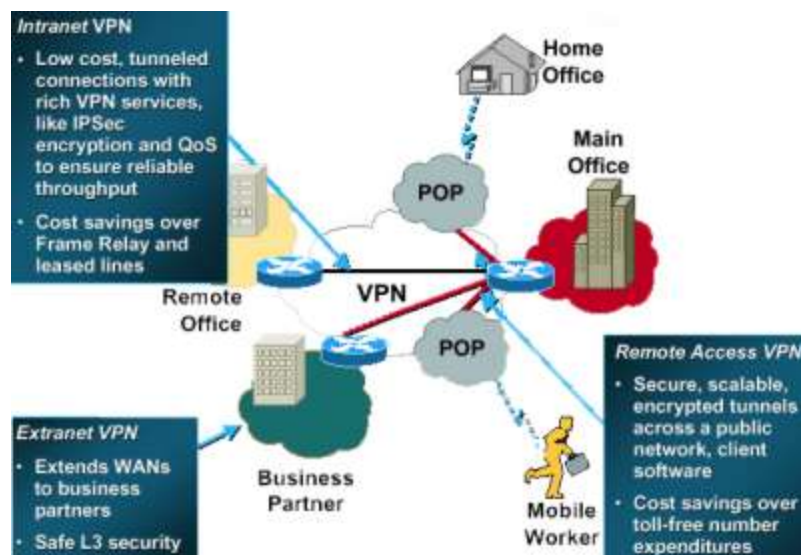
Image courtesy Cisco Systems, Inc.

Fig 3.3 : Examples of VPN

3.3.1 Network Models

1.   Client-Server : Client-Server networks are comprised servers -- typically powerful computers running advanced network operating systems -- and user workstations (clients) which access data or run applications located on the servers. Servers can host e-mail; store common data files and serve powerful network applications such as Microsoft's SQL Server. As a centerpiece of the network, the server validates logins to the network and can deny access to both networking resources as well as client software. Servers are typically the center of all backup and power protection schemas.

While it is technically more complex and secure, the Client-Server network easier than ever to administer due to new centralized management software. It is also the most "scaleable" network configuration; additional capabilities can be added with relative ease. The drawbacks to the Client-Server model are mostly financial. There is a large cost up front for specialized hardware and software. Also, if there are server problems, down time means that users lose access to mission-critical programs and data until the server can be restored.

2. Peer to peer : In peer-to-peer architecture, there are no dedicated servers. All computers are equal, and therefore, are termed as peer. Normally, each of these machines functions both as a client and a server. This arrangement is suitable for environments with a limited number of users (usually ten or less) Moreover, the users are located in the same area and security is not an important issue while the network is envisaged to have a limited growth. At the same time, users need to freely access data and programs that reside on other computers across the network.

The basic advantage of this architecture is simplicity of design and maintenance. Since there is no server, all nodes on the network are fully employed. In other types of networks, which use server computers, the server computer is usually dedicated in its role. In other words, the server is not used for anything else.

Secondly, the network is not totally reliant on a particular computer. With a single server based system, which is what most PC LANs consist of, a server malfunction can result in the network shutting down. In contrast, a failure of a node on a peer to peer network means that the network can no longer access the applications or data on that node but other than this it should continue to function.

Thirdly, linking computers in a peer to peer network is significantly more straightforward. The reason being that there is no central server to which all the computers have to be connected. The computers can be connected to the network cable at any convenient point. This can lead to a considerable saving.

3.4 COMPONENTS OF A NETWORK

There are five basic components in any network (whether it is the Internet, a LAN, a WAN, or a MAN):

1. The sending device
2. The communications interface devices
3. The communications channel
4. The receiving device
5. Communications software

3.4.1 Communication Interface Devices :
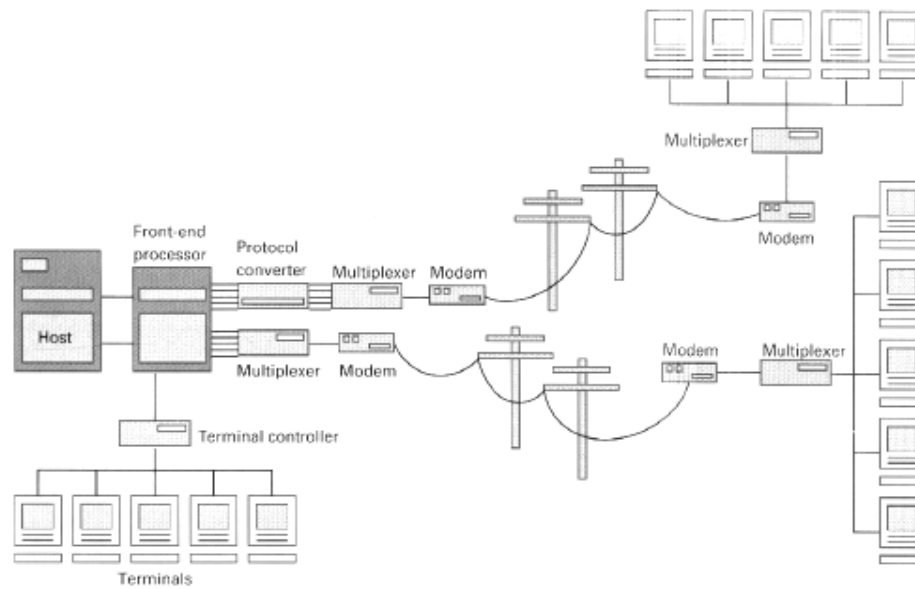
Fig 3.4

In figure 3.4, some of the communication devices are shown. We will now briefly describe the most commonly used communication devices.

(i) Network Interface Cards : Network interface cards (NIC) provide the connection for network cabling to servers and workstations. An NIC first of all, provides the connector to attach the network cable to a server or a workstation. The on-board circuitry then provides the protocols and commands required to support this type of network card. An NIC has additional memory for buffering incoming and outgoing data packets, thus improving the network throughput. A slot may also be available for remote boot PROM, permitting the board to be mounted in a diskless workstation. Network interface cards are available in 8-bit bus or in faster 16-bit bus standards.

(ii) Switches and Routers are hardware devices used to direct messages across a network, switches create temporary point to point links between two nodes on a network and send all data along that link. Router computers are similar to bridges but have the added advantage of supplying the user with network management utilities. Routers help administer the data flow by such means as redirecting data traffic to various peripheral devices or other computers. In an

Internet work communication, routers not only pass on the data as necessary but also select appropriate routes in the event of possible network malfunctions or excessive use.

(iii) Hubs: A hub is a hardware device that provides a common wiring point in a LAN. Each node is connected to the hub by means of simple twisted pair wires. The hub then provides a connection over a higher speed link to other LANs, the company's WAN, or the Internet.

(iv) Bridges, repeaters and gateways: Workstations in one network often need access to computer resources in another network or another part of a WAN. For example, an office manager using a local area network might want to access an information service that is offered by a VAN over the public phone system. In order to accommodate this type of need, bridges and routers are often necessary.

Bridges: The main task of a bridge computer is to receive and pass data from one LAN to another. In order to transmit this data successfully, the bridge magnifies the data transmission signal. This means that the bridge can act as a repeater as well as a link.

Repeaters are devices that solve the snag of signal degradation which results as data is transmitted along the various cables. What happens is that the repeater boosts or amplifies the signal before passing it through to the next section of cable.

Gateways: Gateways are also similar to bridges in that they relay data from network to network. They do not, as a rule, possess the management facilities of routers but like routers they can translate data from one protocol to another. Gateways are usually used to link LANs of different topologies, e.g., Ethernet and Token Ring, so enabling the exchange of data.

The major point of distinction between gateways, bridge, and a router is that a gateway is a collection of hardware and software facilities that enables devices on one network to communicate with devices on another, dissimilar network. *Bridges* have the same general characteristics as gateways, but they connect networks that employ similar protocols and topologies. Routers are similar to bridges in that they connect two similar networks.

(v) Modem : Data communication discussed above could be achieved due to the development of encoding/decoding devices. These units covert the code format of computers to those of communication channels for transmission, then reverse the procedure when data are received. These communication channels include telephone lines, microwave links or satellite transmission. The coding/encoding device is called a modem.

Modem stands for Modulator/Demodulator. In the simplest form, it is an encoding as well as decoding device used in data transmission. It is a device that converts a digital computer signal into an analog telephone signal (i.e. it modulates the signal) and converts an analog telephone signal into a digital computer signal (i.e. it demodulates the signal) in a data

communication system. Modems are used for handling data streams from a peripheral device to the CPU and vice versa through the common carrier network. Modems are required to tele-communicate computer data with ordinary telephone lines because computer data is in digital form but telephone lines are analogue. Modems are built with different ranges of transmission speeds.

One of the greatest benefits of a modem is that it confers the ability to access remote computers. One advantage of this capability is that it allows many employees to work at home and still have access to the computer system at the office. By dialing the company's network number with a modem, an employee can access data and trade files with other employees, and exchange e-mail message. Salespersons who are on road often communicate with their office via modem. A communications software package is used to establish the connection between the salesperson's portable computer and a computer in the office. His data can then be transmitted over telephone lines.

Modems can be categorized according to speed, price and other features. But most commonly, people classify them as internal and external. Internal modems look like the sound cards and video cards that fit inside the computer. Once it is in the computer, it is not accessible to the user unless he/she opens the computer. External modems, on the other hand, connect to the serial port of the computer. This sort of modem usually sits on the top of the CPU of the computer. There is another category of modems called PCMCIA. These modems are used only with laptop computers. They are small—about the size of a visiting card and are quite expensive.

There are also modems that connect to the parallel port of the computer, leaving the serial port free for other uses. But these parallel port modems are rare.

Both internal and external modems work pretty well but people have found external modems to be better because they can see and control them better. External modems connect to the computer like any other device does and can be set up more easily. These can be switched off or on easily too. The lights on the external modem also inform about the status of transmission of data. Internal modems, which are cheaper, are a little more difficult for a novice to set up. If an internal modem disconnects or gets stuck in its operations for some reasons, it can not be reset easily since it is inside the computer. The user has to only restart the computer.

The speed of modems is measured in Kbps (Kilo bits per second) Today a modem is available from Rs. 1,500 and more depending on the features available. The fastest modems available.

Modems in turn are connected to receivers that can actually be any of the several types of devices such as a computer, a multiplexer etc.

(vi) Multiplexer : This device enables several devices to share one communication line. The multiplexer scans each device to collect and transmit data on a single line to the CPU. It also communicates transmission from the CPU to the appropriate terminal linked to the Multiplexer. The devices are polled and periodically asked whether there is any data to transmit. This function may be very complex and on some systems, there is a separate computer processor devoted to this activity and this is called a "front-end-processor".

(vii) Front-end communication processors : These are programmable devices which control the functions of communication system. They support the operations of a mainframe computer by performing functions, which it would otherwise be required to perform itself. These functions include code conversions, editing and verification of data, terminal recognition and control of transmission lines. The mainframe computer is then able to devote its time to data processing rather than data transmission.

(viii) Protocol converters : Dissimilar devices can not communicate with each other unless a strict set of communication standards is followed. Such standards are commonly referred to as protocols. A protocol is a set of rules required to initiate and maintain communication between a sender and receiver device.

Because an organization's network typically evolved over numerous years, it is often composed of a mixture of many types of computers, transmission channels, transmission modes, and data codes. To enable diverse systems components to communicate with one another and to operate as a functional unit, protocol conversion may be needed. For example, it may be necessary to convert from ASCII to EBCDIC. Protocol conversion can be accomplished via hardware, software, or a combination of hardware and software.

(ix) Remote Access Devices: Remote access devices are modem banks that serve as gateways to the Internet or to private corporate networks. Their function is to properly route all incoming and outgoing connections.

3.5 NETWORK STRUCTURE OR TOPOLOGY

The geometrical arrangement of computer resources, remote devices, and communication facilities is known as network structure or network topology. A compute network is comprised of nodes and links. A *node* is the end point of any branch in a computer, a terminal device, workstation or an interconnecting equipment facility. A link is a communication path between two nodes. The terms "circuit" and "channel" are frequently used as synonyms for link.

A network structure determines which elements in a computer network can communicate with each other. Four basic network structures are discussed below.

(i) Star Network : The most common structure or topology known as star network is characterized by communication channels emanating from centralized computer system as shown in the figure 3.5.
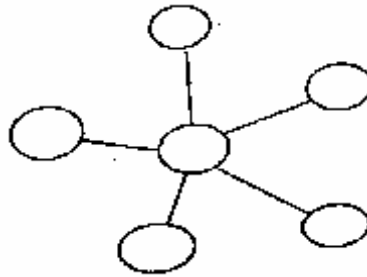
Fig. 3.5

That is, processing nodes in a star network interconnect directly with a central system. Each terminal, small computer, or large main frame can communicate only with the central site and not with other nodes in the network. If it is desired to transmit information from one node to another, it can be done only by sending the details to the central node, which in turn sends them to the destination.

A star network is particularly appropriate for organisations that require a centralized data base or a centralized processing facility. For example, a star network may be used in banking for centralized record keeping in an on-line branch office environment.

Advantages:

- It is easy to add new and remove nodes.

- A node failure does not bring down the entire network

- It is easier to diagnose network problems through a central hub.

Disadvantages:

- If the central hub fails, the whole network ceases to function.

- It costs more to cable a star configuration than other topologies (more cable is required than for a bus or ring configuration)

(ii) Bus network : This structure is very popular for local area networks. In this structure or topology, a single network cable runs in the building or campus and all nodes are linked along

with this communication line with two endpoints called the bus or backbone. Two ends of the cable are terminated with terminators.
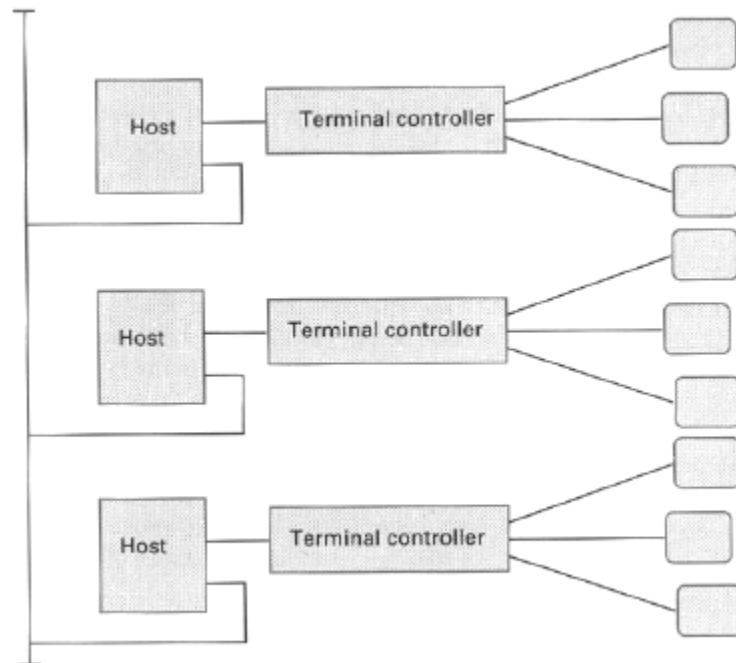
Fig 3.6

Advantages:

- Reliable in very small networks as well as easy to use and understand.

- Requires the least amount of cable to connect the computers together and therefore is less expensive than other cabling arrangements.

- Is easy to extend. Two cables can be easily joined with a connector, making a longer cable for more computers to join the network.

- A repeater can also be used to extend a bus configuration.

Disadvantages:

- Heavy network traffic can slow a bus considerably. Because any computer can transmit at any time. But networks do not coordinate when information is sent. Computers interrupting each other can use a lot of bandwidth.

- Each connection between two cables weakens the electrical signal.

- The bus configuration can be difficult to trouble shoot. A cable break or malfunctioning computer can be difficult to find and can cause the whole network to stop functioning.

(iii) Ring network : This is yet another structure for local area networks. In this topology, the network cable passes from one node to another until all nodes are connected in the form of a loop or ring. There is a direct point-to-point link between two neighboring nodes. These links are unidirectional which ensures that transmission by a node traverses the whole ring and comes back to the node, which made the transmission.
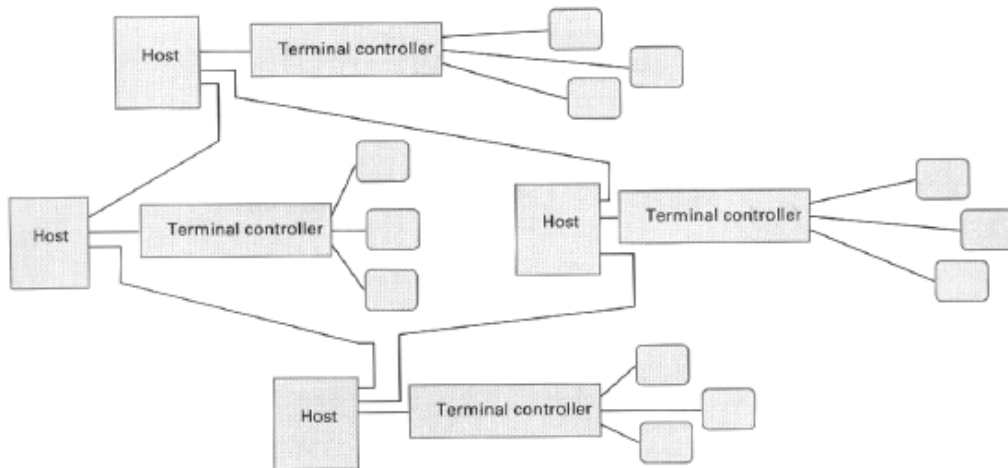
Fig 3.7

Advantages:

- Ring networks offer high performance for a small number of workstations or for larger networks where each station has a similar workload.

- Ring networks can span longer distances than other types of networks.

- Ring networks are easily extendable.

Disadvantages:

- Relatively expensive and difficult to install.
- Failure of one computer on the network can affect the whole network.

- It is difficult to trouble shoot a ring network.

- Adding or removing computers can disrupt the network

(iv) Mesh network : In this structure, there is random connection of nodes using communication links. In real life, however, network connections are not made randomly. Network lines are expensive to install and maintain. Therefore, links are planned very carefully after serious thoughts, to minimize cost and maintain reliable and efficient traffic movement. A mesh network may be fully connected or connected with only partial links. In fully interconnected topology, each node is connected by a dedicated point to point link to every node. This means that there is no need of any routing function as nodes are directly connected. The reliability is very high as there are always alternate paths available if direct link between two nodes is down or dysfunctional. Fully connected networks are not very common because of the high cost. Only military installations, which need high degree of redundancy, may have such networks, that too with a small number of nodes.
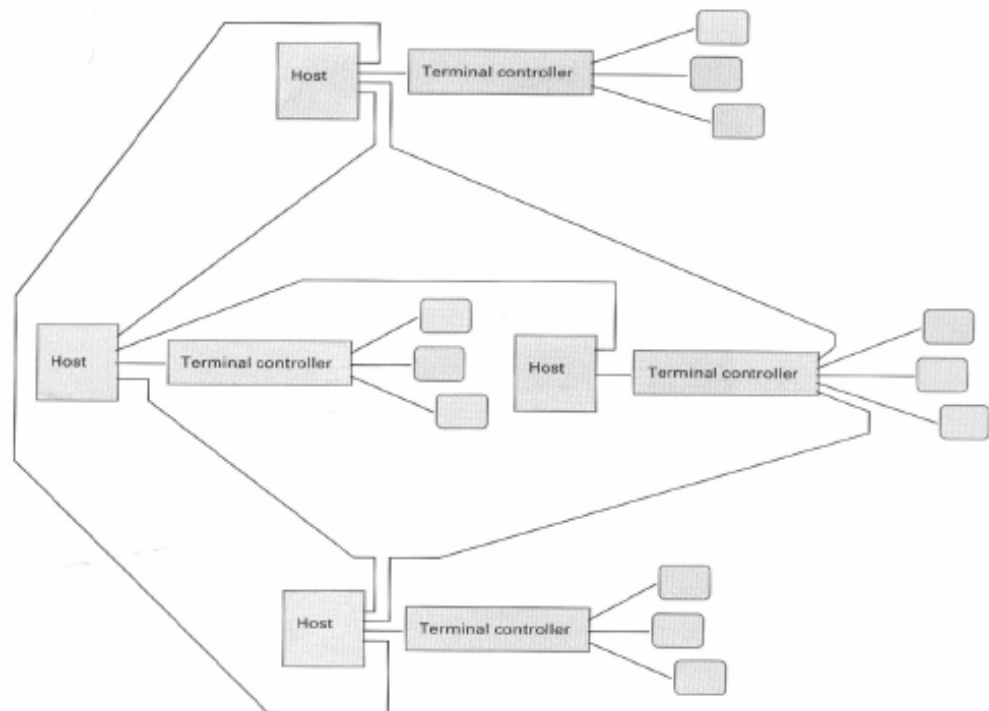
Fig 3.8

Partially connected mesh topology is the general topology for wide area networks. Here computer nodes are widely scattered and it is the only choice. The function of routing information from one node to another is done using routing protocol or procedures.

Advantages:

- Yields the greatest amount of redundancy in the event that one of the nodes fails where network traffic can be redirected to another node.

- Network problems are easier to diagnose.

Disadvantages:

- The cost of installation and maintenance is high (more cable is required than any other configuration)

For any network to exist there must be connections between computers and agreements or what is termed as protocols about the communications language. However, setting up connections and agreements between dispersed computers (from PCs to mainframes) is complicated by the fact that over the last decade, systems have become increasingly heterogeneous in both their software and hardware, as well as their intended functionality.

3.6 TRANSMISSION TECHNOLOGIES

3.6.1 Serial versus Parallel Transmission : Data are transmitted along a communication either in serial or in parallel mode.

Serial Transmission: In serial transmission, the bits of each byte are sent along a single path one after another. An example is the serial port (RS-232) for the mouse or MODEM.

Advantages of serial transmission are :

It is a cheap mode of transferring data .

It is suitable to transmit data over long distance.

The **disadvantage** is :

This mode is not efficient (i.e. slow) as it transfers data in series.
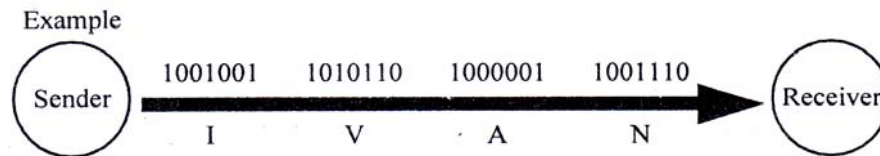
Fig. 3.9

Parallel Transmission: In parallel transmission, there are separate, parallel path corresponding to each bit of the byte so that all character bits are transmitted simultaneously. Example of this transmission is the parallel port (Centronic port) used for printer.

Example
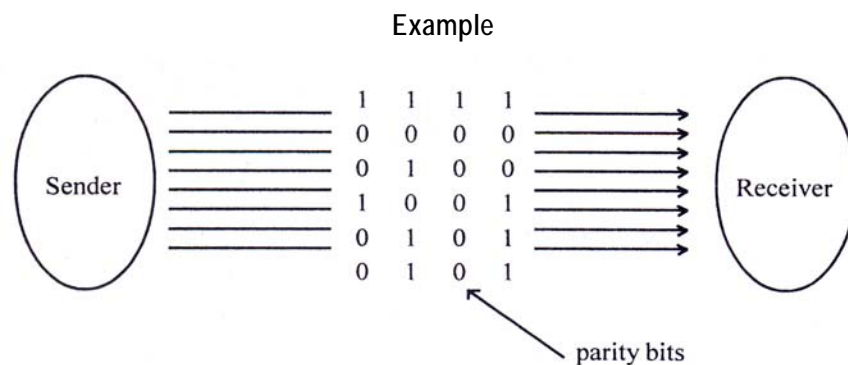
Fig. 3.10

Parallel Transmission offers faster transfer of data. However, it is not practical for long distance communication as it uses parallel path, so cross talk occurs. Hence, the cable length is made limited to minimize cross talk.

3.6.2 Synchronous versus Asynchronous Transmission : Another aspect of data transmission is synchronization (relative timing) of the pulses when transmitted. When a computer sends the data bits and parity bit down the same communication channel, the data are grouped together in predetermined bit patterns for the receiving devices to recognize when each byte (character) has been transmitted. There are two basic ways of transmitting serial binary data: synchronous and asynchronous.

Synchronous Transmission : In this transmission ,bits are transmitted at fixed rate. The transmitter and receiver both use the same clock signals for synchronisation.

- Allows characters to be sent down the line without start-stop bits.

- Allows data to be send as a multi-word blocks.

- Uses a group of synchronisation bits, which is placed, at the beginning and at the end of each block to maintain synchronisation.

- Timing determined by a MODEM
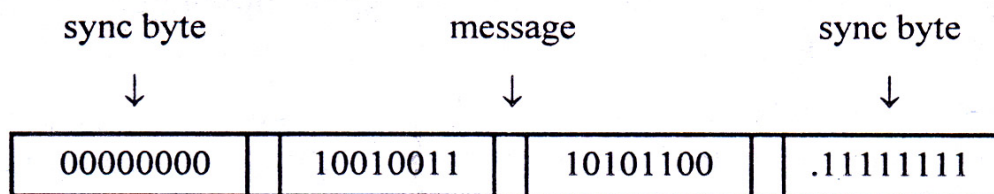
Fig. 3.11

Advantage: Transmission is faster because by removing the start and stop bits, many data words can be transmitted per second.

Disadvantage: The synchronous device is more expensive to build as it must be smart enough to differentiate between the actual data and the special synchronous characters.

Asynchronous Transmission : In this transmission , each data word is accompanied by stop(1) and start (0) bits that identify the beginning and ending of the word. When no information is being transmitted (sender device is idle), the communication line is usually high (in binary 1), i.e., there is a continuous stream of 1.
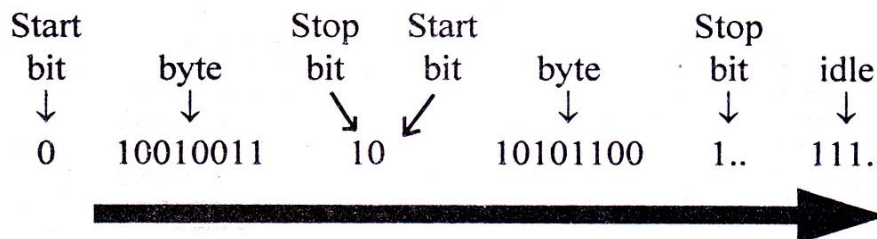
Fig. 3.12

Advantage: Reliable as the start and stop bits ensure that the sender and receiver remain in step with one another.

Disadvantage: Inefficient as the extra start and stop bits slow down the data transmission when there is a huge volume of information to be transmitted.

3.6.3 Transmission Modes : There are three different types of data communication modes :

(i) Simplex : A simplex communication mode permits data to flow in only one direction. A terminal connected to such a line is either a send-only or a receive only device. Simplex mode is seldom used because a return path is generally needed to send acknowledgements, control or error signals.

(ii) Half duplex : Under this mode, data can be transmitted back and forth between

two stations, but data can only go in one of the two directions at any given point of point.

(iii) Full duplex : A full duplex connection can simultaneously transmit and receive data between two stations. It is most commonly used communication mode. A full duplex line is faster, since it avoids the delay that occur in a half-duplex mode each time the direction of transmission is changed.

3.6.4 Transmission Techniques

(i) Circuit switching : Circuit switching is what most of us encounter on our home phones. We place a call and either get our destination party or encounter a busy signal, we can not transmit any message. A single circuit is used for the duration of the call.

(ii) Message Switching : Some organisations with a heavy volume of data to transmit use a special computer for the purpose of data message switching. The computer receives all transmitted data ; stores it ; and, when an outgoing communication line is available, forwards it to the receiving point.

(iii) Packet switching : It is a sophisticated means of maximizing transmission capacity of networks. This is accomplished by breaking a message into transmission units, called packets, and routing them individually through the network depending on the availability of a channel for each packet. Passwords and all types of data can be included within the packet and the transmission cost is by packet and not by message, routes or distance. Sophisticated error and flow control procedures are applied on each link by the network.

3.6.5 Communications Channels : A communications channel is the medium that connects the sender and the receiver in the data communications network. Common communications channels include telephone lines, fiber optic cables, terrestrial microwaves, satellite, and cellular radios. A communications network often uses several different media to minimize the total data transmission costs. Thus, it is important to understand the basic characteristics, and costs, of different communications channels.

Characteristics of Alternative Communications Channels. The different communications channels each posses characteristics that affect the network's reliability, cost, and security. One of the most important characteristics of a channel is its bandwidth. **Bandwidth** refers to a channel's information carrying capacity. Technically, bandwidth, which represents the difference between the highest and lowest frequencies that can be used to transmit data, should be measured in cycles per second, called hertz (Hz) Nevertheless, bandwidth is usually measured in terms of bits per second (bps) All things else being equal, a communications channel with greater bandwidth will be more useful, because it can transmit more information in less time. For example, a web page that takes 15 seconds to download over a T-1 line that transfers data at approximately 1.5 megabits per second (Mbps) will take several minutes to download over normal telephone lines using a 56K modem. Higher bandwidth is essential for applications like real-time video.

3.6.6 Communication Services: Normally, an organization that wishes to transmit data uses one of the common carrier services to carry the messages from station to station. Following is a brief description of these services.

Narrow band Service - Usually, this service is used where data volume is relatively low ; the transmission rates usually range from 45 to 300 bits per second. Examples of this are the telephone companies' typewriters exchange service (TWX) and Telex service.

Voice band Services - Voice band services use ordinary telephone lines to send data messages. Transmission rates vary from 300 to 4,800 bits per second, and higher.

Wide band Services - Wide band services provide data transmission rates from several thousands to several million bits per second. These services are limited to high-volume users. Such services generally use coaxial cable or microwave communication. Space satellites, a more exotic development, have been employed to rapidly transmit data from any part of the world to another part of the world.

Communication services may be either **leased** or **dialed up** A leased communication channel, which gives the user exclusive use of the channel, is used where there are continuing data-transmission needs. The dial-up variety requires the person to dial the computer (and, of course, the line may be busy) ; thus, this alternative is appropriate when there are periodic data to transmit.

3.6.7 Communications Software : Communications software manages the flow of data across a network. It performs the following functions:

- *Access control:* Linking and disconnecting the different devices; automatically dialing and answering telephones; restricting access to authorized users; and establishing parameters such as speed, mode, and direction of transmission.

- *Network management:* Polling devices to see whether they are ready to send or receive data; queuing input and output; determining system priorities; routing messages; and logging network activity, use, and errors.

- *Data and file transmission:* Controlling the transfer of data, files, and messages among the various devices.

- *Error detection and control:* Ensuring that the data sent was indeed the data received.

- *Data security:* Protecting data during transmission from unauthorized access.

Communications software is written to work with a wide variety of protocols, which are rules and procedures for exchanging data.

3.6.8   Transmission Protocols - For any network to exist , there must be connections between computers and agreements or what is termed as protocols about the communications language. However, setting up connections and agreements between dispersed computers (from PCs to mainframes) is complicated by the fact that over the last decade, systems have become increasingly heterogeneous in their software and hardware, as well as their intended functionality.

Protocols are software that performs a variety of actions necessary for data transmission between computers. Stated more precisely, protocols are a set of rules for inter-computer communication that have been agreed upon and implemented by many vendors, users and standards bodies. Ideally, a protocols standard allows heterogeneous computers to talk to each other.

At the most basic level, protocols define the physical aspects of communication, such as how the system components will be interfaced and at what voltage levels will be transmitted.

At higher levels, protocols define the way that data will be transferred, such as the establishment and termination of "sessions" between computers and the synchronisation of those transmissions. At still higher levels, protocols can standardise the way data itself is encoded and compressed for transmission.

A transmission protocols is a set of conventions or rules that must be adhered to by both the communicating parties to ensure that the information being exchanged between the two parties is received and interpreted correctly. A protocol defines the following three aspects of digital communication.

(a) Syntax: The format of data being exchanged, character set used, type of error correction used, type of encoding scheme (e.g., signal levels) being used.

(b) Semantics: Type and order of messages used to ensure reliable and error free information transfer.

(c) Timing: Defines data rate selection and correct timing for various events during data transfer.

As stated earlier, communication protocols are rules established to govern the way the data are transmitted in a computer network. Communication protocols are defined in layers, the first of which is the physical layer or the manner in which nodes in a network are connected to one another. Both the network software and the network-interface card (NIC) have to adhere to a network protocol. The RS-232C connector is the standard for some communication protocols. Subsequent layers, the number of which vary between protocols, describe how messages are packaged for transmission, how messages are routed through the network, security procedures, and the manner in which messages are displayed.

A number of different protocols are in common use. For example, X. 12 is the standard for electronic data interchange (EDI-discussed later in the chapter); X.75 is used for interconnection between networks of different countries; XON/XOFF is the de-facto standard for microcomputer data communication; and XMODEM is used for uploading and downloading files.

OSI or the open System Interconnection has been outlined by International Organization for Standardization (ISO) to facilitate communication of heterogeneous hardware or software platforms with each other with the help of following seven layers of functions with their associated controls: -

Layer 1 or **Physical Layer** is a hardware layer which specifies mechanical features as well as electromagnetic features of the connection between the devices and the transmission. Network topology is a part of this layer.

Layer 2 or **Data Link Layer** is also a hardware layer which specifies channel access control method and ensures reliable transfer of data through the transmission medium.

Layer 3 or **Network Layer** makes a choice of the physical route of transmission of say, a message packet, creates a virtual circuit for upper layers to make them independent of data transmission and switching, establishes, maintains, terminates connections between the nodes, ensures proper routing of data.

Layer 4 or **Transport Layer** ensures reliable transfer of data between user processes, assembles and disassembles message packets, provides error recovery and flow control. Multiplexing and encryption are undertaken at this layer level.

Layer 5 or **Session Layer** establishes, maintains and terminates sessions (dialogues) between user processes. Identification and authentication are undertaken at this layer level.

Layer 6 or Presentation Layer controls on screen display of data, transforms data to a standard application interface. Encryption, data compression can also be undertaken at this layer level.

Layer 7 or **Application Layer** provides user services by file transfer, file sharing, etc. Database concurrency and deadlock situation controls are undertaken at this layer level.

Network protocols which are essentially software are sets of rules for –

- Communicating timings, sequencing, formatting, and error checking for data transmission.

- Providing standards for data communication

    These rules are embedded or built into the software which reside either in –

    (i)   Computer's memory or

    (ii) Memory of transmission device

Different protocols cannot talk to each other hence standard protocols have been structure to resolve the problem. The entire operation of data transmission over a network is broken down into discrete systematic steps. Each step has its won rules or protocol. For example, in the above mentioned OSI each of the seven layers use different protocols. Accordingly steps must be carried out in consistent order. This order is same for every computer in the network, either receiving or sending data.

At the sending computer, protocols –

(i)   Break data down into packets,

(ii)   Add destination address to the packet,

(iii) Prepares data for transmission through Network Interface Card (NIC)

At the receiving computer, protocols –

(i)   Take data packets off the cable

(ii)   Bring packets into computer through Network Interface Card (NIC)

(iii) Strip the packets off any transmitting information,

(iv)   Copy data from packet to a buffer for reassembly,

(v)   Pass the reassembled data to the application,

A protocol stack is a combination of a set of protocols. Each layer specifies a different protocol–

(i)   For handling a function or,

(ii)   As a subsystem of the common process,

(iii) Each layer has its won set of rules, for example the protocol stack of the Application Layer initiates or accepts a request from the user. The Presentation Layer adds

formatting, displays and encrypts information to the packet. The Session Layer adds traffic flow information to determine when the packet gets sent or received. Transport Layer adds error handling information like CRC. The Network Layer does sequencing and adds address information in the packet. The data Link Layer adds error checking information and prepares the data for going on to the destination.

The protocols used on the Internet is called **TCP/IP (transmission Control Protocol/Internet Protocol)** A TCP/IP protocol which has two parts–

(i)   TCP deals with exchange of sequential data

(ii)   IP handles packet forwarding and is used on the Internet

TCI/IP has four layers–

(i)   The Application Layer which provides services directly the users such as e-mail,

(ii)   The Transport Layer which provides end-to-end communication between applications and verifies correct packet arrival,

(iii) The Internet Layer which provides packet routing for error checking and addressing and integrity.

(iv)   The Network Interface Layer which provides an interface to the network hardware and device drivers. This can also be called the Data Link Layer.

TCP/IP creates a packet-switching network. When a message, whether it is a file or just e-mail, is ready to be sent over the Internet, the TCP protocol breaks it up into small packets. Each packet is then given a header, which contains the destination address. The packets are then sent individually over the Internet. The IP protocol guides the packets so that they arrive at the proper destination. Once there, the TCP protocol resembles the packets into the original message.

3.6.9 Broad Band Networks (ISDN): -Integrated Services Digital Network (ISDN) is a system of digital phone connections to allow simultaneous voice and data transmission across the world. Such voice and data are carried by bearer channels (B channels) having a bandwidth of 64 kilobits per second. A data channel can carry signals at 16kbps or 64kbps, depending on the nature of service provided. There are two types of ISDN service – Basic Rate Interface (BRI) and Primary Rate Interface (PRI) BRI consists of two 64 kbps B channels and one 16kbps D channel for a total of 144kbps and is suitable for individual users. PRI consists of twenty three B channels and one 64kbps D channel for a total of 1536kbps and is suitable for users with higher capacity requirements. It is possible to support multiple primary PRI lines with one 64kbps D channel using Non Facility Associated Signaling (NFAS)

Advantages:

(i) ISDN allows multiple digital channels to be operated simultaneously through the same regular phone cable meant for analog signals. However, that is possible if the telephone company's switches can support digital connections. The digital scheme permits a much higher data transfer rate than analog lines. BRI ISDN, after using a channel aggregation protocol like 'Bonding' or Multilink-PPP can support a clear text data transfer at a speed of 128kbps apart from bandwidth for overhead and signaling. Besides, the amount of time it takes for a communication to start up or the latency time period is about half of that of an analog line.

(ii) With ISDN it is possible to combine many different digital data sources and have the information routed to the proper destination. In a digital line it is easier to keep noise and interference out even after combining these signals.

(iii) The phone company sends a ring voltage signal to ring the bell which is an In Band signal. However ISDN sends a digital packet on a separate channel which is an Out Band signal without disturbing the established connections, without taking any bandwidth from data channels and setting up call much faster. The signaling also indicates who is calling, whether it is a data or voice and what number was dialed. Then the ISDN phone equipment makes intelligent decisions on how to direct the call.

(iv) Usually the telephone company provides the BRI customers with a U interface which is nothing but a single pair of twisted wire from the phone switch just like the same interface provided for the telephone lines. It can transmit full duplex data and therefore only a single device can be connected with a U interface, which is known as Network Termination 1

3.7 LOCAL AREA NETWORKS

3.7.1 The Emergence of Local Area Networks : The advent of IBM PCs in the early 1980s set a whole new standard in both business and personal computing. Along with PCs came a new operating system called DOS. DOS provided an easy programming environment for software vendors developing and publishing software. The significance of the DOS standard is that it stimulates growth of new products by providing software and hardware vendors with an open development platform to build both accessories and software products. Since this brought in an abundance of software, the use of personal computers increased. As more and more people began to use computers, it became obvious that a way of connecting them together would provide many useful benefits, such as printer and hard disk sharing, especially when budgets became a constraint. This gave birth to the Local Area Network (LAN) concept.

3.7.2 The Concept : While personal computers were becoming more powerful through the use of advanced processors and more sophisticated software, users of mainframes and minicomputers began to break with the tradition of having a centralized information systems division. PCs were easy to use and provided a better and more effective way of maintaining

data on a departmental level. In the mainframe and mini environment, the data required by individual departments was often controlled by the management information system department or some such similar department. Each user was connected to the main system through a dumb terminal that was unable to perform any of its own processing tasks. In the mainframe and minicomputer environment, processing and memory are centralized.

The host computer became the center of the computing environment, and was managed by a team of data processing DP professionals whose sole task was to operate the system and provide reports to the various departments in the organisation. While this method of computerization had its merits, the major minus point was that the system could get easily overloaded as the number of users and consequently, terminals, increased. Secondly, most of the information was centralised to one pool of people, the systems professionals, rather than the end users.

This type of centralised processing systems differ from the distributed processing systems used in LANs. In distributed processing systems, most of the processing is done in the memory of the individual PCs, or workstations. The file server or host system becomes the central point for storing files, connecting and sharing printers or other network resources and for managing the network.

A local area network is best defined in terms of the purpose it is meant to serve rather than in terms of how it does it. *A local area network is primarily a data transmission system intended to link computers and associated devices within a restricted geographical area*; however, many suppliers propose to include speech in their systems. The linked computers and related equipments may be anything from full-scale mainframe computing systems to small desk-top office workstations, terminals, peripherals, etc. The key characteristic of a local area network is the fact that the whole of the network, confined to one site, is completely under the control of one organisation. This does not prevent communications taking place between users of the local area network on one site and others elsewhere. This would be achieved using wide area networks with special bridging equipment common to both the local and wide area network to perform the function of taking messages from one network and putting them on the other. Local area networks could conceivably be used as device concentrators for a wide area network.

Having decided to restrict the range of the network to within one site, various options are open to the designer. The network can have one shape (topology) among several, and many methods of transmitting the information can be used. It is unrealistic to attempt to define local area networks in terms of the topology or transmission technology as these can have mush wider applicability. Local area networks can be used in the manner suited to the organisation which owns them, and can be completely independent of the constraints imposed by public telephone authorities, or other public services.

Since a local area network is confined to a small area, it is possible to employ vastly different transmission methods from those commonly used on other telecommunication systems. Inexpensive line-driving equipment can be employed instead of the relatively complex modems needed for public analogue network. High data transmission speed can be achieved by utilizing the advantages of short distances and the latest electronic circuits. Thus, local area networks are typified by short distances (up to 10 km. although 1 km. is more usual), by a high transmission rate (0.1 to 30 Mbps), and by a low error rate. It is equally important to stress that local area networks are cheap to install and run, and provide a convenient method for interconnecting a large number of computer based devices on a single site (e.g. word processors, personal computers, as well as ordinary computers)

The main attributes of present-day local area networks can be summarised :

- inexpensive transmission media;

- inexpensive devices (modems, repeaters and transceiver) to interface to the media;

- easy physical connection of devices to the media;

- high data transmission rates;

- network data transmissions are independent of the rates used by the attached devices, making it easier for devices of one speed to send information to devices of another speed;

- a high degree of inter-connection between devices;

- every attached device having the potential to communicate with every other device on the network;

- there is seldom a central controlling processor which polls the attached devices on the network;

- in the majority of cases, each attached device hears (but does not process) messages intended for other devices as well as for itself.

It is important to note that neither the actual data transmission rate used, the access method not the topology of the network are essential characteristics.

3.7.3 Why Lans ? - One of the original reasons for users going in for LANs was that such a distributed environment gave them the ability to have their own independent processing stations while sharing expensive computer resources like disk files, printers and plotters. Today, however, more critical reasons have emerged for users to increasingly move towards LAN solutions. These include :

(i) Security - Security for programs and data can be achieved using servers that are locked through both software and by physical means. Diskless nodes also offer security by not allowing users to download important data on floppies or upload unwanted software or virus.

(ii) Expanded PC usage through inexpensive workstation - Once a LAN has been set up, it actually costs less to automate additional employees through diskless PCs. Existing PCs can be easily converted into nodes by adding network interface cards.

(iii) Distributed processing - Many companies operate as if they had distributed system in place. If numerous PCs are installed around the office, these machines represent the basic platform for a LAN with inter-user communication and information exchange.

(iv) Electronic mail and Message Broadcasting - Electronic mail allows users to communicate more easily among themselves. Each user can be assigned a mail-box on the server. Messages to other users can then be dropped into the mail-box and read by them when they log into the network.

(v) Organisational Benefits : Benefits of LANs are numerous. These include reduced costs in computer hardware, software and peripherals, and a drastic reduction in the time and cost of training or re-training manpower to use the systems. In addition, the fact that you are networked helps managers and executive to communicate with each other more easily and faster, without any logistical constraints. Information flow too becomes a lot smoother with various departments having the ability to access or request for information and data pertinent to them.

(vi) Data management benefits - Since data is located centrally on the server, it becomes much easier to mange it, as well as back it up. No file is transferred between users through floppies.

(vii) Software cost and upgradation - If the organisation is concerned about using licensed software purchasing a network version can save a lot of money, since there would be no need to buy multiple copies of the same software for every machine in the organisation. Therefore, software upgrades are much easier as any given package is stored centrally on the server.

3.7.4 LAN Requirements - There are certain features that every LAN should have and users would do well to keep note of these when they decide to implement their own network. These features essentially invoice hardware and software components. Broadly, these are :

(i) Compatibility - A local area network operating system must provide a layer of compatibility at the software level so that software can be easily written and widely distributed. A LAN operating system must be flexible, which means that it must support a large variety of hardware. Novell Net Ware is a network operating system that can provide these features, and has today, become an industry standard.

(ii) Internetworking - Bridging of different LANs together is one of the most important requirements of any LAN. Users should be able to access resources from all workstations on the bridge network in a transparent way; no special commands should be required to cross the bridge. A network operating system must be hardware independent, providing the same user interface irrespective of the hardware.

(iii) Growth Path and Modularity. - One of the most important requirements of a LAN is its modularity. A set of PCs should get easily converted into a LAN which can grow in size simply by adding additional workstations. If more storage is required, one should be able to add another hard disk drive, or another server. If you need to connect with a user on another LAN, you should be able to install a bridge.

(iv) System Reliability and Maintenance. - All computers are prone to system lockups, power failures and other catastrophes. If a centralized processing system goes down, all users connected to it are left without a machine to work on. Such a situation can arise even in a distributed or local area network system. However, a LAN operating system should be powerful enough to withstand accidents. In fact, Novells SFT Level I and Level II include fault-tolerance as a feature.

3.7.5 Components of a LAN - A typical local area network running under Novell NetWare has five basic components that make up the network. These are :

- File Servers
- Network operating system
- Personal Computers, Workstations or Nodes
- Network Interface Cards
- Cabling

(i) File Server - A network file server is a computer system used for the purpose of managing the file system, servicing the network printers, handling network communications, and other functions. A server may be dedicated in which case all of its processing power is allocated to network functions, or it may be non-dedicated which means that a part of the servers functions may be allocated as a workstation or DOS-based system.

(ii) The network operating system - It is loaded into the server's hard disk along with the system management tools and user utilities. When the system is restarted, NetWare boots and the server comes under its control. At this point, DOS or Windows is no longer valid on the network drive, since it is running the network operating system or NetWare; however most DOS/Windows programs can be run as normal. No processing is done on the server, and hence it is called a Passive Device. The choice of a dedicated or non-dedicated network server is basically a trade-off between the cost and performance, and operation of a network.

The larger the network, the more important it becomes to have a high performance server. Larger amounts of RAM are required to support disk caches and printer queues (which are created due to sharing of same hard disk and printers by number of nodes on the network) The server should be matched with anticipated throughout as closely as possible. While most IBM systems are satisfactory for NetWare, a Pentium system is preferable for better overall performance of the network.

(iii) Workstations - Workstations are attached to the server through the network interface card and the cabling. The dumb terminals used on mainframes and minicomputer systems are not supported on networks because they are not capable of processing on their own. Workstations are normally intelligent systems, such as the IBM PC. The concept of distributed processing relies on the fact that personal computers attached to the networks perform their own processing after loading programs and data from the server. Hence, a workstation is called an Active Device on the network. After processing, files are stored back on the server where they can be used by other workstations.

The workstation can also be a diskless PC, wherein loading of operating system takes place from the file server. In short, a PC + a LAN card = a Workstation.

*(iv) Network interface card: A*s discussed earlier, every device connected to a LAN needs a Network interface card(NIC) to plug into the LAN. For example, a PC may have an Ethernet card installed in it to connect to an Ethernet LAN.

(v) Network Cabling - Once the server, workstations and network interface cards are in place, network cabling is used to connect everything together. The most popular type of network cable is the shielded twisted-pair, co-axial and fibre optic cabling as discussed below. Please note that cables and cards chosen should match each other.

(a)   Twisted-Pair wiring - Twisted-pair wiring or cabling is the same type of cabling system which is used for home and office telephone system. It is inexpensive and easy to install. Technological improvements over the last few years have increased the capacity of twisted-pair wires so that they can now handle data communications with speeds upto 10 mbps (million of bits per second) over limited distances.

(b)   Coaxial cable - It is a well established and long-used cabling system for terminals and computers. This cabling comes in a variety of sizes to suit different purposes. Coaxial cable is commonly used to connect computers and terminals in a local area such as an office, floor, building or campus.

(c)   Fiber Optic Cables - Many organisations are replacing the older, copper wire cables in their networks with fiber Optic cables. Fiber optic cables use light as the communications medium. To create the on-and-off bit code needed by computers, the light is rapidly turned on and off on the channel. Fiber optic channels are light weight, can handle many times the telephone conversation or volumes of data handled by copper wire cabling, and can be

installed in environments hostile to copper wire, such as wet areas or areas subject to a great deal of electromagnetic interference. Data is more secure in fiber optic networks.

3.8 CLIENT / SERVER TECHNOLOGY

Recently, many organisations have been adopting a form of distributed processing called client / server computing. It can be defined as " a form of shared, or distributed, computing in which tasks and computing power are split between servers and clients (usually workstations or personal computers) Servers store and process data common to users across the enterprise, these data can then be accessed by client system. In this section we will discuss various aspects of client/server technology. But before that, let first look at the characteristics of the traditional computing models and various limitations that led to the client/ server computing.

3.8.1 Limitation of the traditional computing models

(i)   Mainframe architecture: With mainframe software architectures, all intelligence is within the central host computer (processor) Users interact with the host through a dump terminal that captures keystrokes and sends that information to the host. Centralized host-based computing models allow many users to share a single computer's applications, databases, and peripherals. Mainframe software architectures are not tied to a hardware platform. User interaction can be done using PCs and UNIX workstations.

A limitation of mainframe software architectures is that they do not easily support graphical user interfaces or access to multiple databases from geographically dispersed sites. They cost literally thousands of times more than PCs, but they sure don't do thousands of times more work.

(ii)   Personal Computers: With introduction of the PC and its operating system, independent-computing workstations quickly became common. Disconnected, independent personal computing models allow processing loads to be removed from a central computer. Besides not being able to share data, disconnected personal workstation users cannot share expensive resources that mainframe system users can share: disk drives, printers, modems, and other peripheral computing devices. The data (and peripheral) sharing problems of independent PCs and workstations, quickly led to the birth of the network/file server computing model, which links PCs and workstations together in a Local Area Network-LAN, so they can share data and peripherals.

(iii) File sharing architecture: The original PC networks were based on file sharing architectures, where the server downloads files from the shared location to the desktop environment. The requested user job is then run in the desktop environment.

The traditional file server architecture has many disadvantages especially with the advent of less expensive but more powerful computer hardware. The server directs the data while the

workstation processes the directed data. Essentially this is a dumb server-smart workstation relationship. The server will send the entire file over the network even though the workstation only requires a few records in the file to satisfy the information request. In addition, an easy to use graphic user interface (GUI) added to this model simply adds to the network traffic, decreasing response time and limiting customer service.

Unfortunately two defects limit a file server for multi-user applications.

- The file server model does not support data concurrence (simultaneous access to a single data set by multiple user) that is required by multi-user applications.

- If many workstations request and send many files in a LAN, the network can quickly become flooded with traffic, creating a block that degrades overall system performance. (It can only satisfy about 12 users simultaneously)

3.8.2 Need for Client Server Model: Client server technology, on the other hand, intelligently divides the processing work between the server and the workstation. The server handles all the global tasks while the workstation handles all the local tasks. The server only sends those records to the workstation that are needed to satisfy the information request. Network traffic is significantly reduced. The result of this system is that is fast, secure, reliable, efficient, inexpensive, and easy to use.

3.8.3 What is Client/Server? : Client/Server (C/S) refers to computing technologies in which the hardware and software components (i.e., clients and servers) are distributed across a network. The client/server software architecture is a versatile, message-based and modular infrastructure that is intended to improve usability, flexibility, interoperability, and scalability as compared to centralised, mainframe, time sharing computing. This technology includes both the traditional database-oriented C/S technology, as well as more recent general distributed computing technologies. The use of LANs has made the client/server model even more attractive to organisations.

3.8.4 Why Change to Client/Server Computing : Client/server is described as a `cost-reduction' technology. This technology allows doing what one may be currently doing with computers much less expensively. These technologies include client/server computing, open systems, fourth generation languages, and relational databases. Cost reductions are usually quoted as the chief reasons for changing to client/server. However, the list of reasons has grown to include improved control, increased data integrity and security, increased performance, and better connectivity. The key business issues dividing adoption are:

- Improving the Flow of Management Information

- Better Service to End-User Departments.

- Lowering IT costs

- The ability to manage IT costs better
- Direct access to required data
- High flexibility of information processing
- Direct control of the operating system

Client/ server has been defined as "the provision of information that is required by a user, which is easily accessed despite the physical location of the data within the organisation.

3.8.5 Implementation examples of client / server technology:

- Online banking application
- Internal call centre application
- Applications for end-users that are stored in the server
- E-commerce online shopping page
- Intranet applications
- Financial, Inventory applications based on the client Server technology.
- Tele communication based on Internet technologies

3.8.6 Benefits of the Client /Server Technology

Client/server systems have been hailed as bringing tremendous benefits to the new user, especially the users of mainframe systems. Consequently, many businesses are currently in the process of changing or in the near future will change from mainframe (or PC) to client / server systems. Client / Server has become the IT solution of choice among the country's largest corporations. In fact, the whole transition process, that a change to a client/ server invokes, can benefit a company's long run strategy.

- People in the field of information systems can use client/server computing to make their jobs easier.
- Reduce the total cost of ownership.
- Increased Productivity
- End user productivity
- Developer productivity
- Takes less people to maintain a client/server application than a mainframe
- The expenses of hardware and network in the client/server environment are less than those in the mainframe environment

- Users are more productive today because they have easy access to data and because applications can be divided among many different users so efficiency is at its highest.

- Client/server applications make organisations more effective by allowing them to port applications simply and efficiently.

- Reduce the cost of the client's computer: the server stores data for the clients rather than clients needing large amounts of disk space. Therefore, the less expensive network computers can be used instead.

- Reduce the cost of purchasing, installing, and upgrading software programs and applications on each client's machine: delivery and maintenance would be from one central point, the server.

- The management control over the organisation would be increased.

- Many times easier to implement client/server than change a legacy application.

- Leads to new technology and the move to rapid application development such as object oriented technology.

- Long term cost benefits for development and support.

- Easy to add new hardware to support new systems such as document imaging and video teleconferencing which would not be feasible or cost efficient in a mainframe environment.

- Can implement multiple vendor software tools for each application.

3.8.7 Characteristics of Client / Server Technology

There are ten characteristics that reflect the key features of a client / server system. These ten characteristics are as follows:

1. Client/server architecture consists of a client process and a server process that can be distinguished from each other.

2. The client portion and the server portions can operate on separate computer platforms.

3. Either the client platform or the server platform can be upgraded without having to upgrade the other platform.

4. The server is able to service multiple clients concurrently; in some client/server systems, clients can access multiple servers.

5. The client/server system includes some sort of networking capability.

6. A significant portion of the application logic resides at the client end.

7. Action is usually initiated at the client end, not the server end.

8. A user-friendly graphical user interface (GUI) generally resides at the client end.

9. A structured query language (SQL) capability is characteristic of the majority of client/ server systems.

10. The database server should provide data protection and security.

3.8.9 Components of client server architecture

Client: Clients, which are typically PCs, are the "users" of the services offered by the servers described above. There are basically three types of clients. Non-Graphical User Interface (GUI) clients require a minimum amount of human interaction; non-GUIs include ATMs, cell phones, fax machines, and robots. Second, GUI-Clients are human interaction models usually involving object/action models like the pull-down menus in Windows 3-X. Object-Oriented User Interface (OOUI) Clients take GUI-Clients even further with expanded visual formats, multiple workplaces, and object interaction rather than application interaction. Windows 95 is a common OOUI Client.

Server: Servers await requests from the client and regulate access to shared resources. File servers make it possible to share files across a network by maintaining a shared library of documents, data, and images. Database servers one their processing power to executed Structured Query Language (SQL) requests from clients. Transaction servers execute a series of SQL commands, an online transaction-processing program (OLTP), as opposed to database servers, which respond to a single client command. Web servers allow clients and servers to communicate with a universal language called HTTP.

Middleware: The network system implemented within the client/server technology is commonly called by the computer industry as middleware. Middleware is all the distributed software needed to allow clients and servers to interact. General middleware allows for communication, directory services, queuing, distributed file sharing, and printing. Service-specific software like ODBC. The middleware is typically composed of four layers, which are Service, Back-end Processing, Network Operating System, and Transport Stacks. The Service layer carries coded instructions and data from software applications to the Back-end Processing layer for encapsulating network-routing instructions. Next, the Network Operating System adds additional instructions to ensure that the Transport layer transfers data packets to its designated receiver efficiently and correctly. During the early stage of middleware development, the transfer method was both slow and unreliable.

Fat-client or Fat-server: Fat-client or fat-server are popular terms in computer literature. These terms serve as vivid descriptions of the type of client/server systems in place. In a fat-client system, more of the processing takes place on the client, like with a file server or database server. Fat-servers place more emphasis on the server and try to minimize the processing done by clients. Examples of fat-servers are transaction, GroupWare, and web

servers. It is also common to hear fat-clients referred to as "2-Tier" systems and fat-servers referred to as "3-Tier" systems.

Network: The network hardware is the cabling, the communication cords, and the device that link the server and the clients. The communication and data flow over the network is managed and maintained by network software. Network technology is not well understood by business people and end users, since it involves wiring in the wall and function boxes that are usually in a closet.

3.9 TYPES OF SERVERS

3.9.1 Database Servers: Database management systems (DBMS) can be divided into three primary components: development tools, user interface, and database engine. The database engine does all the selecting, sorting, and updating. Currently, most DBMS combine the interface and engine on each user's computer. Database servers split these two functions, allowing the user interface software to run on each user's PC (the client), and running the database engine in a separate machine (the database server) shared by all users. This approach can increase database performance as well as overall LAN performance because only selected records are transmitted to the user's PC, not large blocks of files. However, because the database engine must handle multiple requests,the database server itself can become a bottleneck when a large number of requests are pending.

Database servers offer real potential for remote database access and distributed databases. Because the database server only returns selected database record(s) to the client machine (instead of large blocks of data), remote access over relatively slow telephone lines can

provide acceptable performance. In addition, a client computer can make requests of multiple servers regardless of physical location.
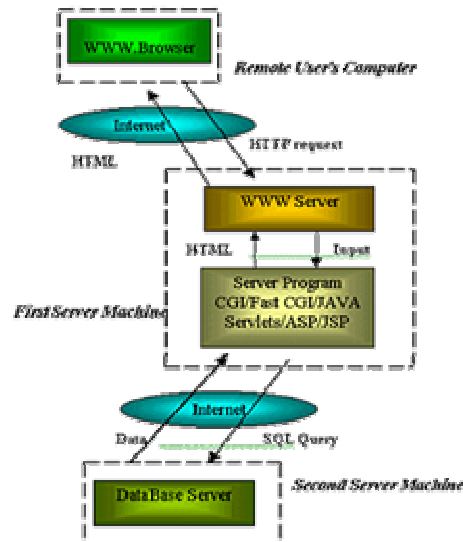
3.9.2 Application Servers : An application server is a server program that resides in the server (computer) and provides the business logic for the application program. The server can be a part of the network, more precisely the part of the distributed network. The server program is a program that provides its services to the client program that resides either in the same computer or on another computer connected through the network.

Application servers are mainly used in Web-based applications that have a 3-tier architecture.

➢   First Tier: Front End - Browser (Thin Client) -

a GUI interface lying at the client/workstation.

➢ Second Tier: Middle Tier - Application Server - set of application programs

➢ Third Tier: Back End - Database Server.

The application server is a second/middle tier of the three-tier architecture. In other words, application servers are now an integral part of the three-tier architecture.

The application server syncs and combines with the Web server for processing the request made by the client.

If we look at the request-response flow between client, Web server and application server, we come to know that the client's request first goes to the Web server, which then sends the required information to the application server. It then sends the response back to the Web server after taking an appropriate action. The Web server then sends the processed information back to the client. Web servers use different approaches or technology for forwarding or receiving back processed information. Some of the most common approaches are given below.

CGI (Common Gateway Interface) : Can be written either in JAVA, C, C++, or Perl.

ASP (Active Server Pages)   :   A Microsoft Technology

JSP (Java Server Pages)   :   Java Servlets - Sun's Technology

Java Script (Server Side)   :   NetScape Technology requires livewire for
                                         database connectivity.

Features of the Application Servers

Component Management: Provides the manager with tools for handling all the components and runtime services like session management, and synchronous/asynchronous client notifications, as well as executing server business logic.

Fault Tolerance: Ability of the application server with no single point of failure, defining policies for recovery and fail-over recovery in case of failure of one object or group of objects.

Load Balancing: Capability to send the request to different servers depending on the load and availability of the server.

Transaction Management.

Management Console: Single point graphical management console for remotely monitoring clients and server clusters.

Security: There are Security features for applications security
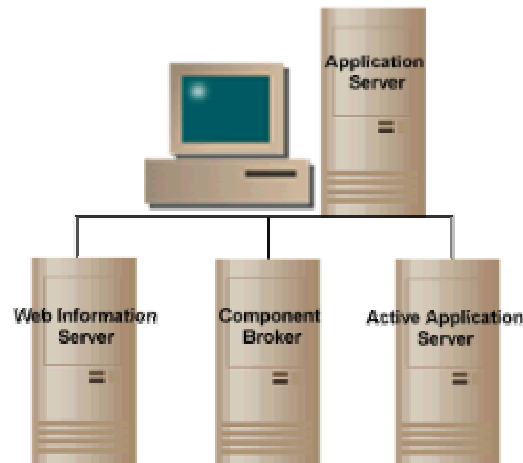
Application servers are mainly categorized into three types:

Web Information Servers: This type of server employs HTML templates and scripts to generate pages incorporating values from the database in them. These types of servers are stateless servers. Such servers include Netscape Server, HAHT, Allaire, Sybase, and SilverStream.

Component Servers: The main purpose of these servers is to provide database access and transaction processing services to software components including DLLs, CORBA, and JavaBeans. First, they provide environment for server-side components. Second, they provide access to database and other services to the component. These types of servers are stateless. Examples include MTS (which provides an interface for DLL), Sybase Jaguar, and IBM Component broker.

Active Application Server: This type of server supports and provides a rich environment for server-side logic expressed as objects, rules and components. These types of servers are most suitable for dealing with based e-commerce and decision processing.

3.9.3 Print Servers: Print servers provide shared access to printers. Most LAN operating systems provide print service. Print service can run on a file server or on one or more separate print server machines. Non-file server print servers can be dedicated to the task of print service, or they can be non-dedicated workstations.

The disadvantages of using workstations as print servers are similar to the disadvantages of using file servers as workstations. The workstation may run a little slower when print services are being used, a user could shut down the server without warning, or an application could lock up the server. The consequences of a lock-up or shut-down on a print server, however,

are usually less severe than the consequences of locking up a file server. The time involved in dealing with these problems, however. can be costly.

3.9.4 Transaction Servers: MTS or Microsoft Transaction Server is an integral part of Windows NT, and is installed by default as part of the operating system in NT5. It is a **service** in much the same way as Internet Information Server or the File and Print services that we now take for granted. In other words, it is part of the system that is available in the background whenever one of our applications requires it.

Control and configuration of MTS is via either a snap-in to the Microsoft Management Console, or through the HTML administration pages that are included with MTS. This is very similar to the interface provided for Internet Information Server 4, and gives an integrated management function that is useful when building and setting up distributed applications.

What Does Transaction Server Do? To understand what MTS is and what it does, we need to first make one very important point clear. This software should really have been named Microsoft **Component** Server, not Microsoft Transaction Server. MTS is all about managing the way applications use components, and not just about managing transactions. Yes, transactions are a big part of many applications we write and MTS can help to manage these—but MTS also provides a very useful service for applications that don't use transactions at all. To be able to define MTS accurately, we first need to understand what goes on inside it in the most basic way.

3.9.5 Types of Internet Servers

File server: A file server, one of the simplest servers, manages requests from clients for files stored on the server's local disk. A central file server permits groups and users to share and access data in multiple ways. Central file servers are backed up regularly and administrators may implement disk space quotas for each user or group of users.

For example: Using a certain software client, PC users are able to "mount" remote UNIX server file systems. As a result, the remote network file system appears to be a local hard drive on the user's PC.

Mail server: A mail server is the most efficient way to receive and store electronic mail messages for a community of users. A central mail server runs 24 hours a day. The mail server can also provide a global email directory for all community and school users, as well as email gateway and relay services for all other mail servers in the district. In such a scenario, user email boxes would be maintained on a separate email server located at each school

Example: "Eudora" is a powerful cross-platform email client that receives incoming mail messages from and sends outgoing mail messages to a mail server.

DNS server: Domain Name Service is an Internet-wide distributed database system that documents and distributes network-specific information, such as the associated IP address for

a host name, and vice versa. The host that stores this database is a name server. The library routines that query the name server, interpret the response and return the information to the program that requested it are resolvers.

For example: To determine the location of a remote computer on the Internet, communications software applications (such as NCSA Telnet) use resolver library routines to query DNS for the remote computer's IP address.

Gopher server: Gopher is an Internet application that uses multiple Gopher servers to locate images, applications, and files stored on various servers on the Internet. Gopher offers menu choices to prompt users for information that interests them, and then establishes the necessary network connections to obtain the resource. For example, "Veronica" is a Gopher application that searches databases of the file contents of worldwide Gopher servers to help locate Gopher resources.

Web server: The World Wide Web (WWW) is a very popular Internet source of information. Web browsers present information to the user in hypertext format. When the user selects a word or phrase that a Web page's author has established as a hypertext link, the Web browser queries another Web server or file to move to another Web page related to the link. For example, "Netscape" is a Web browser which queries Web servers on the Internet. Which Web server Netscape queries depends upon which hypertext link the user selects.

FTP server: File Transfer Protocol (FTP) is an Internet-wide standard for distribution of files from one computer to another. The computer that stores files and makes them available to others is server. Client software is used to retrieve the files from the server. The two most common way to transfer files are with anonymous FTP, where anyone can retrieve files from or place files on a specific site, and logged file transfers, where an individual must login into the FTP server with an ID and password.

For example, Merit Network, Inc. makes network configuration files such as Domain Name Registration templates available for anonymous FTP on ftp.merit.edu

News server: Usenet News is a world wide discussion system consisting of thousands of newsgroups organized into hierarchies by subject. Users read and post articles to these newsgroups using client software. The "news" is held for distribution and access on the news server. Because newsgroups tend to generate large amounts of Internet traffic, you may wish to consider the method in which you intend to receive Usenet news.

There are two ways to accept Usenet News: as a "push" or "pull" feed. With a "push" feed, news articles are "pushed" onto your news server, whether or not your users read those articles. With a "pull" feed, your news server has all of the headers for the collection of Usenet News articles, but does not retrieve the article itself unless it is specifically requested by a user.

For example, the newsgroup "k12.ed.comp.literacy" contains a discussion of topics dealing with Computer Literacy in K12 schools.

Chat server: Some organizations choose to run a server that will allow multiple users to have "real-time" discussions, called "chats" on the Internet. Some chat groups are moderated; most however are unmoderated public discussions. Further, most chat servers allow the creation of "private" chat rooms where participants can "meet" for private discussions. You can participate in chats on other servers without running a chat server yourself.

The popularity of chat rooms has grown dramatically over the past few years on the Internet, however, the ability to talk in small groups on the Internet is not new. "Chat" is a graphical form of an Internet service called IRC, or Internet Relay Chat. IRC was a replacement for a UNIX command called "talk." Using talk, and even IRC can be cumbersome. Chat clients, on the other hand, are available for all platforms and are graphical in nature, opening up their utility to the majority of Internet users.

Example:

http://chat.redding.net/about.htm
http://www.chatspace.com/products/small.htm

Caching server: A caching server is employed when you want to restrict your number of accesses to the Internet. There are many reasons to consider doing this. Basically, a caching server sits between the client computer and the server that would normally fulfill a client's request. Once the client's request is sent, it is intercepted by the caching server. The caching server maintains a library of files that have been requested in the recent past by users on the network. If the caching server has the requested information in its cache, the server returns the information without going out to the Internet.

Storing often-used information locally is a good way to reduce overall traffic to and from the Internet. A caching server does not restrict information flow. Instead, it makes a copy of requested information, so that frequently requested items can be served locally, instead of from the original Internet source. Caching servers can also be connected in a hierarchy so if the local cache does not have the information, it can pass the request to nearby caching servers that might also contain the desired files.

Proxy server: A proxy server is designed to restrict access to information on the Internet. If, for example, you do not want your users to have access to pornographic materials, a proxy server can be configured to refuse to pass the request along to the intended Internet server.

A proxy server operates on a list of rules given to it by a System Administrator. Some proxy software uses list of specific forbidden sites, while other proxy software examines the content of a page before it is served to the requester. If certain keywords are found in the requested page, access to it is denied by the proxy server.

Technologically, there's no substantial difference between a caching server and a proxy server. The difference comes in the desired outcome of such a server's use.

If you wish to reduce the overall amount of traffic exchanged between your network and the Internet, a caching server may be your best bet. On the other hand, if you wish to restrict or prohibit the flow of certain types of information to your network, a proxy server will allow you to do that. There are several different packages that will allow a System Administrator to set up a caching or proxy server. Additionally, you can buy any of a number of turn-key solutions to provide these services.

3.9.6 IDS Components : The goal of intrusion detection is to monitor network assets to detect anomalous behavior and misuse. This concept has been around for nearly twenty years but only recently has it seen a dramatic rise in popularity and incorporation into the overall information security infrastructure. Below we have given a layman's description of the primary IDS components:

Network Intrusion Detection (NID) : Network intrusion detection deals with information passing on the wire between hosts. Typically referred to as "packet-sniffers," network intrusion detection devices intercept packets traveling along various communication mediums and protocols, usually TCP/IP. Once captured, the packets are analyzed in a number of different ways. Some NID devices will simply compare the packet to a signature database consisting of known attacks and malicious packet "fingerprints", while others will look for anomalous packet activity that might indicate malicious behavior. In either case, network intrusion detection should be regarded primarily as a perimeter defense.

Host-based Intrusion Detection (HID) : Host-based intrusion detection systems are designed to monitor, detect, and respond to user and system activity and attacks on a given host. Some more robust tools also offer audit policy management and centralization, supply data forensics, statistical analysis and evidentiary support, and in certain instances provide some measure of access control. The difference between host-based and network-based intrusion detection is that NID deals with data transmitted from host to host while HID is concerned with what occurs on the hosts themselves.

Host-based intrusion detection is best suited to combat internal threats because of its ability to monitor and respond to specific user actions and file accesses on the host. The majority of

computer threats come from within organizations, from many different sources; disgruntled employees and corporate spies are just two examples.

Hybrid Intrusion Detection : Hybrid intrusion detection systems offer management of and alert notification from both network and host-based intrusion detection devices. Hybrid solutions provide the logical complement to NID and HID - central intrusion detection management.

Network-Node Intrusion Detection (NNID) : Network-node intrusion detection was developed to work around the inherent flaws in traditional NID. Network-node pulls the packet-intercepting technology off of the wire and puts it on the host. With NNID, the "packet-sniffer" is positioned in such a way that it captures packets after they reach their final target, the destination host. The packet is then analyzed just as if it were traveling along the network through a conventional "packet-sniffer." This scheme came from a HID-centric assumption that each critical host would already be taking advantage of host-based technology. In this approach, network-node is simply another module that can attach to the HID agent. Network node's major disadvantage is that it only evaluates packets addressed to the host on which it resides. Traditional network intrusion detection, on the other hand, can monitor packets on an entire subnet. Even so, "packet-sniffers" are equally incapable of viewing a complete subnet when the network uses high-speed communications, encryption, or switches since they are essentially "without a sense of smell". The advantage to NNID is its ability to defend specific hosts against packet-based attacks in these complex environments where conventional NID is ineffective.

3.10. 3-Tier and N-Tier Architecture

Through the appearance of Local-Area-Networks, PCs came out of their isolation, and were soon not only being connected mutually but also to servers. Client/Server-computing was born.

Servers today are mainly file and database servers; application servers are the exception. However, database-servers only offer data on the server; consequently the application intelligence must be implemented on the PC (client) Since there are only the architecturally tiered data server and client, this is called 2-tier architecture. This model is still predominant today, and is actually the opposite of its popular terminal based predecessor that had its entire intelligence on the host system.

One reason why the 2-tier model is so widespread, is because of the quality of the tools and middleware that have been most commonly used since the 90's: Remote-SQL, ODBC, relatively inexpensive and well integrated PC-tools (like Visual Basic, Power-Builder, MS

Access, 4-GL-Tools by the DBMS manufactures) In comparison the server side uses relatively expensive tools. In addition the PC-based tools show good Rapid-Application-Development (RAD) qualities i.e. that simpler applications can be produced in a comparatively short time. The 2-tier model is the logical consequence of the RAD-tools' popularity : for many managers it was and is simpler to attempt to achieve efficiency in software development using tools, than to choose the steep and stony path of "brainware".

3.10.1 Why 3-tier?

Unfortunately the 2-tier model shows striking weaknesses, that make the development and maintenance of such applications much more expensive.

The complete development accumulates on the PC. The PC processes and presents information which leads to monolithic applications that are expensive to maintain.

In a 2-tier architecture, business-logic is implemented on the PC. Even the business-logic never makes direct use of the windowing-system, programmers have to be trained for the complex API under Windows.

Windows 3.X and Mac-systems have tough resource restrictions. For this reason applications programmers also have to be well trained in systems technology, so that they can optimize scarce resources.

The 2-tier-model implies a complicated software-distribution-procedure: as all of the application logic is executed on the PC, all those machines (maybe thousands) have to be updated in case of a new release. This can be very expensive, complicated, prone to error and time consuming. Distribution procedures include the distribution over networks (perhaps of large files) or the production of an adequate media like floppies or CDs. Once it arrives at the user's desk, the software first has to be installed and tested for correct execution. Due to the distributed character of such an update procedure, system management cannot guarantee that all clients work on the correct copy of the program.

3- and n-tier architectures endeavour to solve these problems. This goal is achieved primarily by moving the application logic from the client back to the server.

3.10.2   What is 3-tier and n-tier architecture?

From here on we will only refer to 3-tier architecture, that is to say, at least 3-tier architecture.

The following diagram shows a simplified form of reference-architecture, though in principal, all possibilities are illustrated.
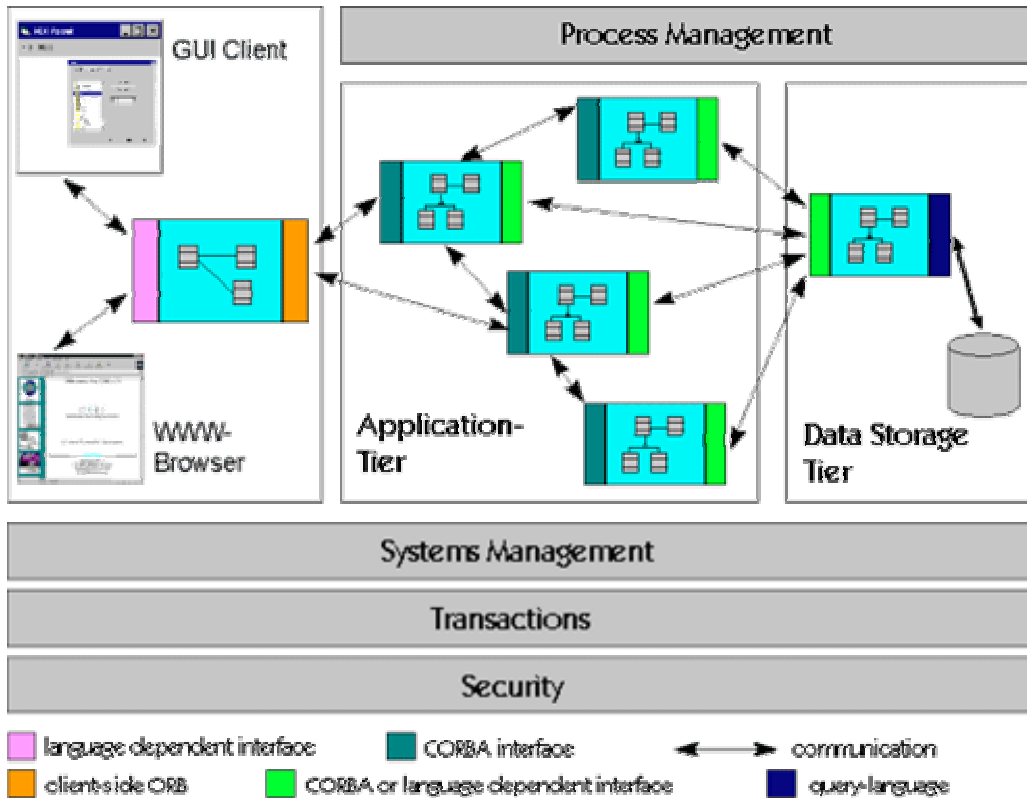
Client-tier: It is responsible for the presentation of data, receiving user events and controlling the user interface. The actual business logic (e.g. calculating added value tax) has been moved to an application-server. Today, Java-applets offer an alternative to traditionally written PC-applications. See our Internet-page for further information.

Application-server-tier: This tier is new, i.e. it isn't present in 2-tier architecture in this explicit form. Business-objects that implement the business rules "live" here, and are available to the client-tier. This level now forms the central key to solving 2-tier problems. This tier protects the data from direct access by the clients.

The object oriented analysis "OOA", on which many books have been written, aims in this tier: to record and abstract business processes in business-objects. This way it is possible to map out the applications-server-tier directly from the CASE-tools that support OOA.

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Furthermore, the term "component" is also to be found here. Today the term pre-dominantly describes visual components on the client-side. In the non-visual area of the system, components on the server-side can be defined as configurable objects, which can be put together to form new application processes.

Data-server-tier: This tier is responsible for data storage. Besides the widespread relational database systems, existing legacy systems databases are often reused here.

It is important to note that boundaries between tiers are logical. It is quite easily possible to run all three tiers on one and the same (physical) machine. The main importance is that the system is neatly structured, and that there is a well planned definition of the software boundaries between the different tiers.

3.10.3 The advantages of 3-tier architecture: As previously mentioned 3-tier architecture solves a number of problems that are inherent to 2-tier architectures. Naturally it also causes new problems, but these are outweighed by the advantages.

Clear separation of user-interface-control and data presentation from application-logic: Through this separation more clients are able to have access to a wide variety of server applications. The two main advantages for client-applications are clear: quicker development through the reuse of pre-built business-logic components and a shorter test phase, because the server-components have already been tested.

Dynamic load balancing: If bottlenecks in terms of performance occur, the server process can be moved to other servers at runtime.

Change management: Of course it's easy - and faster - to exchange a component on the server than to furnish numerous PCs with new program versions. To come back to our VAT example: it is quite easy to run the new version of a tax-object in such a way that the clients automatically work with the version from the exact date that it has to be run. It is, however, compulsory that interfaces remain stable and that old client versions are still compatible. In addition such components require a high standard of quality control. This is because low quality components can, at worst, endanger the functions of a whole set of client applications. At best, they will still irritate the systems operator.

Multi-tier looks like this.
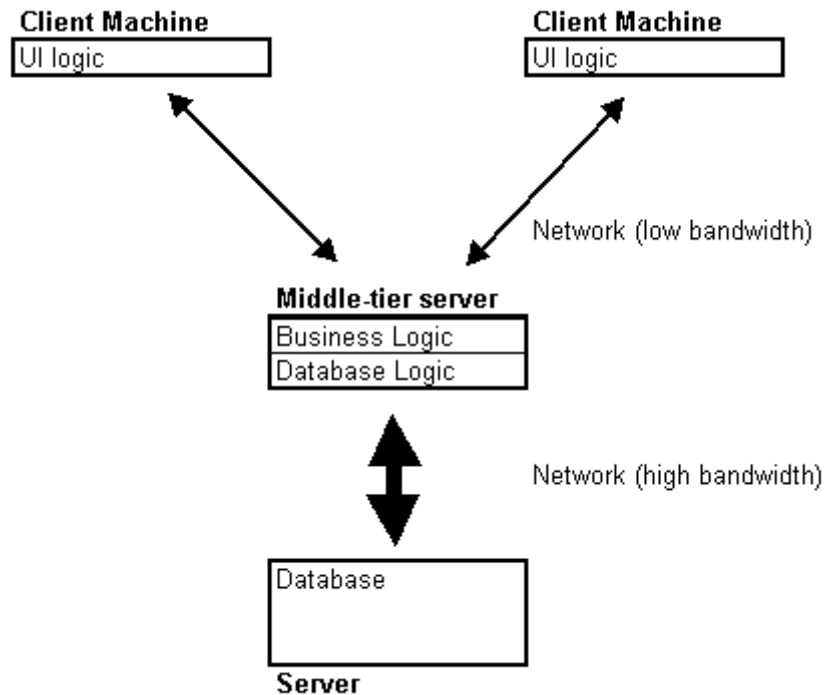
The client program has only UI code. The UI code talks, via a network, to the "middle tier" on which the business and database logic sits. In turn the middle tier talks, via a network, to the database. In practice the middle tier can be placed, if necessary, on the same machine as the database.

In either architecture the data "traffic" is highest between database logic and database server (illustrated by a thicker arrow) This means that the network infrastructure that connects the database logic with the database server needs to be very high bandwidth; i.e. expensive. With a traditional client/server architecture it is easy to create a scenario where no existing network technology would be enough to cope.

The advantages of a multi-tier architecture are:

➢ Forced separation of UI and business logic.

➢ Low bandwidth network.

➢ Business logic sits on a small number (maybe just one) of centralized machines.

➢ Enforced separation of UI and business logic.

3.11 WHAT IS A DATA CENTRE ?

A data center is a centralized repository for the storage, management and dissemination of data and information. Data centers can be defined as highly secure, fault-resistant facilities, hosting customer equipment that connects to telecommunications networks. Often referred to as an Internet hotel/ server farm, data farm, data warehouse, corporate data center, Internet service provide(ISP) or wireless application service provider (WASP), the purpose of a data center is to provide space and bandwidth connectivity for servers in a reliable, secure and scaleable environment. These data centers are also referred to as public data centers because they are open to customers. Captive, or enterprise data centers, are usually reserved for the sole and exclusive use of the parent company, but essentially serve the same purpose. These facilities can accommodate thousands of servers, switches, routers and racks, storage arrays and other associated telecom equipment.

A data center also provides certain facilities, like housing websites, providing data serving and other services for companies. This kind of data center may contain a network operations center (NOC), which is a restricted access area containing automated systems that constantly monitor server activity, Web traffic, network performance and report even slight irregularities to engineers, so that they can spot potential problems before they happen. They primary 'goal' of a data center is to deploy the requisite state-of-the-art redundant infrastructure and systems so as to maximize availability and prevent or mitigate any potential downtime for customers.

3.11.1   Types and Tiers : According to the varied computing needs of the businesses they serve, data centers fall into following two main categories:

(i) Private Data Centre: A private data center (also called enterprise data centers) is managed by the organization's own IT department, and it provides the applications, storage, web-hosting, and e-business functions needed to maintain full operations. If an organization prefers to outsource these IT functions, then it turns to a public data center.

(ii) Public data centers: A public data center (also called internet data centers) provide services ranging from equipment colocation to managed web-hosting. Clients typically access their data and applications via the internet.

Typically, **data centers can be classified in tiers**, with tier 1 being the most basic and inexpensive, and tier 4 being the most robust and costly. The more 'mission critical' an application is, the more redundancy, robustness and security are required for the data center. A **tier 1 data center** does not necessarily need to have redundant power and cooling infrastructures. It only needs a lock for security and can tolerate upto 28.8 hours of downtime per year.

In contrast, a **tier 4 data center** must have redundant systems for power and cooling, with multiple distribution paths that are active and fault tolerant. Further, access should be controlled with biometric reader and single person entryways; gaseous fire suppression is

required; the cabling infrastructure should have a redundant backbone; and the facility must permit no more than 0.4 hours of downtime per year.

Tier 1 or 2 is usually sufficient for enterprise data centers that primarily serve users within a corporation. Financial data centers are typically tier 3 or 4 because they are critical to our economic stability and, therefore must meet the higher standards set by the government. Public data centers that provide disaster recovery/backup services are also built to higher standards.

3.11.2   Which sectors use them? : Any large volume of data that needs to be centralized, monitored and managed centrally needs a data center. Of course, a data center is not mandatory for all organizations that have embraced IT; it depends on the size and criticality of data. Data centers are extremely capital-intensive facilities. Commissioning costs run into millions of dollars, and operational costs involved in maintaining levels of redundant connectivity, hardware and human resources, can be stratospheric. The percentage of enterprises for which it makes business sense to commission and operate an enterprise data center is, consequently, extremely small. The majority of small, medium and large enterprises host their online and Web-enabled applications with established public data centers, in order to leverage the existing infrastructure services and round-the –clock support and monitoring infrastructure that is already in place. Certain sectors, like defence and banks, go in for their own infrastructure.

3.11.3   What can they do? : Some of the value added services that a data center provides are:

(i)   Database monitoring:

- This is done via a database agent, which enables the high availability of the database through comprehensive automated management.

(ii)   Web monitoring:

- This is to assess and monitor website performance, availability, integrity and the responsiveness from a site visotor's perspective.

- It also reports on HTTP, FTP service status, monitors URL availability and round-trip response times, and verifies Web content accuracy and changes.

(iii)   Backup and restore:

- It provides centralized multi-system management capabilities.

- It is also a comprehensive integrated management solution for enterprise data storage using specialized backup agents for the operating system, database, open files and application.

(iv) Intrusion detection system (IDS): ID stands for Intrusion Detection, which is the art of detecting inappropriate, incorrect, or anomalous activity. ID systems that operate on a host to detect malicious activity on that host are called host-based ID systems, and ID systems that operate on network data flows are called network-based ID systems. Sometimes, a distinction is made between misuse and intrusion detection. The term intrusion is used to describe attacks from the outside; whereas, misuse is used to describe an attack that originates from the internal network.

- The IDS is scalable so that the system grows with the organization, from smaller networks to enterprise installation.

- It provides automated network-based security assessment and policy compliance evaluation.

(v) Storage on demand:

- It provides the back-end infrastructure as well as the expertise, best practices and proven processes so as to give a robust, easily management and cost-effective storage strategy.

- It provides data storage infrastructure that supports your ability to access information at any given moments – one that gives the security, reliability and availability needed to meet company demands.

3.11.4   Features of Data Centres

(i) Size : Data centers are characterized foremost by the size of their operations. A financially viable data center could contain from a hundred to several thousand servers. This would require a minimum area of around 5,000 to 30,000 square metres. Apart from this, the physical structure containing a data center should be able to withstand the sheer weight of the servers to be installed inside. Thus, there is a need for high quality construction.

(ii) Data Security : Another issue critical for data centers is the need to ensure maximum data security and 100 per cent availability. Data centers have to be protected against intruders by controlling access to the facility and by video surveillance. They should be able to withstand natural disasters and calamities, like fire and power failures. Recovery sites must be well maintained as it is here that everything in the data center is replicated for failure recovery.

(iii) Availability of Data : The goal of a data center is to maximize the availability of data, and to minimize potential downtime. To do this, redundancy has to be built in to all the mission critical infrastructure of the data center, such as connectivity, electrical supply, security and surveillance, air conditioning and fire suppression.

(iv) Electrical and power systems: A data center should provide the highest power availability with uninterrupted power systems (UPS)

(v) Security: Physical security and systems security are critical to operations. Thus, it should provide both types of security measures to ensure the security of equipment and data placed at the data center.

(a) Physical security: It can be achieved through

- Security guards
- Proximity card and PIN for door access
- Biometrics access and PIN for door access
- 24 x 365 CCTV surveillance and recording

(b) Data security: Data security within a data center should be addressed at multiple levels.

- Perimeter security: This is to manage both internal and external threats. This consists of firewalls, intrusion detection and content inspections; host security; anti-virus and access control and administrative tools.
- Access management: This is for both applications and operating systems that host these critical applications.

System monitoring and support

The data center should provide system monitoring and support, so that you can be assured that the servers are being monitored round the clock.

- 24x7x365 hours network monitoring
- Proactive customer notification
- Notification to customers for pre-determined events
- Monitoring of power supply, precision air conditioning system, fire and smoke detection systems, water detection systems, generators and uninterruptible power supply (UPS) systems.

For a data center to be considered world-class, there can be no shortcuts in the commissioning of the facility. Connectivity, electrical supply and security are perhaps the three paramount requirements of any data center.

Storage : Data centers offer more than just network storage solutions. While SAN (Storage) are used primarily for the storage needs of large enterprises and service providers, data centers host websites and act as convergence points for service providers' networks as well. In public data centers, cumulative data storage runs into multiple terabytes. Due to differing

customer requirements, data centers usually have hybrid storage and backup infrastructure. Primarily, data center storage can be differentiated into:

- Primary storage (SAN, NAS, DAS)
- Secondary storage (tape libraries)
- Tertiary storage (offline tape storage, such as DAT drives, and magneto-optical drives)

Most data centers today operate in hands-off mode, where no individual enters the data center unless there is a genuine need to do so. All the storage is operated and managed from remote consoles, which are located outside the data centers. The same holds true for all servers and tape libraries. This reduces dust and also accidental damage by people, like tripping over cables or accidentally touching the reset buttons on a server.

3.11.5   Constituents of a Data Centre

To keep equipment running reliably, even under the worst circumstances, the data center is built with following carefully engineered support infrastructures:

- Network connectivity with various levels of physical (optical fibre and copper) and service (both last mile and international bandwidth) provider redundancy
- Dual DG sets and dual UPS
- HVAC systems for temperature control
- Fire extinguishing systems
- Physical security systems: swipe card/ biometric entry systems, CCTV, guards and so on.
- Raised flooring
- Network equipment
- Network management software
- Multiple optical fibre connectivity
- Network security: segregating the public and private network, installing firewalls and intrusion detection systems (IDS)

3.11.6   Leveraging the best

In both enterprise/captive and public data centers, the systems and infrastructure need to be leveraged fully to maximize ROI. For companies that host their online applications with public data centers, in addition to the primary benefit of cost savings, perhaps the biggest advantage is the value-added services available. Enterprises usually prefer to select a service provider,

which can function as a one-stop solution provider and give them an end-to-end outsourcing experience.

Data centers need to strike a careful balance between utilization and spare infrastructure capacity. They need to be able to provide additional infrastructure to their customers who wish to scale their existing contracts with little or no advance notice. Thus it is necessary that there be additional infrastructure at all times. This infrastructure could include bandwidth and connectivity, storage, server or security infrastructure (firewalls, etc.)

Ensuring that the mission critical data centers systems and infrastructure conforms to the highest technological standards, before investing in non-core, fringe accessories, can mitigate expenditures. In the past, data centers floated by some of the largest enterprises in the world have succumbed to mismanagement of finances. Another way to mitigate expenditures is to manage inventories efficiently. Bloated inventories lead to large amounts of sunken capital, and if this is not used in time, they can eventually become obsolete. Having a streamlined inventory can ensure that a data center has sufficient resources to meet the customer demand for scalability, without over-provisioning.

3.11.7   Challenges faced by the management

(i) *Maintaining a skilled staff and the high infrastructure needed for daily data center operations:.* A company needs to have staff which is expert at network management and has software / OS skills and hardware skills. The company has to employ a large number of such people, as they have to work on rotational shifts. The company would also used additional cover in case a person leaves

(ii) *Maximising uptime and performance* : While establishing sufficient redundancy and maintaining watertight security, data centers have to maintain maximum uptime and system performance.

 (iii) *Technology selection :* The other challenges that enterprise data centers face is technology selection, which is crucial to the operations of the facility keeping business objectives in mind. Another problem is compensating for obsolescence.

(iv*) Resource balancing :* The enterprise chief technical officer today needs to strike a working balance between reduced operational budgets, increased demands on existing infrastructure, maximizing availability, ensuring round-the-clock monitoring and management, and the periodic upgrades that today's technology demands. This is why even some of the largest enterprises in the world choose to host their mission-critical and sensitive data with established data centers, where security concerns can be met and the technology and resources are already in place.

3.11.8   Disaster recovery sites

Data centers need to be equipped with the appropriate disaster recovery systems that minimize downtime for its customers. This means that every data center needs to invest in solutions, such as power backup and remote management. Downtime can be eliminated by having proper disaster recovery (DR) plans for mission-critical types of organisations, so as to be prepared when disaster strikes. Some of the larger IT organizations, which cannot tolerate too much downtime, tend to set up their DR site as a hot site, where both the primary and DR sites are kept in real-time synchronization , all the time. The different types of plans are:

Cold site: An alternative facility that is devoid of any resources or equipment, except air conditioning and raised flooring. Equipment and resources must be installed in such a facility to duplicate the critical business functions of an organisation. Cold sites have many variations depending on their communication facilities.

Warm site: An alternate processing site that is only partially equipped, as compared to a hot site, which is fully equipped. It can be shared (sharing servers equipment) or dedicated (own servers)

Hot site: An alternative facility that has the equipment and resources to recover business functions that are affected by a disaster. Hot sites may vary in the type of facilities offered (such as data processing, communications, or any other critical business functions needing duplication) The location and size of the hog site must be proportional to the equipment and resources needed.

3.11.9   Business Continuity Planning (BCP)

Disaster events: -

(i)   There is a potential for significantly interrupt normal business processing,

(ii)   Business is associated with natural disasters like earthquake, flood, tornadoes, thunderstorms, fire, etc.

(iii)   It is not a fact that all the disruptions are disasters,

(iv)   Disasters are disruptions causing the entire facility to be inoperative for a lengthy period of time (usually more than a day)

(v)   Catastrophes are disruptions resulting from disruption of processing facility.

A Business Continuity Plan (BCP) is a documented description of action, resources, and procedures to be followed before, during and after an event, functions vital to continue business operations are recovered, operational in an acceptable time frame.

Components of BCP –

(i)   Define requirements based on business needs,

(ii)   Statements of critical resources needed,

(iii) Detailed planning on use of critical resources,

(iv)   Defined responsibilities of trained personnel,

(v)   Written documentations and procedures cove all operations,

(vi)   Commitment to maintain plan to keep up with changes.

The Phase –I of a BCP involves risk analysis in critical, vital, sensitive and non critical areas, determining critical time period, applications to recover in critical recovery time period and coverage of insurance.

The Phase-II of BCP involves determination of minimum resources necessary, review operations between current practices and backup procedures (whether they are adequate to support a business resumption plan) The review should address a data file back up, software libraries, operations documentation, stationery requirement, backup communication paths, other operational adjustments (like splitting system between dual processors, or tandems, disk mirroring), off site storage.

The Phase-III of BCP involves:

(i)   Identification of most appropriate recovery solutions including information processing and telecommunication recovery,

(ii)   Hot sites which are fully configured and ready to operate within several hours, with compatible equipments and systems software so that primary installation can be backed up. Cost associated with the use of a third party hot site is usually high but often this cost is justified for critical applications because this is intended for emergency operations of a limited time period.

(iii) Warm sites are partially configured with network connections and selected peripheral equipments but without the main computer.

(iv)   Cold sites are ready to receive equipment but do not offer any equipment at the site in advance of the need, thus by creating a basic environment to operate an information processing facilities.

(v)   Duplicate information processing facilities.

(vi)   Reciprocal agreements

(vii) Preparing a list of alternatives,

(viii) Visits and reviews

The Phase-IV of BCP involves:

(i)   Plan preparation

(ii)   Provision for requirement of manual process,

(iii) Document revised work flow,

(iv)   Plan development,

(v)   Team building,

(vi)   Developing general plan.

The Phase-V of BCP involves: Testing BCP, in various phases like –

(i)   Pretest,

(ii)   Test,

(iii) Posttest,

(iv)   Paper test,

(v)   Preparedness test,

(vi)   Review test,

(vii) Review test results

The Phase-VI of BCP involves Maintenance by BCP Coordinator who has to arrange for scheduled and unscheduled tests, develop a scheduled training, maintain records of test, training and review, update notification directory.

3.12 NETWORK SECURITY

3.12.1   Need for security: The basic objective for providing network security is two fold:

(i) to safeguard assets and (ii) to ensure and maintain the data integrity.

 The boundary subsystem is an interface between the potential users of a system and the system itself controls in the boundary subsystem have the following purposes like

 (i) to establish the system resources that the users desire to employ and (ii) to restrict the actions undertaken by the users who obtain the system resource to an authorized set.

There are two types of systems security. A physical security is implemented to protect the physical systems assets of an organization like the personnel, hardware, facilities, supplies and documentation. A logical security is intended to control (i) malicious and non-malicious threats to physical security and (ii) malicious threats to logical security itself.

3.12.2   Level of Security: The task of a Security Administration in an organization is to conduct a security program which is a series of ongoing, regular and periodic review of controls exercised to ensure safeguarding of assets and maintenance of data integrity. Security programs involve following eight steps –

(i)   Preparing project plan for enforcing security,

(ii)   Assets identification,

(iii)   Assets valuation,

(iv)   Threats identification,

(v)   Threats probability of occurrence assessment,

(vi)   Exposure analysis,

(vii)   Controls adjustment,

(viii)   Report generation outlining the levels of security to be provided for individual systems, end user, etc.

The project plan components are at first outlining the objectives of the review followed by in sequence determining the scope of the review and tasks to be accomplished, assigning tasks to the project team after organizing it, preparing resources budget which will be determined by the volume and complexity of the review and fixing a target / schedule for task completion.

Assets which need to be safeguarded can be identified and subdivided into Personnel, Hardware, Facilities, Documentation, Supplies, Data, Application Software and System Software.

Third step of valuation of Assets can pose a difficulty. The process of valuation can differ depending on who is asked to render the valuation, the way in which the asset can be lost and the period for which it is lost and how old is the asset.

Valuation of physical assets cannot be considered apart from the valuation of the logical assets. For example, the replacement value of the contents in a micro computer's hard disk may be several times more than the replacement value of the disk itself.

The fourth step in a security review is Threats Identification. The source of a threat can be external or internal and the nature of a threat can be accidental / non-deliberate or deliberate. The example of a non-deliberate external threat is an act of God, non-deliberate internal threat is pollution, deliberate external threat is hackers, and deliberate internal threat is employees. More exhaustively, the sources of threat are the Nature or acts of God like earthquake, flood, fire, extreme temperatures, and electromagnetic radiations followed by other sources like Hardware / Software Suppliers, Competitors, Contractors, Shareholders / Debenture holders, Unions, Governmental Regulations, Environmentalists, Criminals / Hackers, Management, Employees and Unreliable Systems.

The fifth step in a security review is assessment or the probability of occurrence of threats over a given time period. This exercise is not so difficult if prior period statistical data is available. If however, prior period data is not available, it has to be elicited from the

associated stakeholders like end users (furnishing the data aspect) and the management (furnishing the control aspect)

The sixth step is the Exposures Analysis by first identifying the controls in the place, secondly assessing the reliability of the existing controls, thirdly evaluating the probability that a threat can be successful and lastly assessing the resulting loss if the threat is successful.

For each asset and each threat the expected loss can be estimated as the product of the probability of threat occurrence, probability of control failure and the resulting loss if the threat is successful.

The seventh step is the adjustment of controls which means whether over some time period any control can be designed, implemented and operated such that the cost of control is lower than the reduction in the expected losses. The reduction in the expected losses is the difference between expected losses with the (i) existing set of controls and (ii) improved set of controls.

The last step is report generation documenting, the findings of the review and specially recommending new assets safeguarding techniques that should be implemented and existing assets safeguarding mechanisms that should be eliminated / rectified, and also recommending the assignment of the levels of security to be pervaded for individual end users and systems.

3.12.3 Threats and Vulnerabilities:

The threats to the security of systems assets can be broadly divided into nine categories:

(i)   Fire,

(ii)   Water,

(iii) Energy variations like voltage fluctuations, circuit breakage, etc.,

(iv)   Structural damages,

(v)   Pollution,

(vi)   Intrusion like physical intrusion and eavesdropping which can be eliminated / minimized by physical access controls, prevention of electromagnetic emission and providing the facilities with their proper locations / sites,

(vii) Viruses and Worms (being discussed in detail later on),

(viii) Misuse of software, data and services which can be avoided by preparing an employees' code of conduct and

(ix)   Hackers, the expected loss from whose activities can be mitigated only by robust logical access controls.

A virus is itself a program that instructs the operating system to append it to other programs and thus propagates to other programs via files containing macros which are sent as attachments to electronic mail messages. A virus can be benign like it can cause minor disruptions by printing laughing message or can be malignant like it can delete files or corrupt other programs.

The controls to guard against the virus are threefold –

(i)   Preventive controls like using only clean and licensed copies of software files, cutting the use of pubic domain software / shareware, downloading files or software only from a reliable websites, implementing read-only access to software. Checking new files / software with anti-virus software before installation, importing education and training programs to end users

(ii)   Detective controls like regularly running antivirus software, undertaking file size comparison to observe whether the size of programs has changed, undertaking date / time comparisons to detect any unauthorized modifications.

(iii)   Corrective controls like maintaining a clean backup, having a recovery plan from virus infections, regularly running antivirus software (which is useful for both detection and removal of virus)

Worms, unlike virus, exist as separate and independent programs and like virus, propagate their copies with benign or malignant intention using operating system as their medium of replication. They exploit security weakness / bug in the operating system to infiltrate other systems.

Exposures that arise from worms are more difficult to control than that arise from virus. These exposures should be addressed by all users of a network; other wise control weaknesses in a user's system can give rise to control weaknesses in another user's system.

Abuse of software, Data and Services can arise in the following ways:

(i)   Generalized software and proprietary databases of the organization are often copied and taken away without an authority, by the employees who may keep it for their own purposes or for handing it over to competitors,

(ii)   Organization fails to protect the privacy of the individuals who data are stored in it databases,

(iii)   Employees use system services for their own personal gains and activities,

Hackers attempt to gain unauthorized entry in a system by circumventing the access control mechanism of the system. They can have a benign or a malignant intension for hacking like just by trespassing resort to read files without changing them or can wreak havoc through deletion of critical files, disruption / suspending operation, stealing sensitive data and / or

programs. They can be avoided only through the robust logical access control and / or Cyber Laws of the Land.

Controls of last resorts are designed and practised as a last mile approach keeping in view the disaster recovery of systems. For this purpose a backup and recovery plan is prepared in anticipation, which specifies how normal operations are to be restored. Besides, Insurance companies mitigate the losses associated with a disaster.

3.12.4   Techniques of Network security

Firewalls :   Access controls are common form of controls encountered in the boundary subsystem by restricting the use of system resources to authorize users, limiting the actions authorized users can take with these resources and ensuring that the users obtain only authentic system resources.

Current systems are designed to allow users to share their resources. This is done by having a single system simulate the operations of several systems, where each of the simulated system works as virtual machine allowing more efficient use of resources by lowering the idle capacity of the real system. Here, a major design problem is to ensure that each virtual system operates as if it were totally unaware of the operations of the other virtual systems. Besides increased scope exists for unintentional or deliberate damage to system resources / user's actions. The route is resource sharing through virtual systems through need for isolation through need for access controls. Access controls associate with authentic users the resources, which the users are permitted to access and the action privileges, which the users have with reference to those resources. It acts as a part of the operating system. Now a days, special systems or firewalls are used to protect network from an untrusted one. In that effect it has a routing ability.

Firewall is a device that forms a barrier between a secure and an open environment when the latter environment is usually considered hostile, for example the Internet. It acts as a system or combination of systems that enforces a boundary between more that one networks.

SELF-EXAMINATION QUESTIONS

1.   What is meant by Data Communication ?

2.   Describe briefly the additional equipments used which distinguish data Communication System from other computer systems.

3.   Define the following terms :

   (i)   Modem

   (ii)   Multiplexer.

4. Discuss various Data transmission modes.

5. Define the term 'Computer Network'.

6. Discuss various types of Computer Network.

7. What do you understand by the term Network Topology ? Describe various network topologies.

8. Discuss local area networks and wide-area networks.

9. Discuss various components of a local area network.

10 What are the comparative advantages and disadvantages of the various Network Topologies?

11 What are the advantages and disadvantages of a Local Area Network?

12 What are the limitations of Client-Server Technology? What are the attributes of Three Tier Architecture?

13 Define the characteristics of the following: -

(i) Application Servers,   (ii) Print Servers,   (iii) Transaction Servers,

(iv) Internet Servers,   (v) Mail Servers and   (vi) Chat Servers.

14 (a) What are the OSI Protocols?

   (b) What are the TCP/IP Protocol?

15 (a) What is a Data Center? Discuss the difference between an onsite data center and an offsite data center.

   (b) Differentiate between Hot Site, Warm Site and Cold Site.

16 What are the Network Threats and Vulnerabilities?

CHAPTER 4

INTERNET AND OTHER TECHNOLOGIES

4.1 INTRODUCTION

The following material will discuss the role of the Internet in electronic commerce (EC) and its significant impact on the continued growth and acceptability of EC as a routine means of conducting business. The Internet, an umbrella term covering countless networks and services that comprise a super-network, is a global network of computer networks that was initiated in the 1960's by a team of scientists under a U.S. government research contract.

The Internet eventually became a link for academic institutions to share research results and then evolved into an instrument for mixed academic, commercial, and personal uses; but even the most visionary original development team member could not have anticipated the phenomenal growth and current state of the Internet. The Internet now provides access to EC transactions to millions of consumers and businesses

This vast network, by its very nature, however, has significant security and control weaknesses that must be addressed. As with many technological advances (for example, many consumers had serious reservations about using the "new" automated teller machines), controls lag behind the technology, and universal acceptance will be unattainable until effective controls have been implemented.

Internet usage can be as secure as a company requires. It is important to put in place the appropriate tools and procedures to protect information assets. It is also important, however, not to overreact and incur unnecessary costs and difficulties.   For individual Internet connections used for normal business purposes, security is often not a problem.

4.1.1 History and Background : The history of the Internet is closely tied to the U.S. Department of Defense. The military was a leader in the use of computer technology in the 1960's and saw the need to create a network that could survive a single network computer's malfunction. In the 1970's, the Advanced Research Projects Agency (ARPA) developed a network that has evolved into today's Internet. The network was named ARPANET and had many objectives that are still relevant today.

ARPANET Objectives

♦ The network would continue to function even if one or many of the computers or connections in the network failed.

♦ The network had to be useable by vastly different hardware and software platforms.

♦ The network had to be able to automatically reroute traffic around non-functioning parts of the network.

♦ The network had to be a network of networks, rather than a network of computers (Hoffman, 1995)

It rapidly became evident that people wanted to share information between networks, and as a result, commercial networks were developed to meet consumer demand. The Internet became the umbrella name for this combination of networks in the late 1980's .Today's Internet is somewhat difficult to describe. Essentially, the Internet is a network of computers that offers access to information and people.

Since the mid 1990's, the growth of the Internet and the associated number of individuals connected to it has been phenomenal. Tens of millions of people currently use the Internet with the number of users exceeding over 100 million by end of year 2000. This increase can be attributed to several trends including the expansion in the number of personal computers at businesses and in homes.

The Internet is difficult to define. In some ways, it's like an information service, because it offers e-mail, bulletin boards, and information-retrieval services that can access file directories and databases around the world. However, the Internet is different from an information service, primarily because there's no central computer system - there is just a web of connections between thousands of independent systems connected to each other through telephone lines. It is estimated that there are over 50 million such computers all over the world and they are growing at a rate of 10 per cent per month. Using the telephone network worldwide, these computers can communicate with each other. These connections can use the regular **dial up telephone lines** or **dedicated higher capacity lines** to connect a user to the nearest *Internet Service Provider* (ISP) ISP makes Internet access available on a local telephone call and helps user avoid direct long distance or international calls to connect to computers in other parts of the world.

However, since the Internet has grown to a phenomenal size, it has also become complex for users. To help the growing number of users, who are not computer professionals, various developments have occurred. First is the setting up of Online Services like CompuService, America Online, etc. These online services operate on one powerful computer, connected to the Internet. Users from any part of the world connect to this computer and avail various facilities there, which include access to information from database, software libraries, news, bulletin boards for various interest groups, online chat facilities, E-mail etc.

A recent but revolutionary development on the Internet is the World Wide Web (WWW).

4.1.2 World Wide Web : The World Wide Web or the Web is a component of the Internet that provides access to large amounts of information located on many different servers. The Web also provides access to many of the services available on the Internet.

The fundamental unit of the Web is the **Web page**. The Web page is a text document that contains links to other Web pages, graphic and audio files, and other Internet services such as file transfer protocol (FTP) and E-mail.

Web pages reside on servers that run special software that allow users to access Web pages and to activate links to other Web pages and to Internet services. Tens of thousands of Web servers are currently connected to the Internet. A user can directly access any Web page on one of these servers and then follow the links to other pages. This process creates a Web of links around the world and, thus, the name World Wide Web.

Web pages are created by using *hypertext Markup Language* (HTML) HTML lets the creator of a Web page specify how text will be displayed and how to link to other Web pages, files, and Internet services. These links are formally known as **hypertext links**, because they are activated when a user clicks on specific text or images within a Web page.

To view a Web page, the user must use a special client software package called a **Web browser**. The first such browser capable of displaying graphics within a Web page was Mosaic. Since Mosaic's development, Netscape and Internet Explorer have also been created and are widely used.

Some other popular search engines include:

♦   Hot Bot (http://hotbot.com/)
♦   Yahoo (http://www.yahoo.com/
♦   Savy Search (http://www.cs.colostate.edu/~dreiling/smartform.html)
♦   Alta Vista (http://www.altavista.digital.com)
♦   All for One (http://www.all4one.com)

To illustrate the vast nature of information on the Web, the following general topics are included on the Yahoo search engine (http://www.yahoo.com/) :

♦   Arts and Humanities
♦   Business and Economy
♦   Computers and Internet
♦   Education
♦   Entertainment
♦   Government
♦   Health

- ◆ News and Media
- ◆ Recreation and Sports
- ◆ Reference
- ◆ Regional
- ◆ Science
- ◆ Social Science
- ◆ Society and Culture

To illustrate the power and magnitude of these search engines, a search on the phrase "Year 2000" was conducted using the search engine from Alta Vista (http://altavista.digital.com/) The search performed in February 1998 identified 1,569,234 documents on the Web that matched the query. This example illustrates the enormous power of the Web; however, it also demonstrates the potential for information overload due to the volume of matches. With so much information available it is often difficult to word the search criteria appropriately to achieve the desired results.

The Web browser reads a specified Web page using the HTML commands within the Web page to display the desired information. Text positioning, fonts, colors, and size are specified through HTML. The browser software interprets the HTML commands and displays the information on the user's monitor. It is important to realize that different browsers can interpret an HTML command differently and thus display text differently. For example, a Web page may contain HTML code specifying that text be emphasized. One browser may emphasize text by bolding the text, but another browser may use Italics for emphasis.

4.1.3 Uniform Resource Locators (URLs) are used to address and access individual Web pages and Internet resources. The format of a URL is: **protocol/Internet address/Web page address.**

The protocol that the Web uses for HTML codes for Web page is **HyperText Transport Protocol** (HTTP) For example, consider the web page address: http://pages.**prodigy**.com/kdallas/index.htm.

The **http://** specifies that HTTP will be used to process information to and from the Web server; pages.**prodigy.com** is the Web server's Internet address; and **kdallas/index.htm** is the address of the page on the server. Index.htm could have been omitted, because this is the default for the main page within a directory (i.e., kdallas in this example) Within HTML, there is the capability to display information in list or tables and to create forms for users to send information to someone else. In addition, HTML provides the capability to specify graphic files to be displayed. These and other features let a user create complex Web pages.

Surfing on the Internet: Many of the servers on the Internet provide information, specialising on a topic or subject. There is a large number of such servers on the Internet. When a user is

looking for some information, it may be necessary for him/her to look for such information from more than one server. WWW links the computers on the Internet, like a spider web, facilitating users to go from one computer to another directly. When a user keeps hopping from one computer to another, it is called **"surfing"**.

The Internet facilitates "many to many" communication. Modern technology has, so far, made possible communication, "one to many" as in broadcasting; "one to one" as in telephony; "a few to a few" as in telephone conferencing; and "many to one" as in polling. In addition WWW works on "multi-media", and information can be accessed and transmitted in text, voice, sound and/or video. Graphics and interactive communication are two distinctive features of the Internet and WWW.

4.1.4 Applications of Internet - Internet's applications are many and depend on the innovation of the user. The common applications of the Internet can be classified into three primary types namely: Communication, Data retrieval and Data publishing.

(i)   **Communication :** Communication on the Internet can be online or offline. When some users connect to a single server or an on-line service at the same time, they can communicate in an "online chat". This can be truly "many to many" as in a room full of people talking to each other on peer to peer basis. Alternatively, the users send e-mail to each other which can be read by the receiver whenever he/she finds the time. This is off-line communication, but "one to one" or "one to many". Similarly, it is possible for users to get together electronically with those sharing common interests in **"usenet"** groups. The users post messages to be read and answered by others at their convenience, in turn all of which can be read and replied to by others and so on.

(ii)   **Data Retrieval :** For meaningful data retrieval, availability of data that has been compiled from various sources and put together in a usable form is an essential prerequisite. On the Internet, a large number of databases exist. These have been put together by commercially run data providers as well as individuals or groups with special interest in particular areas. To retrieve such data, any user needs to know the address/s of such Internet servers. Then depending on the depth of information being sought, different databases have to be searched and required information compiled. The work involved is similar to a search process in a large library; except that this Internet "library" is immense, dynamic, because of regular updating, and entirely electronic. While some skill is required for searching, the user will be able to access, search and check a large collection of servers. Conceivably, Internet will have the latest information available, because all data is transmitted electronically world over. For corporate users who are looking for latest information on products, markets and strategies, such sources are welcome.

(iii)   **Data publishing :** Data publishing is a new opportunity that Internet has made possible. Information that needs to be made available to others can be either forwarded to specific

addresses, posted in a Usenet site or kept on display in a special site. Internet discourages by social pressure, sending of unsolicited E-mail.

4.1.5 Business use of Internet : Business has taken to Internet only recently. Though Internet has existed over many years, mostly research and education sectors have been the primary users all these years. The Internet has developed references on what is acceptable and unacceptable practice. For example, the Internet is open and anyone can communicate with anyone anywhere on the Internet, but the prevalent custom prevents unsolicited E-mail and promotional communication on the Internet. Hence, business has to use Internet innovatively but within the norms and modes of this fast growing world community.

The world is shrinking. That was what everyone believed when steam engines and other transportation means changed the way people lived. Then again global communication facilities made the world appear even smaller. Now Internet is affecting human living more than any other change that the world went through. If living styles change, business methods and practices also have to change.

This is already happening in the economically advanced countries led by USA. Telephone and fax are things of the past. No one is able to conduct any worthwhile business unless the business communication occurs on E-mail. An E-mail address is the basic facility that anyone on the Internet gains. The communication is quicker and more convenient that any other mode ever used. It is reliable and provides easy identification of sender. Electronic mail works similar to paper mail through postal system but is entirely electronic (Electronic mail has been discussed in detail in the subsequent section)

Through the Internet, users can have *online interactive communication*. This is another major facilitator for any business. Most businesses need a lot of interaction internally among their executives and externally with business associates, when many persons have to contribute to discussions. This is normally achieved by arranging meetings and conferences for which people travel from different locations to come together at one place. This "many to many" communications can be handled on the Internet quite effectively, without any need for people to travel. At pre-defined timings, those who have to communicate together can be online through Internet and have **electronic conferences.** This will be truly "many to many". Similarly, many discussions can be done through a forum where people post messages for each other and respond to them periodically. This is similar to having a **bulletin board** on which everyone posts messages.

Businesses require a lot of external information in various functions regularly for taking decisions. For this, lot of time is spent in searching and getting information. Internet is a storehouse of information and is able to cater to a very wide range of information needs. This is possible since users are able to electronically identify common interest groups and share information. It is easy to create databases and make information accessible to other users on

the Internet. Users have to only search for information sites, qualify and retrieve useful information.

When business need to make information on their products and services available to others, e.g.for their clients, Internet provides a very convenient vehicle. Such businesses can set up their own **web sites or home pages.** When the potential clients and others visit the site or the "home pages", they will have the option to send E-mail immediately indicating their interest or queries. For a business, such queries are not preliminary but qualified inquiries. It will also be possible to monitor the number of visitors to the "home pages" periodically.Very often, in a marketing situation, a number of preliminary queries are received and they are responded to with brochures and literature. Mostly such material is sent by ordinary mail because of the amount and quality of material and distances involved. Internet presents an alternative scenario in dealing with such a situation. Particularly, international queries can be attended to by advising the potential clients to access this information at the web site of the organisation at their convenience. The web site can not only surpass the brochures in presentation quality because of multi-media options, but also be dynamic and give the latest information. It is easy to update the "home page" electronically and regularly. The potential customer can also complete a query form and forward it electronically by clicking a few choices on screen.

4.1.6 Internet Intrinsic Benefits

♦ Information on the business and services is placed in an assembled fashion in a common location.

♦ Access to this information is provided at reasonable costs (which are steadily declining, and with a significant reduction in duplication and distribution costs)

♦ A mechanism for immediate feedback from consumers or business partners is provided.

♦ The cost of information delivery to internal and external sources is reduced.

♦ Employee access to significant amounts of information is increased.

♦ An efficient means of updating and disseminating current information to customers and internal staff is provided.

♦ Customized information to consumers is delivered (for example, individual investment portfolios can be tracked).

These benefits make up just a small sample of the numerous intrinsic benefits of using the Internet as a business resource. Companies are primarily drawn to the Internet with the promise of access to new market segments and lower sales costs. The growth in online shopping sales, for example, is projected to grow from $518 million in 1996 to $6.6 billion in the year 2000, says Forresters research of Cambridge, MA .

4.1.7 Cost of connecting on the Indian Internet : Different cost structures exist for different ways in which the Internet can be accessed in India. First the basics:

Currently, Videsh Sanchar Nigam Limited (VSNL) is the most popular Internet Service Provider (ISP) in India though some other organisations such as Mahanagar Telephone Nigam Limited (MTNL), Satyam, Mantra, Airtel and many more are also providing (ISP) services. To connect to the Internet, the user however has to still reach VSNL or other service providers from his place. This is through the local telephone facility, Mahangar Telephone Nigam Limited (MTNL) in the metros and Department of Telecommunications (DOT) in other locations.

Those located in locations where VSNL provides Internet access will be able to connect to Internet on a local telephone connection. Those in other locations have to still call long distance (STD) to one of these locations.

There are two options for connecting: one is dial up and the other is through leased line.

Dial up connection requires only a normal telephone connection with a computer, modem and suitable Internet software. With a VSNL , Satyam or Mantra etc. Internet account, it is possible then to connect to the Internet.

The alternative to dial up is the **leased line**. DOT charges for leased telephone line depending on the speed required - 128 Kbps, 256 Kbps 512 Kbps, 1 Mbps and 2 Mbps, and the distance to be covered. Unlike the dial up, the user is permanently connected while using the leased line. For a corporate user with multiple users within the organisation, the leased line can work out economical and the comparison can easily be worked out.

The Internet is a new opportunity that is sweeping the world and unlike any other technological development so far, the Internet offers a level playing field to everyone irrespective of location. On the Internet, there are no barriers of gender, professional background, or time and place. There are only two kinds of users namely those who provide information and those who use information. It is also necessary to use and experience the Internet to be able to first appreciate its potential and then to exploit it.

4.2 INTERNET COMPONENTS

4.2.1 Electronic Mail (e-mail)[*] **:** Electronic mail is an increasingly utilized technology, which has become the primary means of communication for many organizations and individuals. Electronic mail on the Internet provides quick, cost-effective transfer of messages to other E-mail users worldwide. This is probably one of the fastest and most convenient ways of communicating. The burden on the ever so popular Khakhi uniform clad Postman has been reduced considerably with the availability of the E-mail facility to Indians in most cities.

At present, all Internet subscribers in India get the E-mail facility free with each subscription. Thus, all Internet subscribers in India have unique and separate E-mail address. This E-mail account can be accessed by the subscriber from any part of the world!

In addition to the E-mail facility provided by VSNL, there are a handful of private E-mail service providers in a few of the metros in India who provide exclusive E-mail facility. However, these connections do not allow access to the Internet.

As mentioned earlier, when one takes an Internet connection with any Internet Service Provider, he gets an exclusive E-mail address. With each E-mail address, the subscriber gets a certain amount of Disk space on the Server on which he has been registered. This disk space serves as the post box of the respective subscriber. When somebody sends an E-mail message to the subscriber, the message lies in this post box. Even after the message has been accessed by the subscriber, it continues to lie in the post box till it is downloaded onto the local computer of the user or it is specifically deleted. As and when the post box starts getting filled to its full capacity, the service provider sends a warning to the subscriber to empty his post box.

The facility of E-mail has several features that are of immense help to us. One can send common circulars/letters to all those clients or other recipients who have E-mail facilities. This would result in saving a lot of stationery as well as postage charges. By creating Address Books in the computer, one does not have to remember the E-mail addresses of others. Further, a lot of time, energy and money can be saved by creating a Mailing List of all clients and using it to send common letters/notices/circulars. Another advantage of using E-mail is that as long as the correct E-mail address of the addressee has been keyed in by the sender, the chances of the addressee not receiving the message without the sender being aware of this are remote. Also, the transmission of messages to the server of the addressee is virtually instantaneous. Thus, E-mail beats the Postman and the Courier boy in the race by miles. E-mail transcends all time zones and barriers.

We can also send files created in any application such as, say, a Word Processor or a Spreadsheet, as attachments with the E-mail messages. Thus, for example, if we have created a Spreadsheet containing the computation of Total Income of a client, then we can write a letter to him in an E-mail and inform him that his computation is ready and also attach the Spreadsheet and send it to him for verification. Of course, care must be taken to ensure that the attachments are not very large files, otherwise, the recipient's mail box is likely to get jammed. Further, the recipient, to be able to open the file at his place, must also have the same application software in his computer. In certain cases, the recipient must also have the same version of the software that was used for preparing the attachment.

The E-mail software supplied with Internet connection comprises of some important and useful features, which are as follows:

Composing messages : With the help of the Internet Browser, it is possible to compose messages in an attractive way with the help of various fonts. It is also possible to spell-check the message before finalising it.

Replying to the mail received : It is possible to reply to any mail received by merely using the " Reply" facility available on the Internet Browser. This facility also allows one to send the same reply to all the recipients of the original message. This facility results in saving of a lot of time in terms of remembering addresses, typing the subject matter also.

Address Book : This is an electronic form of Address Book wherein the following features can be saved : Name, full name, E-mail address, name of organisation to which the person belongs, the designation of such person etc.

When one has to send an E-mail, by merely typing the first name, for example, it would be possible to recall the E-mail address of the recipient. It is also possible to store addresses on the basis of categories. Thus, a group containing addresses of all clients could be created. Then, when a common letter or circular is to be sent to all clients, one has to merely type in the name of the category in place of the addresses. This would automatically send the letter to all persons listed in that category. This does away with the tedious task of retyping or reprinting the same letter again and again and putting the letters in envelopes, addressing and stamping the envelopes and finally, mailing the same.

Printing of messages : It is possible to print messages received as well as sent. Thus, if a person wants to keep a hard copy of any message, it would be possible for him to do so.

Offline Editing/Composing/Reading : One does not have to be connected to the Internet all the time to be able to read/edit/compose messages. This is a very important feature which many people do not make use of. Ideally, one should log onto the Internet, download all the messages onto one's own hard disk and then disconnect from the Internet. Once the user is offline, he should read all the messages that have been received. Even composing one's own messages, editing the same or replying to messages received ought to be done when one is off-line. This results in saving of Internet time as also helps in keeping telephone lines free. It is also possible to compose messages and save them as drafts so that at a later stage, the same can be edited or continued and then sent.

Forwarding of messages : It is possible to forward any message received from, say, Mr. A to Mrs. B without retyping the message.

Transfer of Data Files : An important use of the E-mail is the ability to send/receive data files to/from a client. For example, at the time of consolidation of accounts of a client, the data files containing final accounts of the branches of that client can be obtained *via* E-mail and after consolidation and finalisation, the same can be sent back to the client's branches for closing entries etc. This would result in considerable saving of time, energy and money.

Greeting Cards : On the Internet, there are several sites which offer free greeting cards for thousands of occasions to anybody who wants to send greeting differently. To send an electronic greeting card, one has to simply visit a site offering this facility, select a card from amongst the several available, type in one's message, name and E-mail address of the

recipient, name of the sender and with a simple click, send the card. The recipient is notified by E-mail that he has been sent a greeting card. He can then access the card by simply clicking on the web-site address of the site which has provided the facility of the greeting card. Most such cards also come with music. This makes the card extremely attractive, interesting and many times better than the traditional printed cards.

4.2.2 Webcasting or Push Technology : Another Web-based technology is **push technology—or Webcasting**—which allows users to passively receive broadcast information rather than actively search the Web for information. Push technology allows users to choose from a menu of sources, specifying what kind of information they want to receive. Once selected, the information is automatically forwarded to the user. Internet news services, which deliver the day's activities to the user's desktop, are an example of push technology. Users can also download software, select the frequency with which they will receive services, and subscribe to a variety of information sources. There is very little cost to the user for push services because information is delivered with advertising, and users view their custom-tailored news off-line.

Push technology differs from the traditional uses of the Internet. The Internet is, for the most part, **a pull environment** where a user opens a browser application and searches for information. While there are millions of Web pages, these pages are not of much use unless the user finds them and "pulls" the required information. The Web pages, then, are essentially dormant until they are located and the user successfully navigates his or her way to the correct destination. As any current Web user knows, this navigation process can sometimes be frustrating and time consuming. Push technology eliminates this frustration.

Push technology is having a major impact on the Internet, probably the biggest impact since the emergence of the Web. In fact, the Yankee Group has predicted that the push technology market will generate $5.7 billion in revenues out of $19.1 billion total annual Web based expenditures by the year 2000 ("Pushing IT," 1997).

4.3 INTRANET

The Intranet is a type of information system that facilitates communication within the organisation, among widely dispersed departments, divisions, and regional locations. Intranets connect people together with Internet technology, using Web Browsers, Web Servers and Data Warehouses in a single view. With an Intranet, access to all information, applications and data can be made available through the same browser. The objective is to organise each individual's desktop with minimal cost, time and effort to be more productive, cost-efficient, timely and competitive. According to James Cimino, the challenge is to realize the following from focused Intranet work:

- Easily accessible information

- Reduced information searching time

- Sharing and reuse of tools and information

- Reduced set-up and update time

- Simplified reduced corporate licensing

- Reduced documentation costs

- Reduced support costs

- Reduced redundant page creation and maintenance

- Faster & cheaper creation

- One-time archive development costs

- Sharing of scare resources of skills.

A properly planned Intranet implemented after a careful study of the business problems or issues can be a great help in the streamlining of a company. Some of the key benefits of using Intranet are:

- Reduced costs - printing, paper, software distribution, mailing, order processing, telephone

- Easier, faster access to information

- Easier, faster access to remote locations

- Latest, up-to-date research base

- Easier access to customers and partners

- Collaborative, group working

Intranet Applications : AT&T uses Intranet for its internal telephone directory, called POST, and Sandia National Laboratories has set up each of its departments with home pages. Tyson Foods, Federal Express, Levi Strauss, and Microsoft are other firms that have jumped on the Intranet bandwagon.

An Intranet usually has a system of access privileges controlled by passwords, restricting access to certain areas of the network. Payroll, sales projections, product development notes, and client memos are all examples of the kinds of information that a corporation would not want made accessible to every employee.

Often a company Intranet is a main means of infra-office communication. Updates to business policies and procedures can be posted, as can job openings, information on health insurance and other benefits, profiles of various employees, the company's organisational structure, as well as in-house training for employees.

Intranets also can be set up to provide an electronic directory service so employees can easily find someone's telephone number and location. Another possibility is a constantly updated company calendar so employees can check the time and location of all company events and meetings. If an employee wants to schedule a Sales Department meeting for a specific Friday at 3 p.m., it's good to know the Marketing Department already has a meeting set for 2 p.m.

An Intranet also may have a whiteboard, an electronic chat space where employees can "talk" to each other in real time by posting text messages.

Some employees even have their own home pages on their company's Intranet. The individual home pages are hooked into the company's Intranet electronic directory so other employees can access the pages easily. Personal home pages allow employees to get to know each other, and promote camaraderie among co-workers.

Use of an Intranet for access to GroupWare offers exceptionally high potential. **GroupWare** is the name given to software used in a group decision support system, in which several people jointly solve a problem. Such Internet service vendors as Netware and such GroupWare vendors as IBM/Lotus Notes are adding features to their products that are aimed at using the Net for collaborative problem solving.

Most major corporations already have at least one Intranet, and many larger companies have several. Even entry-level employees are expected to have enough familiarity with digital operations to be able to use such a network with minimal training.

Many universities and colleges have their own Intranets for students, faculty, and other designated users. For students, this is an excellent way to gain experience using Intranets. Standard University, for example, posts documents about campus life on its Intranet. Students can log onto the Intranet and read a variety of informational postings about campus events, programs, and activities.

4.4 EXTRANET

An Extranet is an extension of an Intranet that makes the latter accessible to outside companies or individuals with or without an Intranet. It is also defined as a collaborative Internet connection with other companies and business partners. Parts of an Intranet are made available to customers or business partners for specific applications. The Extranet is thus an extended Intranet, which isolates business communication from the Internet through secure solutions. Extranets provide the privacy and security of an Intranet while retaining the global reach of the Internet.

The key characteristics of an Extranet is that it extends the Intranet from one location to another across the Internet by securing data flows using cryptography and authorisation procedures, to another Intranet of a business partner. This way, Intranets of business partners, material suppliers, financial services, distributors, customers, etc. are connected to

the Extranets by an agreement between the collaborating parties. The emphasis is on allowing access to authorised groups through strictly controlled mechanisms. This has led to the true proliferation of e-commerce. It is the combination of Intranets with Extranets that has established the virtual corporation paradigm. This business paradigm is turning out to be critical for e-commerce, allowing corporations to take advantage of any market opportunity anywhere, anytime and offering customized services and products.

4.5 INTERNET PROTOCOL SUITE

The **Internet protocol suite** is the set of communications protocols that implement the protocol stack on which the Internet and most commercial networks run. It is sometimes called the **TCP/IP** protocol suite, after the two most important protocols in it: the Transmission Control Protocol (TCP) and the Internet Protocol (IP), which were also the first two defined.

The Internet protocol suite — like many protocol suites — can be viewed as a set of layers, each layer solves a set of problems involving the transmission of data, and provides a well-defined service to the upper layer protocols based on using services from some lower layers. Upper layers are logically closer to the user and deal with more abstract data, relying on lower layer protocols to translate data into forms that can eventually be physically transmitted.

The **OSI model** describes a fixed, seven layer stack for networking protocols. Comparisons between the OSI model and TCP/IP can give further insight into the significance of the components of the IP suite, but can also cause confusion, as TCP/IP consists of only 4 layers.

Layer	TCP / IP Protocols
Application	DNS, TLS/SSL, TFTP, FTP, HTTP, IMAP, IRC, NNTP, POP3, SIP, SMTP, SNMP, SSH, TELNET, BitTorrent, RTP, rlogin, …
Transport	TCP, UDP, DCCP, SCTP, IL, RUDP, …
Network	IP (IPv4, IPv6), ICMP, IGMP, ARP, RARP, …
Link	Ethernet, Wi-Fi, Token ring, PPP, SLIP, FDDI, ATM, DTM, Frame Relay, SMDS

4.6 ELECTRONIC COMMERCE

Electronic commerce and its related technologies are unquestionably the current leading-edge business and finance delivery systems for the 21st Century. The explosion in the application

of technologies and the delivery of these technologies into the hands of consumers has made the vision, the dream, the fantasy, of conducting business electronically, anywhere in the global community, a reality. Electronic Commerce (EC) is no longer just a concept; it is a market force to be reckoned with. As more and more organizations launch Internet/World Wide Web (WWW) home pages and intranets to disseminate company/product information, and expand their customer base, countless yet unnamed companies are just beginning to investigate this alternative. These companies are realizing that business via the Internet is inevitability that they will not be able to ignore. The lure of reaching additional customers, expanding market shares, providing value-added services, advancing technological presence, and increasing corporate profits is just too valuable to disregard, and will eventually attract companies to electronic commerce like moths to a flame.

Many businesses will rush headlong into this cyber marketplace in an attempt to stake their claim to these potential riches, unaware of the risks which await them as they venture forth into this "new frontier." Unfortunately, if not properly controlled, the organization's leap to electronic commerce will result in the same fate as the moth's fatal attraction to the flame. The move to "cyber-business" requires the commitment of the entire corporation. Accounting and audit professionals along with security, telecommunications, legal, and marketing personnel must all become involved with the planning, securing and control of this electronic business.

4.6.1 Defining Electronic Commerce : Electronic commerce is quickly entering our daily vocabulary, becoming common terminology. But, what exactly is electronic commerce, and why is EC quickly becoming a phenomenon to be reckoned with?

Depending upon the industry, and upon the company's grasp of technology and the implementation of that technology into the fabric of daily processing activities, EC has varied definitions. A fairly broad definition of EC is given below:

Electronic commerce is the process of doing business electronically. It involves the automation of a variety of business-to-business and business-to-consumer transactions through reliable and secure connections.

It would be unfair to give the impression that this is an all-inclusive definition for such an evolving, maturing business strategy. To demonstrate, a limited examination of EC-related literature revealed the following definitions of EC:

- Electronic Commerce is a composite of technologies, processes and business strategies that foster the instant exchange of information within and between organizations. EC strengthens relationships with buyers, makes it easier to attract new customers, improves (and in some cases reinvents) customer responsiveness, and opens new markets on a global scale. (Greg Martin, Interchange Software Group of Sterling Commerce)

- Electronic Commerce is the application of various communications technologies to provide the automated exchange of business information with internal and external

customers, suppliers and financial institutions. Examples of these technologies include Electronic Data Interchange (EDI), bar coding, scanning, E-mail and fax, to name a few. The bottom line is that Electronic Commerce requires a paradigm shift in the way corporations do business today. (Electronic Commerce Forum)

- Electronic Commerce, simply put, is the automation of the business process between buyers and sellers. (IBM Corporation)

- Electronic business transactions, without paper documents, using computer and telecommunication networks. These networks can be either private or public, or a combination of the two. Traditionally, the definition of electronic commerce has focused on Electronic Data Interchange (EDI) as the primary means of conducting business electronically between entities having a pre-established contractual relationship. More recently, however, the definition of electronic commerce has broadened to encompass business conducted over the Internet (specifically the Web) and includes entities not previously known to each other. This is due to the Web's surge in popularity and the acceptance of the Internet as a viable transport mechanism for business information. The use of a public network-based infrastructure like the Internet can reduce costs and "level the playing field" for small and large businesses. This allows companies of all sizes to extend their reach to a broad customer base. (The American Institute of Certified Public Accountants)

Thus, it should be apparent that currently there is no single, globally accepted definition of EC, and there may never be EC could be considered a methodology which, depending on an organization's needs, can involve different technologies and value-added services. These technologies and services can include, but are not be limited to: electronic data interchange (EDI), e-mail, electronic funds transfer (EFT), electronic benefits transfer (EBT), electronic forms, digital cash (DC), interoperable database access, bulletin boards (BBs), electronic catalogs, intranets, cable services, World Wide Web (WWW)/Internet services, electronic banking (EB), Web broadcasting, push technologies, Web site management tools, Extranets, Internet Telephony, Bar-coding - 2D, Imaging, Internet - Electronic Forms, Internet - Publishing, , Voice Recognition, security services such as firewalls, encryption, and gateway managers and many more.

Thus, EC is not a single technology, but rather a sophisticated combination of technologies and consumer-based services integrated to form a new paradigm in business transaction processing. The future of EC is bright and viable—the application, however, has not yet reached full integration into the business mainstream. Several significant hurdles remain, which must be cleared before electronic commerce will become a mainstay business strategy.

Electronic Commerce impacts a broad number of business activities such as:

♦ marketing, sales and sales promotion

♦   pre-sales, subcontracts, supply

♦   financing and insurance

♦   commercial transactions: ordering, delivery, payment

♦   product service and maintenance

♦   co-operative product development

♦   distributed co-operative working

♦   use of public and private services

♦   business-to-administrations (concessions, permissions, tax, customs, etc)

♦   transport and logistics

♦   public procurement

♦   automatic trading of digital goods

♦   accounting

4.6.2 Benefits of Electronic Commerce Application and Implementation : EC presents many benefits to individual organizations, consumers, and society as a whole.

1.   Reduced costs to buyers from increased competition in procurement as more suppliers are able to compete in an electronically open marketplace.

2.   Reduced errors, time, and overhead costs in information processing by eliminating requirements for re-entering data.

3.   Reduced costs to suppliers by electronically accessing on-line databases of bid opportunities, on-line abilities to submit bids, and on-line review of rewards.

4.   Reduced time to complete business transactions, particularly from delivery to payment.

5.   Creation of new markets through the ability to easily and cheaply reach potential customers.

6.   Easier entry into new markets, especially geographically remote markets, for companies of all sizes and locations.

7.   Better quality of goods as specifications are standardized and competition is increased, and improved variety of goods through expanded markets and the ability to produce customized goods.

8.   Faster time to market as business processes are linked, enabling seamless processing and eliminating time delays.

9. Optimization of resource selection as businesses form cooperative teams to increase the chances of economic successes, and to provide the customer products and capabilities more exactly meeting his or her requirements.

10. Reduced inventories and reduction of risk of obsolete inventories as the demand for goods and services is electronically linked through just-in-time inventory and integrated manufacturing techniques.

11. Ability to undertake major global programs in which the cost and personnel needed to manage a non-automated system would be unreasonable or prohibitive.

12. Reduced overhead costs through uniformity, automation, and large-scale integration of management processes.

13. Reduced use of ecologically damaging materials through electronic coordination of activities and the movement of information rather than physical objects)

14. Reduced advertising costs.

15. Reduced delivery cost, notably for goods that can also be delivered electronically.

16. Reduced design and manufacturing cost.

17. Improved market intelligence and strategic planning.

18. More opportunity for niche marketing.

19. Equal access to markets (i.e. for small-to-medium enterprises (SMEs) vis-a-vis larger corporations)

20. Access to new markets.

21. Customer involvement in product and service innovation (Caniglia 1996, Timmers, 1996)

Clearly, the benefits of corporate-wide implementation of EC are many, and this list is by no means complete. With the benefits, however, also come the risks. An organisation should be cautious not to leap blindly into EC, but rather first develop an EC strategy, and then organize a corporate-wide team to implement that strategy. Key users throughout the organization should be represented on this implementation team.

4.6.3 The Internet's Role in Electronic Commerce : Why is the Internet considered a viable alternative to traditional commerce methods? The answer lies in the sheer number of potential consumers or business partners in an existing and extremely cost-effective network. Where else can tens of millions of potential consumers be reached at virtually no network cost? Now virtually may be stretching it a bit, since there are some costs involved, however, those costs are largely fixed costs. Today the Internet provides an inexpensive and information-rich, shared, multimedia network interconnecting more than 100 million users and 50 million servers, in more than 150 countries. Today in New York (U.S.) [for example], costs

to publish on this infrastructure are as low as $3,000 for server hardware and software, and $650 per month for a shared T1 connection. Individual dial-up access costs around $15 per month and continues to fall. This and the Internet's usefulness will capture million of users every year. According to a report from international strategic management consultants and industry analysts, Datamonitor, there were more than 600 companies in Europe and 1,500 companies in the U.S. using the Internet for business to business EC at the end of 1997. The report also revealed that 64,000 European companies are forecast to conduct Internet-based EC by year-end 2000.

When comparing the enormous costs of a private network and the associated limits in terms of access to consumers, electronic commerce (on the Internet) appears to be a godsend. In fact, it has been claimed that doing EDI (discussed in subsequent section) over the Internet is less expensive than using private networks by as much as 90% .

At least six reasons exist for the Internet's dramatic impact on the scope of business networking applications and for the Internet's emergence as the foundation for the world's new information infrastructure:

1. **Universality**—Any business using the Internet can interact with any other business using the Internet. This is by no means true of earlier networking technologies that allowed businesses to ship goods to only those companies connected to the same network.

2. **Reach**—The Internet is everywhere: large cities and small towns throughout the modern and developing world.

3. **Performance**—Unlike many other public networks, the Internet can handle visual images, audio clips, and other large electronic objects. It provides its users with a high-function window to the world, in addition to handling everyday networking tasks such as electronic mail.

4. **Reliability**--The design concepts for the Internet came out of U.S. Department of Defense. Hence, Internet technology is highly robust and reliable, in spite of significant differences in the extent to which various Internet service providers actually implement and ensure this reliability.

5. **Cost**—Compared with alternative networking technologies, Internet costs are surprisingly low.

6. **Momentum**—Tens of millions of individuals are already connected to the Internet, and business use is increasing at a dramatic rate.

4.6.4 EC and Internet successes - Two successful areas in Web based electronic commerce have been through the sales of books and electronic stock transactions. Many companies have entered these two EC arenas, including Amazon.com and E*TRADE.

Amazon.com (http://www.amazon.com) "Earth's Biggest Bookstore" "opened its doors" on the World Wide Web in July 1995. It quickly became not only the leading online retailer of books, but also one of the most widely used and cited commerce sites on the World Wide Web.

Another example of a success story in EC on the Web is E*TRADE Group, Inc. (http://www.etrade.com/html/alliance/yahoo/team.shtml) which is a leading provider of online investing services. Since 1992, they have been offering secure, online stock and options trading to independent investors. In 1997, they added mutual fund trading capabilities to their Web site.

E*Trade grew from virtually nothing to over $50 million in revenue in just a few years. With $3.7 billion in assets under management, E*Trade has become a financial force. According to Forrester Research, E*Trade has 125,000 active on-line accounts of the 1.5 million accounts nationwide. Trading volume also is rising, with E*Trade handling 11,000 stock transactions a day up 120 percent from last year. They are even making money - unusual for an Internet firm. For its 1996 fourth quarter, the company earned $506,000 on revenues of $17.1 million (http://www.etrade.com/news/cc12097.html, 1998).

Advertising has become an increasingly popular revenue producer for Web sites. Companies are eager to place advertisements on heavily visited sites, such as search engines. Often these advertisement are "banners" that flash across the computer screen with the hope that the consumer will click on the banner and enter the advertiser's site. The advertising is also becoming increasingly targeted. For example, a consumer that searches on financial related matters will have targeted advertisements, such as electronic trading or mutual fund companies.

EC on the Internet is at the crossroads of explosion, and many businesses and consumers want to exploit the technology but have reservations about the security and reliability of transactions. Auditors and security personnel, as a result, will play a crucial role in helping organizations design and review security and control standards to make EC on the Internet safe and secure.

4.7 TYPES OF E-COMMERCE

There are three distinct general classes of e-commerce applications:

(a)   Business-to-business (B2B)

(b)   Business-to- consumer (B2C)

(c)   Consumer-to-consumer (C2C)

4.7.1 Business-to-Business (B2B) : It is a short form of business-to-business, the exchange of services, information and/or products from one business to another, as opposed to between a business and a consumer.

Business-to-business electronic commerce (B2B) typically takes the form of automated processes between trading partners and is performed in much higher volumes than business-to-consumer (B2C) applications. For example, a company that makes cattle feed would sell it to a cattle farm, another company, rather than directly to consumers. An example of a B2C transaction would be a consumer buying grain-fed cattle at a grocery store. B2B can also encompass marketing activities between businesses, and not just the final transactions that result from marketing. B2B also is used to identify sales transactions between businesses. For example a company selling Xerox copies would likely be a B2B sales organization as opposed to a B2C (business to consumer) sales organization.

B2B standards: UN/EDIFACT is one of the most well-known and established B2B standards. ANSI ASC X12 is also a popular standard in the States. Rosetta Net is an XML based, emerging B2B standard in the heavy technology industry.

4.7.2 Business-to-Customer (B2C) : It is a short form of business-to-consumer, the exchange of services, information and/or products from a business to a consumer, as opposed to between one business and another. Business-to-consumer electronic commerce (B2C) is a form of electronic commerce in which products or services are sold from a firm to a consumer.

Two Classifications of B2C E-Commerce are –

(a) *Direct Sellers :* Companies that provide products or services directly to customers are called direct sellers. There are two types of direct sellers: E-tailers and Manufacturers.

   (i) **E-tailers** : Upon receiving an order, the E-tailer ships products directly to the consumer or to a wholesaler or manufacturer for delivery.

   (ii) **Manufacturers** : The manufacturer sells directly to consumers via the Internet. The goal is to remove intermediaries, through a process called dis-intermediation, and to establish direct customer relationships. Dis-intermediation is not a new idea as catalog companies have been utilizing this method for years.

(b) *Online Intermediaries :* Online intermediaries are companies that facilitate transactions between buyers and sellers and receive a percentage. There are two types of online intermediaries: brokers and infomediaries.

   (i) **Brokers:** A broker is a company that facilitates transactions between buyers and sellers. There are various t*ypes of Brokers*:

- Buy/Sell Fulfillment – A corporation that helps consumers place buys and sell orders.

- Virtual Mall – A company that helps consumers buys from a variety of stores.

- Metamediary – A firm that offers customers access to a variety of stores and provides them with transaction services, such as financial services.

- Bounty – An intermediary that offers a fee to locate a person, place, or idea.

- Search Agent – A company that helps consumers compare different stores.

- Shopping Facilitator – A company that helps consumers uses online shops easier and potentially in a user customized interface, by providing currency conversion, language translation, and payment and delivery solutions.

(ii) **Infomediaries:**

- Advertising-Based Models : In an advertising-based system, businesses' sites have ad inventory, which they sell to interested parties. There are two guiding philosophies for this practice: high-traffic or niche. Advertisers take a high-traffic approach when attempting to reach a larger audience. These advertisers are willing to pay a premium for a site that can deliver high numbers, for example advertisements on any web site. When advertisers are trying to reach a smaller group of buyers, they take a niche approach. These buyers are well-defined, clearly identified, and desirable. The niche approach focuses on quality, not quantity. For example, an advertisement may be mainly viewed by business people and executives.

- Community-Based Models : In a community-based system, companies allow users worldwide to interact with each other on the basis of similar areas of interest. These firms make money by accumulating loyal users and targeting them with advertising.

- Fee-Based Models : In a fee-based system, a firm charges a subscription fee to view its content. There are varying degrees of content restriction and subscription types ranging from flat-fees to pay-as-you-go.

The B2C model can save time and money by doing business electronically but customers must be provided with safe and secure as well as easy-to-use and convenient options when it comes to paying for merchandise. This minimizes internal costs created by inefficient and ineffective supply chains and creates reduces end prices for your customers. This could be beneficial especially if you are in the business of commodity-like products where you must be innovative and accommodating to gain and retain customers.

Payment Options for B2C E-commerce businesses: The following are types of online payment options that could be used in B2C E-commerce:

Financial cyber mediary: an internet based company that facilitates payment between two individuals online usually by credit card.

Electronic Cheque: transferring money from your checking account to another over the internet.

Electronic bill presentment and payment (EBPP): a Computer system that generates electronic bills and sends them to customers over the internet.

Smart Card: Debit cards that contain information about how much money you have and deduct purchases from that total. These are provided by all banks.

B2C can be used no matter what product is being offered online. The following are the types of merchandise that can be sold easily online by a B2C E-commerce business: Convenience Goods: low priced products but that are bought frequently Specialty Goods: high priced merchandise that is ordered rarely and usually requires customization Commodity-like Goods: products that are the same where ever they are bought and are highly substituted. Digital Goods: products that are created and sent electronically. These are the best to provide given their low cost to keep in inventory and ship.

Advantages of B2C E-commerce

(i)   Shopping can be faster and more convenient.

(ii)   Offerings and prices can change instantaneously.

(iii) Call centers can be integrated with the website.

(iv)   Broadband telecommunications will enhance the buying experience.

Challenges Faced by B2C E-Commerce: the two main challenges faced by b2c e-commerce are building traffic and sustaining customer loyalty. Due to the winner-take-all nature of the b2c structure, many smaller firms find it difficult to enter a market and remain competitive. In addition, online shoppers are very price-sensitive and are easily lured away, so acquiring and keeping new customers is difficult.

4.7.3 Consumer-to-consumer (C2C) : Consumer-to-consumer electronic commerce (abbreviated C2C) is an internet-facilitated form of commerce that has existed for the span of history in the form of barter, flea markets, swap meets, yard sales and the like. Most of the highly successful C2C examples using the Internet take advantage of some type of corporate intermediary and are thus not strictly good examples of C2C.

4.8 CRM

Customer Relationship Management (CRM) includes the methodologies, technology and capabilities that help an enterprise manage customer relationships. The general purpose of CRM is to enable organizations to manage their customers in a better way through the introduction of reliable systems, processes and procedures.

Implementing CRM: Customer Relationship Management is a corporate level strategy which focuses on creating and maintaining lasting relationships with its customers. Although there are several commercial CRM software packages on the market which support CRM strategy, it

is not a technology itself. Rather, a holistic change in an organization's philosophy which places emphasis on the customer.

A successful CRM strategy cannot be implemented by simply installing and integrating a software package and will not happen over night. Changes must occur at all levels including policies and processes, front of house customer service, employee training, marketing, systems and information management; all aspects of the business must be reshaped to be customer driven.

To be effective, the CRM process needs to be integrated end-to-end across marketing, sales, and customer service. A good CRM program needs to:

(i)   Identify customer success factors

(ii)   Create a customer-based culture

(iii)   Adopt customer-based measures

(iv)   Develop an end-to-end process to serve customers

(v)   Recommend what questions to ask to help a customer solve a problem

(vi)   Recommend what to tell a customer with a complaint about a purchase

(vii) Track all aspects of selling to customers and prospects as well as customer support.

When setting up a CRM segment for a company it might first want to identify what profile aspects it feels are relevant to its business, such as what information it needs to serve its customers, the customer's past financial history, the effects of the CRM segment and what information is not useful. Being able to eliminate unwanted information can be a large aspect of implementing CRM systems.

When designing a CRM's structure, a company may want to consider keeping more extensive information on their primary customers and keeping less extensive details on the low-margin clients

Architecture of CRM: There are three parts of application architecture of CRM –

(i)   Operational - automation is provided to the basic business processes like marketing, sales, service.

(ii)   Analytical - support to analyze customer behavior, implements business intelligence alike technology.

(iii)   Collaborative - ensures the contact with customers like phone, email, fax, web, sms, post, in person.

(i)   Operational CRM: Operational CRM means supporting the front office business processes, which include customer contact like sales, marketing and service. Tasks resulting

from these processes are forwarded to employees responsible for them, as well as the information necessary for carrying out the tasks and interfaces to back-end applications are being provided and activities with customers are being documented for further reference.

It provides the following benefits –

- Delivers personalized and efficient marketing, sales, and service through multi-channel collaboration.

- Enables a reverse view of the customer while the organization is interacting with them.

- Sales people and service engineers can access complete history of all customer interaction with your company, regardless of the touch point.

The operational part of CRM typically involves three general areas of business –

- **Sales force automation (SFA)** : SFA automates some of the company's critical sales and sales force management functions, for example, lead/account management, contact management, quote management, forecasting, sales administration, keeping track of customer preferences, buying habits, and demographics, as well as performance management. SFA tools are designed to improve field sales productivity. Key infrastructure requirements of SFA are mobile synchronization and integrated product configuration.

- **Customer service and support (CSS)** : CSS automates some service requests, complaints, product returns, and information requests. Traditional internal help desk and traditional inbound call-center support for customer inquiries are now evolved into the "customer interaction center" (CIC), using multiple channels (Web, phone/fax, face-to-face, kiosk, etc) Key infrastructure requirements of CSS include computer telephony integration (CTI) which provides high volume processing capability, and reliability.

- **Enterprise marketing automation (EMA)** : EMA provides information about the business environment, including competitors, industry trends, and macro environmental variables. It is the execution side of campaign and lead management. The intent of EMA applications is to improve marketing campaign efficiencies. Functions include demographic analysis, variable segmentation, and predictive modeling occur on the analytical (Business Intelligence) side. Integrated CRM software is often also known as front office solutions. This is because they deal directly with the customer. Many call centers use CRM software to store all of their customer's details. When a customer calls, the system can be used to retrieve and store information relevant to the customer. By serving the customer quickly and efficiently, and also keeping all information of a customer in one place, a company aims to make cost savings, and also encourage new customers. CRM solutions can also be used to allow customers to perform their own service via a variety of communication channels. For example, you might be able to

check your bank balance via your WAP phone without ever having to talk to a person, saving money for the company, and saving your time.

(ii) Analytical CRM : In analytical CRM, data gathered within operational CRM and/or other sources are analyzed to segment customers or to identify potential to enhance client relationship. Customer analysis typically can lead to targeted campaigns to increase share of customer's wallet. Examples of Campaigns directed towards customers are:

(i) Acquisition: Cross-sell, up-sell

(ii) Retention: Retaining customers who leave due to maturity or attrition.

(iii) Information: Providing timely and regular information to customers.

(iv) Modification: Altering details of the transactional nature of the customers' relationship.

Analysis typically covers but is not limited to decision support:

(i) Dashboards, reporting, metrics, performance etc.

(ii) Predictive modeling of customer attributes

(iii) Strategy and research.

(iv) Analysis of Customer data may relate to one or more of the following analyses:

(v) Campaign management and analysis

(vi) Contact channel optimization

(vii) Contact Optimization

(viii) Customer Acquisition / Reactivation / Retention

(ix) Customer Segmentation

(x) Customer Satisfaction Measurement / Increase

(xi) Sales Coverage Optimization

(xii) Fraud Detection and analysis

(xiii) Financial Forecasts

(xiv) Pricing Optimization

(xv) Product Development

(xvi) Program Evaluation

(xvii) Risk Assessment and Management

Data collection and analysis is viewed as a continuing and iterative process. Ideally, business decisions are refined over time, based on feedback from earlier analysis and decisions. Therefore, most successful analytical CRM projects take advantage of a data warehouse to provide suitable data.

Business Intelligence is a related discipline offering some more functionality as separate application software.

(iii) Collaborative CRM : Collaborative CRM facilitates interactions with customers through all channels like personal, letter, fax, phone, web, E-mail and supports co-ordination of employee teams and channels. It is a solution that brings people, processes and data together so companies can better serve and retain their customers. The data/activities can be structured, unstructured, conversational, and/or transactional in nature.

Collaborative CRM provides the following benefits –

- (i) Enables efficient productive customer interactions across all communications channels

- (ii) Enables web collaboration to reduce customer service costs

- (iii) Integrates call centers enabling multi-channel personal customer interaction

- (iv) Integrates view of the customer while interaction at the transaction level

Purposes of Customer Relationship Management – CRM, in its broadest sense, means managing all interactions and business with customers. This includes, but is not limited to, improving customer service. A good CRM program will allow a business to acquire customers, service the customer, increase the value of the customer to the company, retain good customers, and determine which customers can be retained or given a higher level of service. A good CRM program can improve customer service by facilitating communication in several ways –

- (i) Provide product information, product use information, and technical assistance on web sites that are accessible round the clock.

- (ii) Identify how each individual customer defines quality, and then design a service strategy for each customer based on these individual requirements and expectations.

- (iii) Provide a fast mechanism for managing and scheduling follow-up sales calls to assess post-purchase cognitive dissonance, repurchase probabilities, repurchase times, and repurchase frequencies.

- (iv) Provide a mechanism to track all points of contact between a customer and the company, and do it in an integrated way so that all sources and types of contact are

included, and all users of the system see the same view of the customer (reduces confusion)

(v) Help to identify potential problems quickly, before they occur.

(vi) Provide a user-friendly mechanism for registering customer complaints (complaints that are not registered with the company cannot be resolved, and are a major source of customer dissatisfaction)

(vii) Provide a fast mechanism for handling problems and complaints (complaints that are resolved quickly can increase customer satisfaction)

(viii) Provide a fast mechanism for correcting service deficiencies (correct the problem before other customers experience the same dissatisfaction)

(ix) Use internet cookies to track customer interests and personalize product offerings accordingly.

(x) Use the Internet to engage in collaborative customization or real-time customization.

(xi) Provide a fast mechanism for managing and scheduling maintenance, repair, and on-going support (improve efficiency and effectiveness)

(xii) The CRM can be integrated into other cross-functional systems and thereby provide accounting and production information to customers when they want it.

Improving customer relationships : CRM programs also are able to improve customer relationships. Proponents say this is so because –

CRM technology can track customer interests, needs, and buying habits as they progress through their life cycles, and tailor the marketing effort accordingly. These way customers get exactly what they want as they change.

The technology can track customer product use as the product progresses through its life cycle, and tailor the service strategy accordingly. These way customers get what they need as the product ages.

In industrial markets, the technology can be used to micro-segment the buying centre and help coordinate the conflicting and changing purchase criteria of its members.

When any of the technology-driven improvements in customer service (mentioned above) contribute to long-term customer satisfaction, they can ensure repeat purchases, improve customer relationships, increase customer loyalty, decrease customer turnover, decrease marketing costs (associated with customer acquisition and customer "training"), increase sales revenue, and thereby increase profit margins.

Repeat purchase, however, comes from customer satisfaction - which in turn comes from a deeper understanding of each customer, their individual business challenges and proposing solutions for those challenges rather than a "one size fits all" approach.

CRM software enables sales people to achieve this one on one approach to selling and can automate some elements of it via tailorable marketing communications. However, all of these elements are facilitated by or for humans to achieve - CRM is therefore a company-wide attitude as much as a software solution.

Technical functionality : A CRM solution is characterized by the following functionality:

Scalability: the ability to be used on a large scale, and to be reliably expanded to whatever scale is necessary.

Multiple communication channels: the ability to interface with users via many different devices (phone, WAP, internet, etc)

Workflow: the ability to trigger a process in the back office system, e. g. Email Response, etc.

Assignment: the ability to assign requests (Service Requests, Sales Opportunities) to a person or group.

Database: the centralized storage (in a data warehouse) of all information relevant to customer interaction

Customer privacy considerations: the data encryption and the destruction of records are needed to ensure that they are not stolen or abused.

Privacy and ethical concerns : CRM programs are not however considered universally good - some feel it invades customer privacy and enable coercive sales techniques due to the information companies now have on customers. However, CRM does not necessarily imply gathering new data, it can be used merely to make better use of data the corporation already has. But in most cases they are used to collect new data.

Some argue that the most basic privacy concern is the centralized database itself, and that CRM's built this way are inherently privacy-invasive.

CRM in Business : The use of internet sites and specifically E-mail, in particular, are often touted as less expensive communication methods in comparison to traditional ones such as telephone calls. These types of technologies service can be very helpful, but it is completely useless to a business that cannot reach its customers. Some major companies believe that the majority of their clients trust other means of communication, like telephone, more than they trust E-mail. Clients, however, are usually not the ones to blame because it is often the manner of connecting with consumers on a personal level making them feel as though they are cherished as customers. It is up to companies to focus on reaching every customer and developing a relationship.

It is possible for CRM software to run an entire business. From prospect and client contact tools to billing history and bulk email management. The CRM system allows a business to maintain all customer records in one centralized location that is accessible to an entire organization through password administration. Front office systems are set up to collect data from the customers for processing into the data warehouse. The data warehouse is a back office system used to fulfill and support customer orders. All customer information is stored in the data warehouse. Back office CRM makes it possible for a company to follow sales, orders, and cancellations. Special regressions of this data can be very beneficial for the marketing division of a firm/company.

CRM for nonprofit organizations : CRM is also important to non-profit organizations, which sometimes use the terms like constituent relationship management, contact relationship management or community relationship management to describe their information systems for managing donors, volunteers and other supporters.

4.9 SUPPLY CHAIN MANAGEMENT

Supply chain management (SCM) is the process of planning, implementing, and controlling the operations of the supply chain with the purpose to satisfy customer requirements as efficiently as possible. Supply chain management spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point-of-origin to point-of-consumption.

According to the Council of Supply Chain Management Professionals (CSCMP), a professional association that developed a definition in 2004, Supply Chain Management *encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies.*

Supply chain event management (abbreviated as SCEM) is a consideration of all possible occurring events and factors that can cause a disruption in a supply chain. With SCEM possible scenarios can be created and solutions can be planned.

Some experts distinguish supply chain management and logistics management, while others consider the terms to be interchangeable. From the point of view of an enterprise, the scope of supply chain management is usually bounded on the supply side by supplier's suppliers and on the customer side by customer's customers.

Opportunities enabled by Supply Chain Management – The following strategic and competitive areas can be used to their full advantage if a supply chain management system is properly implemented.

Fulfillment: Ensuring the right quantity of parts for production or products for sale arrive at the right time and is enabled through efficient communication, ensuring that orders are placed with the appropriate amount of time available to be filled. The supply chain management system also allows a company to constantly see what is on stock and making sure that the right quantities are ordered to replace stock.

Logistics: Keeping the cost of transporting materials as low as possible consistent with safe and reliable delivery. Here the supply chain management system enables a company to have constant contact with its distribution team, which could consist of trucks, trains, or any other mode of transportation. The system can allow the company to track where the required materials are at all times. As well, it may be cost effective to share transportation costs with a partner company if shipments are not large enough to fill a whole truck and this again, allows the company to make this decision.

Production: Ensuring production lines function smoothly because high-quality parts are available when needed. Production can run smoothly as a result of fulfillment and logistics being implemented correctly. If the correct quantity is not ordered and delivered at the requested time, production will be halted, but having an effective supply chain management system in place will ensure that production can always run smoothly without delays due to ordering and transportation.

Revenue & profit: Ensuring no sales are lost because shelves are empty. Managing the supply chain improves a company's flexibility to respond to unforeseen changes in demand and supply. Because of this, a company has the ability to produce goods at lower prices and distribute them to consumers quicker then companies without supply chain management thus increasing the overall profit.

Costs: K*eeping the cost of purchased parts and products at acceptable levels.* Supply chain management reduces costs by "… increasing inventory turnover on the shop floor and in the warehouse" controlling the quality of goods thus reducing internal and external failure costs and working with suppliers to produce the most cost efficient means of manufacturing a product.

Cooperation: Among supply chain partners ensures 'mutual success'. Collaborative planning, forecasting and replenishment (CPFR) is a *longer-term commitment, joint work on quality, and support by the buyer of the supplier's managerial, technological, and capacity development.* This relationship allows a company to have access to current, reliable information, obtain lower inventory levels, cut lead times, enhance product quality, improve forecasting accuracy and ultimately improve customer service and overall profits. The suppliers also benefit from the cooperative relationship through increased buyer input from suggestions on improving the quality and costs and though shared savings. Consumers can benefit as well through higher quality goods provided at a lower cost.

Supply chain management problems: Supply chain management must address the following problems –

(i) Distribution Network Configuration: Number and location of suppliers, production facilities, distribution centers, warehouses and customers.

(ii) Distribution Strategy: Centralized versus decentralized, direct shipment, cross docking, pull or push strategies, third party logistics.

(iii) Information: Integrate systems and processes through the supply chain to share valuable information, including demand signals, forecasts, inventory and transportation.

(iv) Inventory Management: Quantity and location of inventory including raw materials, work-in-process and finished goods.

Activities/Functions: Supply chain management is a cross-functional approach to managing the movement of raw materials into an organization and the movement of finished goods out of the organization toward the end-consumer. As corporations strive to focus on core competencies and become more flexible, they have reduced their ownership of raw materials sources and distribution channels. These functions are increasingly being outsourced to other corporations that can perform the activities better or more cost effectively. The effect has been to increase the number of companies involved in satisfying consumer demand, while reducing management control of daily logistics operations. Less control and more supply chain partners led to the creation of supply chain management concepts. The purpose of supply chain management is to improve trust and collaboration among supply chain partners, thus improving inventory visibility and improving inventory velocity.

Several models have been proposed for understanding the activities required to manage material movements across organizational and functional boundaries. SCOR is a supply chain management model promoted by the Supply-Chain Council. Another model is the SCM Model proposed by the Global Supply Chain Forum (GSCF) Supply chain activities can be grouped into strategic, tactical, and operational levels of activities.

Strategic:

(i) Strategic network optimization, including the number, location, and size of warehouses, distribution centers and facilities.

(ii) Strategic partnership with suppliers, distributors, and customers, creating communication channels for critical information and operational improvements such as cross docking, direct shipping, and third-party logistics.

(iii) Product design coordination, so that new and existing products can be optimally integrated into the supply chain.

(iv) Information Technology infrastructure, to support supply chain operations.

(v)   Where to make and what to make or buy decisions

Tactical:

(i)   Sourcing contracts and other purchasing decisions.

(ii) Production decisions, including contracting, locations, scheduling, and planning process definition.

(iii) Inventory decisions, including quantity, location, and quality of inventory.

(iv) Transportation strategy, including frequency, routes, and contracting.

(v)   Benchmarking of all operations against competitors and implementation of best practices throughout the enterprise.

(vi) Milestone Payments

Operational:

(i)   Daily production and distribution planning, including all nodes in the supply chain.

(ii) Production scheduling for each manufacturing facility in the supply chain (minute by minute)

(iii) Demand planning and forecasting, coordinating the demand forecast of all customers and sharing the forecast with all suppliers.

(iv) Sourcing planning, including current inventory and forecast demand, in collaboration with all suppliers.

(v)   Inbound operations, including transportation from suppliers and receiving inventory.

(vi) Production operations, including the consumption of materials and flow of finished goods.

(vii) Outbound operations, including all fulfillment activities and transportation to customers.

(viii) Order promising, accounting for all constraints in the supply chain, including all suppliers, manufacturing facilities, distribution centers, and other customers.

(ix) Performance tracking of all activities

The Bullwhip Effect: The Bullwhip Effect or Whiplash Effect is an observed phenomenon in forecast-driven distribution channels. Because customer demand is rarely perfectly stable, businesses must forecast demand in order to properly position inventory and other resources. Forecasts are based on statistics, and they are rarely perfectly accurate. Because forecast errors are a given, companies often carry an inventory buffer called *safety stock.* Moving up the supply chain from end-consumer to raw materials supplier, each supply chain participant has greater observed variation in demand and thus greater need for safety stock. In periods of rising demand, down-stream participants will increase their orders. In periods of falling

demand, orders will fall or stop in order to reduce inventory. The effect is that variations are amplified the farther you get from the end-consumer.

Supply chain experts have recognized that the Bullwhip Effect is a problem in forecast-driven supply chains. The alternative is to establish a demand-driven supply chain which reacts to actual customer orders. The result is near-perfect visibility of customer demand and inventory movement throughout the supply chain. Better information leads to better inventory positioning and lower costs throughout the supply chain. Barriers to implementing a demand-driven supply chain include investments in information technology and creating a corporate culture of flexibility and focus on customer demand.

Factors contributing to the Bullwhip Effect:

(i)   Forecast Errors

(ii)   Lead Time Variability

(iii)   Batch Ordering

(iv)   Price Fluctuations

(v)   Product Promotions

(vi)   Inflated Orders

(vii)   Methods intended to reduce uncertainty, variability, and lead time:

(viii)   Vendor Managed Inventory (VMI)

(ix)   Just In Time replenishment (JIT)

(x)   Strategic partnership (SP)

4.10 ELECTRONIC DATA INTERCHANGE (EDI)

The term electronic data interchange has many definitions. American National Standards Institute (ANSI) has defined it as :

Electronic Data Interchange (EDI) is the transmission, in a standard syntax, of unambiguous information of business or strategic significance between computers of independent organisations. The users of EDI do not have to change their internal data bases. However, users must translate this information to or from their own computer system formats, but this translation software has to be prepared only once.

In simple terms, EDI is computer-to-computer communication using a standard data format to exchange business information electronically between independent organisations.

EDI no longer merely aids in transmitting documents, but dynamically moves data between companies' computer systems. The computer-to-computer transfer can be direct, between two companies using an agreed upon data protocol, or it can be performed by a third-party service vendor. Users can transmit business documents such as purchase orders, price quotes, shipping notices, and even payment orders electronically to customers and suppliers.

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Design documents, electronic funds transfers, and database transactions can all come under the EDI umbrella. The format for data transmission between trading partners via common carrier, is governed by a predetermined and institutionally agreed upon set standards.

Among the companies and industries that might reap significant benefits by converting to EDI are those companies that handle a large volume of repetitive standard transactions, or operate on very tight margins. Additionally, companies that face strong competition (which requires significant productivity improvements), operates in a time-sensitive environment, or has already received requests to convert to EDI from trading partners, can also benefit. EDI improves the operations dealing with high volumes of transactions by providing electronic information exchange between trading partners. This electronic connection reduces data entry errors (EDI will not prevent input errors from occurring, however) by eliminating repetitive tasks and lowers administrative overhead costs associated with paper-based processing methods.

In the traditional paper-based flow of information, manual data entry is performed at each step in the process. In addition, manual reconciliation—comparison of purchase order, receiving notice, and invoice—is also required, thereby contributing to the higher cost of transaction processing and the continued involvement of the end user in the overall process. These two manual processes are eliminated with the substitution of electronic methods such as EDI.

Some problems with paper-based information systems that EDI can address are:

(*i*)   *Labour costs* - In a paper based system, manual processing is required for data keying, document storage and retrieval, document matching, envelope stuffing etc.

(*ii*)   *Errors* - Since the same information is keyed in a number of times, paper-based systems are error-prone.

(*iii*)   *Inventory* -Due to the fact that delays and uncertainties are commonplace in paper processing, inventories may be higher than they need to be.

(*iv*)   *Uncertainty* - Uncertainty exists in three areas. Firstly, transportation and keying delays mean that timing is uncertain. Secondly, the sender does not know whether the matter dispatched was received at all. Thirdly, in the payment area, it is difficult to tell when the bank will disburse the cheque.

The results of EDI implementation can be dramatic. Time delays are greatly reduced. Mail and processing delays are eliminated. Uncertainty with regard to timings is discarded in some cases and lessened in others. This enables a firm to forecast cash flows more accurately.

A content acknowledgement provides the buyer fast feedback on whether the order will be honored or whether the buyer must look elsewhere. This lessens the need for safety stock. One-time keying means that labour costs can be reduced and payments can be processed through the settlement system the day after initiation.

4.10.1 Advantages of EDI

(*i*) *Issue and receive orders faster* - Since most purchasing transactions are routine, they can be handled automatically, utilising the staff for more demanding and less routine tasks.

(*ii*) *Make sales more easily* - Quotes, estimates, order entry and invoicing will proceed more smoothly and efficiently. Orders received electronically ensure that information is available immediately, so that an organisation can respond faster and be more competitive.

(*iii*) *Get paid sooner* - Invoices received electronically can be reconciled automatically, which means they are earmarked for payment in one's trading partner's accounting department sooner. And, in turn, your own purchasing department is in a position to negotiate for better terms including faster payment.

(*iv*) *Minimise capital tied up in inventory* - For manufacturing organisations with a just-in-time strategy, the right balance is crucial but every organisation stands to benefit from reducing order lead times.

(*v*) *Reduce letters and memos* - Letters and memos do not follow rigid rules for formatting. They can be handled by an electronic mail system.

(*vi*) *Decrease enquiries* - Customers or suppliers can make direct on-line enquiries on product availability, or other non-sensitive information instead of consuming the staff's precious time.

(*vii*) *Make bulk updates of catalogues and parts listings* - One can provide updates of data files, such as catalogues to customers or part listings to franchisees.

Any organisation that sends or receives large volumes of paper transactions, needs to reduce inventory costs, distribute products using repetitive procedures, wants to handle documents more expeditiously, deals with many trading partners, has to manage long delays in the purchasing cycle and conducts business (buying and selling) with mostly the same companies can make optimum use of the EDI.

EDI is vastly implemented in the trucking, marine shipping and air cargo industries in developed countries. Implementation need not be expensive. All that a small firm needs to have is a personal computer, a modem and telephone line and the necessary software.

EDI is considered by many to be the leading application of eCommerce technology, may be because it has been around so long, or maybe because EDI has the look and feel of what eCommerce is eventually suppose to be. It is important to note however, that EDI is simply only one element in the broad eCommerce environment. eCommerce is much more than simply EDI. eCommerce has been defined as a means of conducting business electronically via online transactions between merchants and consumers. Electronic Data Interchange

(EDI), however, is the computer application-to-computer application transmission of business documents in a pre-determined, standard format. While electronic commerce is targeted for global trading and is suited to anyone interested in online commerce, EDI on the other hand, is best suited for a selected group of trading partners.

4.10.2 EDI users and types of activities : Companies of all types and sizes can utilise EDI. The initial impetus for EDI was provided by the transportation industry in the United States, in 1970s. The transportation industry characterised by its paper intensive multi-part bills of landing, way bills, invoices, customs forms, intense competition and pressure to reduce delivery times, was a logical breeding ground for this application of information technology.

The concept gained further momentum with its general acceptance by the American grocery industry in the late 1970s and the automotive industry in the early 1980s, Canadian counterparts in both these sectors followed suit in 1984.

In India, Videsh Sanchar Nigam Limited has recently launched another value added service - the EDI. The service will be used to clear import/export transactions more efficiently.

Internet-based EDI can be interactive and is relatively inexpensive, thus paving the way for Small-Medium-Enterprises (SMEs) to use electronic commerce. These business-to-business transactions include the use of EDI and electronic mail for purchasing goods and services, buying information and consulting services. Additionally, Internet-based EDI trading techniques aim to improve interchange of information between trading partners, suppliers and customers by bringing down the boundaries that restrict how they interact and do business with each other. However, by doing so the risks involved in the process of conducting commercial transactions are increased. Thus it lacks the security and reliability arising from the issues of a *"complete trustworthy relationship"* among the trading partners. The security of electronic commerce is not only critical but is also absolutely inevitable if organizations are to maintain and increase their profitability .

4.10.3 How EDI Works : EDI is the electronic exchange of business documents such as invoices, purchase orders, and shipping notices in a standard, machine-processable data format. EDI automates the transfer of data between dissimilar computer systems. This is a 3-step process. Looking at an outgoing scenario:

| 1. | 2. | 3. |
| Your Application | EDI Translator | Trading Partner |
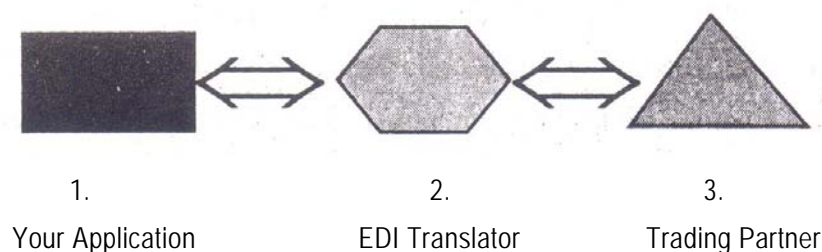
Data from your application is translated into a standard format.

Then, it is transmitted over communication lines to your trading partner.

Finally, it is re-translated by your trading partner's application.

(The process works in reverse when your trading partner wishes to send an EDI transaction to you.)

Communications : To make EDI work, one needs communications software, translation software, and access to standards. Communications software moves data from one point to another, flags the start and end of an EDI transmission, and determines how acknowledgements are transmitted and reconciled. Translation software helps the user to build a map and shows him how the data fields from his application corresponds to the elements of an EDI standard. Later, it uses this map to convert data back and forth between the application format and the EDI format.

Mapping : To build a map, the user first selects the EDI standard that is appropriate for the kind of EDI data he wants to transmit. For example, there are specific standards for invoices, purchase orders, advance shipping notices, and so on. Usually, the trading partner will tell the user what standard to use (or the user may be dictating this to his trading partner, depending on who initiated the request to conduct business via EDI) Next, he edits out parts of the standard that don't apply to his particular application or utilization. Again, the user and his trading partner normally exchange this information.

Next, he imports a file that defines the fields in his application. An application file can be a flat file or a file extracted from a database. An EDI translator displays a selected EDI standard on one side of the screen, and his application file on the other.

Finally, he marks the map to show where the data required by the EDI standard is located in his application. Once the map is built, the translator will refer to it during EDI processing every time a transaction of that type is sent or received.

Profiles : The last step is to write a partner profile that tells the system where to send each transaction and how to handle errors or exceptions. Whereas the user needs a unique map for every kind of document he exchanges with a partner, he should only have to define partner information once.

Coordinating : In summary, to make EDI work, you need to:

Select communications software.

Select a standard for each document you want to exchange with your trading partner.

Import an application file that defines the fields and records in your application.

Define a map that shows how the fields in your application correspond to elements in the standard.

Define partner profiles that tell the system how transactions will be addressed, what they will contain, and how to respond to errors.

Finally, the system should be tested with sample documents

EDI as we know it today is a 25 year-old collection of standards used by organizations to communicate (transmit) invoices, purchase orders, electronic funds transfer, shipping orders, and non-financial records. However, the standards, which define EDI, are showing their age as the World Wide Web (WWW) and the Internet continue to grow in importance as a primary business-transaction delivery system. Redefined software will allow not only data, but also processes and transactions, to flow over the Web. For example, imagine a supply chain in which the retailer's system uses the Web to query the warehouse system of its distributor to determine the status and availability of certain products. The distributor can, in turn, query the manufacturer about specific delivery schedules for certain products. The Web will allow these activities to occur interactively or even automatically.

Traditional EDI will inevitably give way to Web-based EDI and eventually a broader eCommerce strategy for conducting business will dominate organizational sales strategies. Organizations driven to reduce inventories, improve delivery times, and improve customer satisfaction will spearhead this metamorphosis.

4.11 ELECTRONIC FUND TRANSFER (EFT)

EFT stands for "Electronic Funds Transfer" and represents the way the business can receive direct deposit of all payments from the financial institution to the company bank account. Once the user *signs up*, money comes to him directly and sooner than ever before. EFT is Fast, Safe, and means that the money will be confirmed in user's bank account quicker than if he had to wait for the mail, deposit the cheque, and wait for the funds to become available.

The payment mechanism moves money between accounts in a fast, paperless way. These are some examples of EFT systems in operation:

Automated Teller Machines (ATMs): Consumers can do their banking without the assistance of a teller, as John Jones did to get cash, or to make deposits, pay bills, or transfer funds from one account to another electronically. These machines are used with a debit or EFT card and a code, which is often called a personal identification number or "PIN."

Point-of-Sale (POS) Transactions: Some debit or EFT cards (sometimes referred to as check cards) can be used when shopping to allow the transfer of funds from the consumer's account to the merchant's. To pay for a purchase, the consumer presents an EFT card instead of a check or cash. Money is taken out of the consumer's account and put into the merchant's account electronically.

Preauthorized Transfers: This is a method of automatically depositing to or withdrawing funds from an individual's account, when the account holder authorizes the bank or a third party (such as an employer) to do so. For example, consumers can authorize direct electronic deposit of wages, social security, or dividend payments to their accounts. Or they can authorize financial institutions to make regular, ongoing payments of insurance, mortgage, utility, or other bills.

Telephone Transfers: Consumers can transfer funds from one account to another— from savings to checking, for example—or can order payment of specific bills by phone.

4.12 TYPES OF ELECTRONIC PAYMENTS

The methods that have been developed for making payments on the Internet are essentially electronic versions of the traditional payment systems we use everyday-cash, checks, and credit cards. The fundamental difference between the electronic payment systems and traditional one is that everything is digital, and is designed to be handled electronically form the get-go-there's no crinkle of dollar bills, no clink of coins in your pocket, or signing a check with a pen. In a manner of speaking, everything about the payment has been virtualized into strings of bits. This virtualization will make many of the electronic payment options appear similar to each other – often the differences are due more to the companies and consortia developing the software than to the logic involved.

While many of the payment systems that are currently implemented now, uses personal computers, One day you'll be able to use a personal digital assistant (PDA) for handling payment. Trials are already underway with smart cards for making transaction over the net possible.

4.12.1   Credit Cards : In a credit card transaction, the consumer presents preliminary proof of his ability to pay by presenting his credit card number to the merchant. The merchant can verify this with the bank, and create a purchase slip for the consumer to endorse. The merchant then uses this purchase slip to a collect funds form the bank, and, on the next billing cycle, the consumer receives a statement form the bank with a record of the transaction.

Using a credit card to make a purchase over the Internet follows the same scenario. But on the Internet added steps must be taken to provide for secure transactions and authentication of both buyer and seller. This has led to a variety of system for using credit cards over the Internet. Two of the features distinguishing these systems are the level of security they provide for transactions, and the software required on both the customer and business sides of the transaction. *The picture shows Handling credit card and ordering data with HTML forms and CGI script (non secure and secured with SSL)*

Credit cards can be handled on line in two different ways:

(a)   Sending unencrypted credit card numbers over the Internet
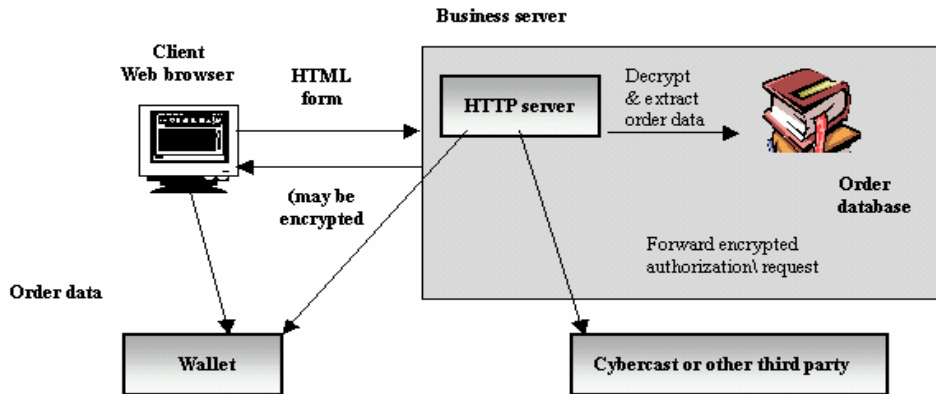
(b)   Encrypting credit card details before any transactions are transmitted.

Encrypting credit card transactions can also be subdivided according to what is encrypted. If the entire transmission between buyer and merchant is encrypted, the merchant has to decrypt at least the order details to a complete a purchase. Then to further assure the customer that only authorized parties see his credit card information and protect against merchant fraud, a trusted third party can be used to separately

Handling credit card and order data with a wallet as helper application and third party for credit card processing decrypt the credit card information for authorization of the purchase.
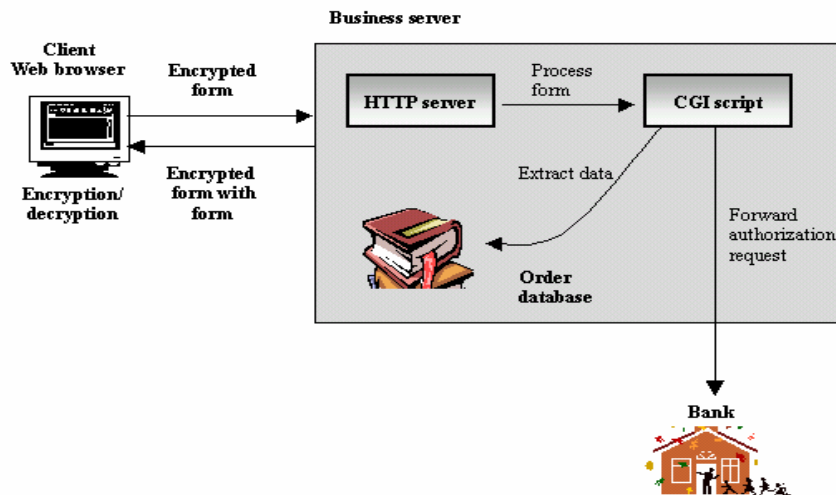
A customer browsing the Web might enter a credit card number in an order form, and click a submit button to transmit the information to the merchant's web server. The data would be raw, and there are no security guarantees for this type of transaction, someone could be monitoring network traffic and could intercept the transmission, or an unscrupulous merchant (or someone posing as a merchant could use the unencrypted number for illegal charges)

On the business end, processing the incoming credit card information only requires a Web server with a CGI script to process the form filled out by the customer. But if you want to secure the communication between buyer and seller against snooping, a good choice is a Web browser-server combination that supports the Secure Sockets Layer (SSL) protocol.

The use of servers and browsers that support the SSL protocol only protects data against network monitors and spies. It does not guarantee that the data is protected form spying eyes on the merchant's end. To protect against merchant fraud (using a credit card for other unauthorized purchases, for example), use systems from either CyberCash, Verifone, of First Virtual. CyberCash and Verifone both use a helper application called a wallet for the Web browser, and pass the encrypted credit card number through the merchant to its own processor/server for authentication and approval of the sale. First Virtual issues a VirtualPIN to the customer who then uses it in place of the credit card number. After receiving the sales information from the merchant, First Virtual converts the VirtualPin to the credit card account number to clear the purchase.

Here's a case where the electronic versions of a traditional payment system offer an added advantage-using encrypted credit card information with a trusted third party, such as Cybercash or First Virtal, instead of allowing the merchant to handle credit card processing, offers more protection against merchant fraud than is commonly seen in the every-day world.

4.12.2   Transaction Using Third Party Verification : The market for handling credit card purchases on the Internet has yet to converge on a single way of doing things, or a single standard that allows the software from different vendors to work together. This lack of interoperability will likely slow down both consumer and business acceptance of using credit cards for making purchases on the Internet.

There are, however, two significant standards in the works that will make the interoperability of electronic wallet and credit card transactions simpler, both for consumers and businesses.
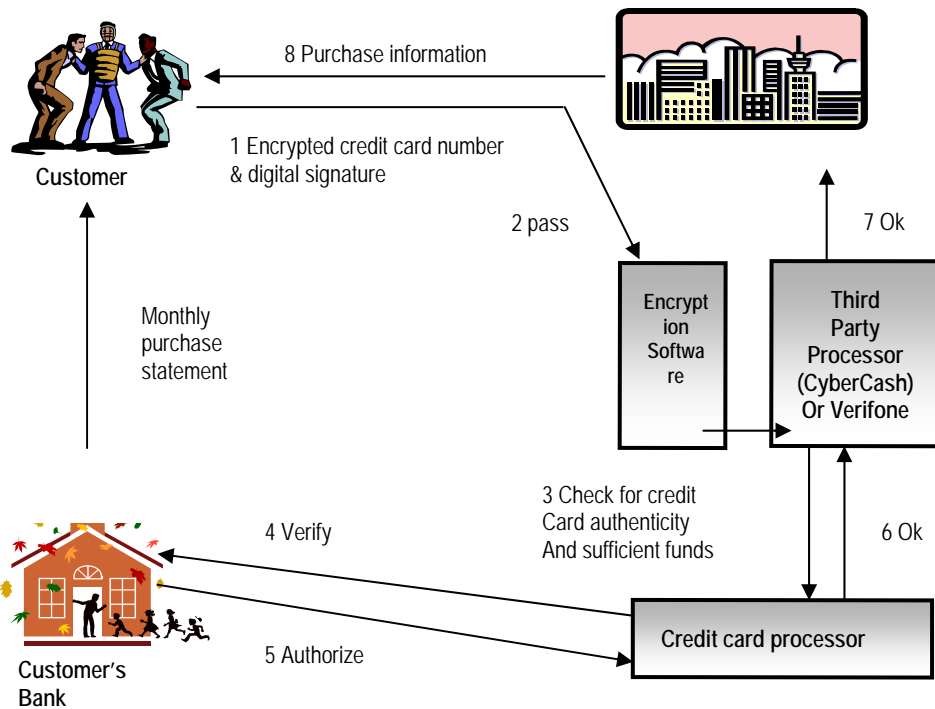
4.12.3   Secured Electronic Transaction (SET) : First, there's the Secured Electronic Transaction protocol (SET) developed by a consortium led by MasterCard and Visa. SET is actually a combination of a protocol designed for use by other applications (Such as Web browsers) and a standard (Recommended procedures) for handling credit card transactions over the Internet. Designed for cardholders, merchants, banks, and other card processors, SET uses digital certificates to ensure the identities of all parties involved in a purchase. SET also encrypts credit card and purchase information before transmission on the Internet.

4.12.4   Joint Electronic Transaction : The second standard is the Joint Electronic Payments Initiative, led by the World Wide Web Consortium and Commerce Net. JEPI, as it's known, is an attempt to standardize payment negotiations. On the buyer's side (the client side), it serves as an interface that enables a Web browser, and wallets, to use a variety of payment protocols. On the merchant's side (the serve side), it acts between the network and transport layers to pass off the incoming transactions to the proper transport protocol (e-mail vs. HTTP, for instance) and proper payment protocol (such as SET) Because it's likely that

multiple protocols will be around for payment, transport, and wallets, JEPI makes it easier for the buyer to use a single application, and single interface, in a variety of commercial situations. It also makes it easier for the merchant to support the variety of payment system that customers will want to use.

4.12.5   Electronic Cheques : Credit card payments will undoubtedly be popular for commerce on the Internet. However, following two systems have been developed to let consumers use electronic cheques to pay Web merchants directly.

(a)   By the Financial Services Technology Corporation (FSTC)

(b)   *By CyberCash* : An electronic cheque has all the same features as a paper cheque. It functions as a message to the sender's bank to transfer funds, and, like a paper cheque, the message is given initially to the receiver who, in turn, endorsees the cheque and presents it to the bank to obtain funds. The electronic cheque can prove to be superior to the paper cheque in one significant aspect. As sender, you can protect yourself against fraud by encoding your account number with the bank's public key, thereby not revealing your account number to the merchant. As with the SET protocol, digital certificates can be used to authenticate the payer, the payer's bank, and bank account.

CyberCash's system for electronic checking is an extension of their **wallet** for credit cards, and it can be used in the same way to make payments with participating vendors. Unlike the Cyber Cash credit card system, through, CyberCash will not serve as an intermediate party for processing the cheque-that function will be handled directly by banks.

The FSTC is a consortium of banks and clearing houses that has designed an electronic cheque. Modeled on the traditional paper cheque, this new cheque is initiated electronically, and uses a digital signature for signing and endorsing.

To add to the flexibility of their payment system, the FSTC wants to offer users a choice of payment instruments that allow them to designate an electronic cheque as a certified cheque or an electronic charge card slip, for example. This means that the user can use a single mechanism, the electronic cheque, to complete payments that vary according to payee's requirements. For example, you could decide to pay your utility bills by standard electronic cheque, but you could designate that one of the electronic cheque be delivered as a certified cheque in order to make a down payment on a new house. The instructions accompanying your electronic cheque would be processed by the electronic payment handler (EPH) software installed at you bank, and distributed by the appropriate payment network.
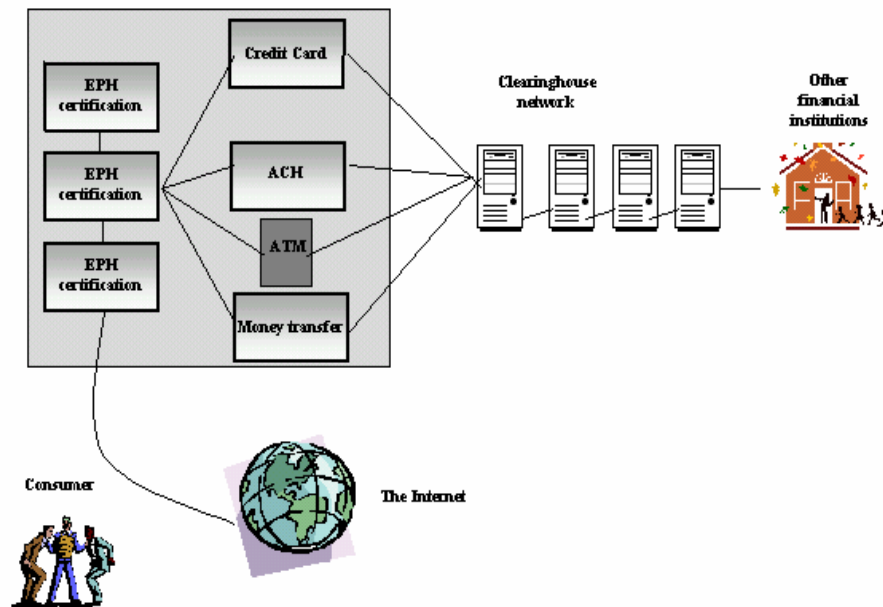
Extending electronic checks to existing payment systems

Electronic cheque can be delivered either by direct transmission over a network, or by electronic mail. In either case, existing banking channels can clear payments over their networks. This leads to a convenient integration of the existing banking infrastructure and the Internet. Because FSTC's plans for electronic checking include money transfers and transactions involving the National Automated Clearing House Association for transferring funds between banks, businesses could use the FSTC scheme to pay in voice from other businesses.

4.12.6   Smart Cards : Smart cards have an embedded microchip instead of magnetic strip. The chip contains all the information a magnetic strip contains but offers the possibility of manipulating the data and executing applications on the card.

Three types of smart cards have established themselves.

➢   **Contact Cards –** Smart cards that need to insert into a reader in order to work, such as a smart card reader or automatic teller machines.

➢   **Contactless Cards** – Contactless smart cards don't need to be inserted into a reader. Just waving them near a reader is just sufficient for the card to exchange data. This type of cards is used for opening doors.

> **Combi Cards –** Combi cards contain both technologies and allow a wider range of applications.

4.12.7   Electronic Purses : Electronic is yet another way to make payments over the net. It is very similar to a pre paid card. For Eg: Bank issues a stored value cards to its customers, the customer can then transfer value from their accounts to the cards at an ATM, a personal computer, or a specially equipped telephone. The electronic purse card can be used as a ATM card as well as a credit card.

While making purchases, customers pass their cards through a vendor's point of sale terminal. No credit check or signature is needed. Validation is done through a Personal Identification Number (PIN Number)

Once the transaction is complete, funds are deducted directly from the cards and transferred to the vendor's terminal. Merchants can transfer the value of accumulated transactions to their bank accounts by telephone as frequently as they choose. When the value on a card is spent, consumers can load additional funds from their accounts to the card.

4.13 RISKS AND SECURITY CONSIDERATIONS

The Internet's use by businesses for electronic commerce will continue to expand. Therefore, the focus for these businesses will be to develop methods of ensuring its safe and effective use. With no oversight body establishing security standards or ensuring the continued availability of Internet services, inherent risks are associated with using the Internet as a primary means of conducting business transactions, and those risks must be addressed and corrected.

Because computers are more accessible and their hackers more numerous, the computer security problem can no longer be ignored by the corporate executives who have, for years, been in a state of denial about the importance of computer security. The accounting firm Ernst & Young (1995) surveyed 1,290 information system executives and found that security continues to be a significant problem in corporate America. The survey results included the following staggering statistics:

- Nearly half of the 1,290 respondents have lost valuable information in the last two years.

- At least 20 respondents have lost information worth more than $1 million.

- Nearly 70 percent say security risks have worsened in the last five years.

- Nearly 80 percent have hired a full-time information-security director/ ("Security.. Survey,")

Fewer than a third of the respondents to the Ernst & Young survey said they are satisfied with Internet security and only about a quarter of them are willing to use the Internet for business purposes.

Another study conducted by Deloitte & Touche's *Leading Trends in Information Services* found that more than half of the 431 respondents to their survey pointed to security concerns as the major barrier to initiating electronic commerce on the Internet.

A number of additional concerns about initiating electronic commerce on the Internet must be addressed before these businesses are ready to take the "electronic plunge":

- Reliability—Will the service level that the company depends upon to conduct business always be available? America Online customers, for example, experienced a 19-hour outage in August of 1996.

- Scalability—How can the Internet and individual services be scaled to meet the needs and expectations of all businesses?

- Ease of use—Can methods be developed to promote easy access and use to all potential trading partners? Will small businesses be at a disadvantage due to a lack of technical sophistication and resources?

- Payment methods—What will be an appropriate, safe, and reliable payment method for electronic commerce?

Many other concerns about the vulnerability of the Internet include the risks inherent in electronic mail transactions, the threat of computer viruses, and the existence of unprofessional employees. Companies or consumers passing information through e-mail that can be intercepted bringing risk to both parties. Businesses connected to the Internet that also store important company information in the same location are subject to tampering, and their information may be accessed and possibly damaged. Financial information such as credit card numbers may be stolen and used by unauthorized parties to make illegal purchases, resulting in damage to customers and businesses alike. These fraudulent purchases, unfortunately, are charged to the customer and prove difficult for the businesses to collect.

Businesses also have general management concerns, many of which are exacerbated by the inherent security weaknesses in the Internet.

General Management Concerns

- *Loss of paper audit trail*: Paper is the prime source of a certifiable audit trail. Without paper certification, the issue of the reliability of electronic certification becomes a management concern.

- *Business continuity*: As increased dependence is placed on an electronic means of conducting business, the loss of EC systems has the potential to cripple an organization.

♦ *Exposure of data to third parties*: As data is shared and organizations become connected to the outside world, the possibility of data exposure to vendors, service providers, and trading partners is significantly increased.

♦ *Potential legal liability*: The inability to complete transactions or meet deadlines, or the risk of inadvertently exposing information of trading partners poses significant legal risks.

♦ *Record retention and retrievability*: Electronic information has the same legal and statutory requirements as paper information. Organizations are responsible for the safe storage, retention and retrieval of this information.

♦ *Segregation of duties:* In an electronic environment, the potential for a significant volume of fraudulent transactions is increased; therefore, duties for those involved in EC must be appropriately segregated and reviewed (Marcella & Chan, 1993)

In spite of the varied concerns, corporations understand that the Internet is clearly the most promising infrastructure for "anywhere, anytime" electronic communication between businesses, customers, and suppliers; and progress is being made as companies further realize and respond to these concerns. Several tools are now available to protect information and systems against compromise, intrusion, or misuse:

1.   **Firewalls** are systems that control the flow of traffic between the Internet and the firm's internal LANs and systems. They are usually packaged as turnkey hardware/software packages, and are set up to enforce the specific security policies that are desired. A firewall is a proven, effective means of protecting the firm's internal resources from unwanted intrusion.

2.   **Encryption** allows information to transit the Internet while being protected from interception by eavesdroppers. There are two basic approaches to encryption:

(i)   Hardware encryption devices are available at a reasonable cost, and can support high-speed traffic. If the Internet is being used to exchange information among branch offices or development collaborators, for instance, use of such devices can ensure that all traffic between these offices is secure.

(ii)   Software encryption is typically employed in conjunction with specific applications. Certain electronic mail packages, for example, provide encryption and decryption for message security.

The free flow of encryption technology is being stifled due to legal constraints that disallow the export of technology that may impact the national interest of a country. The resolution of these export restriction issues will have a major impact on the growth of electronic commerce from an international perspective.

3.   **Message authentication** makes sure that a message is really from whom it purports to be and that it has not been tampered with. Regardless of a company's individual needs,

clearly defined Internet security policies and procedures should always be part of any corporate Internet security strategy.

4. **Site Blocking** is a software-based approach that prohibits access to certain Web sites that are deemed inappropriate by management. For example, sites that contain explicit objectionable material can be blocked to prevent employee's from accessing these sites from company Internet servers. In addition to blocking sites, companies can also log activities and determine the amount of time spent on the Internet and identify the sites visited.

4.13.1 Legal issues : Electronic transactions are often used by businesses to issue instructions to and make commitments with external organizations, and many of these transactions are used to form legally binding contracts. For example, a contract is entered into when a buyer electronically issues a purchase order for goods at a set price and a seller electronically acknowledges the order. In legal terms, the electronic order is an "offer," and the electronic acknowledgment is an "acceptance," constituting a contract.

In his book *The Internet and Business: A Lawyer's Guide to the Emerging Legal Issues*, Benjamin Wright states that electronic contracts raise some important legal issues:

♦   Are electronic transactions enforceable in court?

♦   What terms and conditions are included within those transactions?

♦   Can they be proven in court?

♦   To what extent is a VAN liable if it loses an acceptance message and thereby prevents a contract from being formed?

E-commerce throws up several new challenges. The most important issue that is thrown up by such commerce is that of taxation. For taxation purposes, the first question that has to be addressed is where did the sale take place? Since there is no physical form of the place of business in case of E-commerce, it becomes difficult to determine the country/state/city from where the sale was concluded. Accordingly, jurisdictional disputes arise about the taxation of the same especially with respect to indirect taxes. Even the most advanced nations such as U.S.A, Japan, France and U.K. have not yet been able to satisfactorily solve this problem.

Similarly, another problem that arises is about the transaction escaping the tax net all together. Since there is no paper work involved and all the interaction between the buyer and the seller is done electronically, there is a possibility of the transaction being kept out of the books of account of either or both sides to the transaction. As auditors, Chartered Accountants would have to deal with this problem increasingly as E-commerce takes firm roots in India.

Another problem area of E-commerce is regarding fraud detection. E-commerce comes to us along with the in-built dangers of electronic crimes and frauds. Detection and Prevention of such frauds would be an area of great concern.

As electronic commerce grows and matures, the legal landscape of EC will change at a dynamic pace, presenting a myriad of new legal issues to be discussed and litigated. Organizations must be prepared to protect themselves from potential legal liabilities and ensure that their legal rights are protected.

Internet usage can be as secure as a company requires. It is important to put in place the appropriate tools and procedures to protect information assets. It is also important, however, not to overreact and incur unnecessary costs and difficulties. For individual Internet connections used for normal business purposes, security is often not a problem. The same is usually true of Web servers which are distinct from internal networks, and which are intended for public access. Nevertheless, for corporations with security concerns, effective security measures are available, and new methods are continually being developed to address these concerns.

Since EC and the Internet will be intertwined, it is imperative that organizations take a proactive role in monitoring electronic transactions and protecting assets. As with any major initiative or new technology, corporations must perform a risk assessment and analysis to determine the appropriate direction for the short and long-term viability of the organization. Auditors and security professionals will play a vital role in ensuring that the appropriate preliminary assessments are conducted, ultimately guaranteeing the safety and security of electronic transactions on the Internet.

4.14 MOBILE COMMERCE, or m-Commerce, is about the explosion of applications and services that are becoming accessible from Internet-enabled mobile devices. It involves new technologies, services and business models. It is quite different from traditional e-Commerce. Mobile phones or PDAs impose very different constraints than desktop computers. But they also open the door to a slew of new applications and services.

M-commerce (mobile commerce) is the buying and selling of goods and services through wireless handheld devices such as cellular telephone and personal digital assistants (PDAs) Known as next-generation e-commerce, m-commerce enables users to access the Internet without needing to find a place to plug in. The emerging technology behind m-commerce, which is based on the Wireless Application Protocol (WAP), has made strides in countries, where mobile devices equipped with Web-ready micro-browsers are much more common .

In order to exploit the m-commerce market potential, handset manufacturers such as Nokia, Ericsson, Motorola, and Qualcomm are working with carriers such as AT&T Wireless and Sprint to develop WAP-enabled smart phones, and ways to reach them. Using <u>Bluetooth</u> technology, smart phones offer fax, e-mail, and phone capabilities all in one, paving the way for m-commerce to be accepted by an increasingly mobile workforce.

As content delivery over wireless devices becomes faster, more secure, and scalable, there is wide speculation that m-commerce will surpass wireline e-commerce as the method of choice for digital commerce transactions. The industries affected by m-commerce include:

- Financial services, which includes mobile banking (when customers use their handheld devices to access their accounts and pay their bills) as well as brokerage services, in which stock quotes can be displayed and trading conducted from the same handheld device

- Telecommunications, in which service changes, bill payment and account reviews can all be conducted from the same handheld device

- Service/retail, as consumers are given the ability to place and pay for orders on-the-fly

- Information services, which include the delivery of financial news, sports figures and traffic updates to a single mobile device

IBM and other companies are experimenting with speech recognition software as a way to ensure security for m-commerce transactions

4.15 BLUETOOTH

Bluetooth is a telecommunications industry specification that describes how mobile phones, computers, and personal digital assistants (PDAs) can be easily interconnected using a short-range wireless connection. Using this technology, users of cellular phones, pagers, and personal digital assistants can buy a three-in-one phone that can double as a portable phone at home or in the office, get quickly synchronized with information in a desktop or notebook computer, initiate the sending or receiving of a fax, initiate a print-out, and, in general, have all mobile and fixed computer devices be totally coordinated.

Bluetooth requires that a low-cost transceiver chip be included in each device. The tranceiver transmits and receives in a previously unused frequency band of 2.45 GHz that is available globally (with some variation of bandwidth in different countries) In addition to data, up to three voice channels are available. Each device has a unique 48-bit address from the IEEE 802 standard. Connections can be point-to-point or multipoint. The maximum range is 10 meters. Data can be exchanged at a rate of 1 megabit per second (up to 2 Mbps in the second generation of the technology) A frequency hop scheme allows devices to communicate even in areas with a great deal of electromagnetic interference. Built-in encryption and verification is provided.

The technology got its unusual name in honor of Harald Bluetooth, king of Denmark in the mid-tenth century.

4.16 WIFI- WIRELESS FIDELITY

Wifi (also **WiFi**, **Wi-fi** or **wifi**) is a brand originally licensed by the Wi-Fi Alliance to describe the underlying technology of wireless local area networks (WLAN) based on the IEEE 802.11 specifications. Wi-Fi stands for *Wireless Fidelity*.

Wi-Fi was intended to be used for mobile computing devices, such as laptops, in LANs, but is now often used for increasingly more applications, including Internet and VoIP phone access, gaming, and basic connectivity of consumer electronics such as televisions and DVD players. There are even more standards in development that will allow Wi-Fi to be used by cars in highways in support of an Intelligent Transportation System to increase safety, gather statistics, and enable mobile commerce IEEE 802.11p.

A person with a Wi-Fi device, such as a computer, telephone, or personal digital assistant (PDA) can connect to the Internet when in proximity of an access point. The region covered by one or several access points is called a hotspot. Hotspots can range from a single room to many square miles of overlapping hotspots. Wi-Fi can also be used to create a Wireless mesh network. Both architectures are used in Wireless community network, municipal wireless networks, and metro-scale networks.

Wi-Fi also allows connectivity in peer-to-peer mode, which enables devices to connect directly with each other. This connectivity mode is useful in consumer electronics and gaming applications.

When the technology was first commercialized there were many problems because consumers could not be sure that products from different vendors would work together. The Wi-Fi Alliance began as a community to solve this issue so as to address the needs of the end user and allow the technology to mature. The Alliance created another brand "Wi-Fi CERTIFIED" to denote products are interoperable with other products displaying the "Wi-Fi CERTIFIED" brand.

4.16.1   WI-FI Certification

Wireless technology gives you complete freedom to be connected anywhere if your computer is configured with a WI-FI CERTIFIED device. WI-FI certification means that you will be able to connect anywhere there are other compatible WI-FI CERTIFIED products. The WI-FI CERTIFIED logo means it's a "safe" buy. The color-coded Standard Indicator Icons (SII) on product packaging is the only assurance that a product has met rigorous interoperability testing requirements to ensure that compatible products from different vendors will work together.

Large corporations and campuses use enterprise-level technology and WI-FI CERTIFIED wireless products to extend standard wired Ethernet networks to public areas like meeting rooms, training classrooms and large auditoriums. Many corporations also provide wireless

networks to their off-site and telecommuting workers to use at home or in remote offices. Large companies and campuses often use WI-FI to connect buildings.

WI-FI networks are also found in busy public places like coffee shops, hotels, airport lounges and other locations where large crowds gather. This may be the fastest-growing segment of WI-FI service, as more and more travelers and mobile professionals clamor for fast and secure Internet access wherever they are. Soon, WI-FI networks will be found in urban areas providing coverage throughout the central city, or even highways, enabling travelers access anywhere they can pull over and stop.

SELF-EXAMINATION QUESTIONS

1. What is Internet ? Briefly describe its business uses ?

2. What is a world wide web ? What do you understand by the term "surfing" ?

3. What benefits are offered by the Internet ?

4. Describe, in brief, Electronic mail. What features are offered by an e-mail software ?

5. "E-commerce is not a single technology but a sophisticated combination of technologies." Do you agree ?

6. State the benefits offered by E-commerce applications.

7   (a) Describe three general classes of E-commerce.

    (b) Discuss the following in detail

        (i)   CRM

        (ii) Supply chain management

8. What is Electronic Data Interchange? State some of its advantages.

9   How simple could money be handled over the Internet?

10 How is payment different from transaction?

11 What is the procedure of issuing digital cash?

12 Is it possible to mask the identity of the transacting party in an e-com transaction/payment?

13 How are smart cards different from credit cards?

14. Write short notes on following—

    (i)   Intranet   (ii)   Extranet

    (iii) Mobile commerce   (iv)   Bluetooth

    (v)   Wi-Fi technology   (vi)   Electronic fund transfer

CHAPTER 5

INTRODUCTION TO FLOWCHARTING

The digital computer does not do any thinking and cannot make unplanned decisions. Every step of the problem has to be taken care of by the program. A problem which can be solved by a digital computer need not be described by an exact mathematical equation, but it does need a certain set of rules that the computer can follow. If a problem needs intuition, guessing or is so badly defined that it is hard to put it into words, the computer cannot solve it.

5.1 PROGRAMMING PROCESS

The set of detailed instructions which outline the data processing activities to be performed by a computer is called a program : Computer programming is a process which results in the development of a computer program. Computer programming is not a simple job. It requires lot of planning and thinking. Thus, computer-programming process may be sub-divided into six separate phases.

(*i*)   *Program analysis* - In this stage, the programmer ascertains for a particular application (e.g., up-dating of the stock file) the outputs required (*i.e.,* the up-dated stock file, listing of the replenishment orders, stock movements report, stock valuation report etc.), the inputs available (*i.e.,* the stock master file, the receipts and issues transaction file) and the processing *i.e.,* up-dating the physical balance, computing stock value for various items, determination of placement of the replenishment order etc.). The programmer then determines whether the proposed application can be or should be programmed at all. It is not unlikely that the proposal is shelved for modifications on technical grounds.

(*ii*) *Program design* - In this stage, the programmer develops the general organisation of the program as it relates to the main functions to be performed. Out of several other tools available to him input, output and file layouts and flowcharts are quite useful at this stage. These layouts, and flowcharts etc. are provided to the programmer by the system analyst. The flowchart depicts the flow of data, documents etc. very clearly, what are the steps to be repeated or what are the alternatives or branches at particular step are shown conspicuously. Such details may be difficult to bring out in descriptive language.

(*iii*) *Program Coding* - The logic of the program outlined in the flowchart is converted into program statements or instructions at this stage. For each language, there are specific rules concerning format and syntax. Syntax means vocabulary, punctuation and grammatical rules available in the language manuals which the programmer has to follow

strictly and pedantically. There are special sheets for writing the program instructions in each language. The sheets format of these sheets facilitate writing error free programs. Just as a mathematical problem can be solved in several ways, so is the case with writing a program. Different programmers may write a program using different sets of instructions but each giving the same results. In fact, there is a great scope for elegance in writing the programs but the limitations of time stipulated by management would not encourage the programmers to strive for such elegance. In practice, therefore, the programmers broadly pursue three objectives : simplicity, efficient utilisation of storage and least processing time. It is highly desirable that the programs are simple to understand since a program written by one programmer is very difficult for the other to understand. Since, the programs, upon implementation, may require frequent modifications to suit the changing systems environment, there is a program maintenance group employed on a permanent basis for modifying the programs and this group is different from the ones who wrote the programs initially. It is, therefore, emphasised that programs should be written as simple as possible to start with. There is usually a trade off possible between the other two objectives : efficient utilisation of storage and least processing time.

Each coded instruction is then entered onto a magnetic media using a key-to-disketic device or a key board. This stored file then constitutes the source program *i.e.,* the program in the source language which may be a procedural language such as BASIC or C++. This program is then translated into the machine language of the computer on hand by an interpreter or a complier, both of which have diagnostic capabilities *i.e.,* they can point out several syntax errors like two labels used for the same location and invalid standard label, etc. The programmer, upon getting the print out of the assembly or compiler run, rectifies his program.

(*iv*) *Program debugging* - The assembly compilation run can detect only few syntax errors. Considering that a program of average size would include thousands of instructions, there is an ample scope for the programmers to make errors technically known as bugs. It is asserted that nobody can string together about 200 or more error free instructions. Therefore, before putting the program into use there is a real necessity to debug it *i.e.,* to cleanse it of errors, Towards this purpose, the programmers devise a set of test data transactions to test the various alternative branches in the program. Since the branches in a program tend to proliferate, a large number of transactions would have to be devised for a thorough test. The results of these tests on the master file are derived in long hand also as per the logic of the program. Then, the file is up-dated by the transactions via the computer with the program to be debugged stored in it. The results got from the computer are compared with the ones derived manually prior to computer processing. If the results do not tally for the reasons mentioned above, the

programmer then sits away from the computer and verifies his flowcharts and coding sheets in a hunt for the bugs.

Since, debugging can be a tedious process, computer manufacturers frequently provide facility for memory dump *i.e.,* print out of the data contents and instructions of the various CPU locations. Having had a first round of debugging, a programmer would rectify his coding sheet and correct the instructions in source program and go in for another assembly or compilation run. It is, however, to be noted that the identical results obtained manually and by computer processing do not guarantee that there are no bugs in the program since the program may not provide correct results on different set of transactions. Towards explanation of this consider the past sales history of an item as 60, 62, 64, 66, 68, 78. The exponesstial smoothing model may be used here for sales forecasting and the forecasts derived manually in long hand according to appropriate formulas.

The exponential smoothing forecasting program may then be used to derive the forecasts via the computer. Identical results here would be no guarantee that the program would yield correct results in another sales history of say, 232, 230, 228, 229 etc. This example, should bring out the fact that program debugging can indeed be a formidable task. In a survey conducted by the IBM, It is estimated that program of some scope (trivial programs excluded) may require as many as 20 rounds of debugging before it is thoroughly cleansed of bugs.

(*v*) *Program documentation* - Each program should be documented to diagnose any subsequent program errors, modifying or reconstructing a lost program. Program documentation including the following may be assembled.

   (*a*) The program specifications *i.e.,* what the program is supposed to do.

   (*b*) The program descriptions *i.e.,* input, output and file layout plans, flowcharts etc.

   (*c*) The test data employed in debugging the program. This could be highly useful later to the auditors.

   (*d*) The operation manual which details the operating instructions for the computer operator, viz., insert the data floppy when program has been read into the memory, or load the paper on the printer etc.

   (*e*) The maintenance documentation that is listings of any subsequent amendments to the program.

(*vi*) *Program maintenance* - The requirements of business data processing applications are subject to continual change. This calls for modification of the various programs. There are usually a separate category of programmers called maintenance programmers who are entrusted with this task. There is a difficult task of understanding and then revising

the programs they did not write. This should bring out the necessity of writing programs in the first place that are simple to understand.

5.2 PROGRAM ANALYSIS

Program analysis is an important step in computer programming in which the computer programmer seeks the answer to the question "What is the program supposed to do?" Thus, first of all the programmer has to define the problem.

A good deal of thought must be put into defining the problem and setting it for the computer in such a way that every possible alternative is taken care of. Thus, the steps that comprise a computational procedure must be delineated before the procedure can be programmed for the computer and the computer procedure must be sufficiently detailed at each stage of a computation to permit the required calculations to be performed. Also, computer procedures are designed to solve a whole class of similar problems. The procedure for adding two signed (*i.e.,* positive or negative) numbers a and b serves as an example :

1. If a and b have the same sign, go to step 5.

    (If a and b have different signs, continue with step 2)

2. Subtract the smaller magnitude from the larger magnitude.

    (continue with step 3)

3. Give the result the sign of the number with the larger magnitude. (continue with step 4)

4. Stop

5. Add the magnitudes of the numbers a & b

    (continue with steps 6)

6. Give the result the sign of number a.

7. Stop.

The procedure, in this case, is fairly detailed and would work for any two numbers a and b. For example, (-5) + (-4) = -9, 16 + (-11) = 5, 10 + 20 = 30, and so forth.

Algorithm

A specific procedure of this type that exists as a finite list of instructions specifying a sequence of Operations and that give the answer to any problem of a given type is called an *algorithm.* Computer programs are based on the concept of an algorithm.

Example - Consider an algorithm used to generate a sequence of numbers as Fibonacci numbers.

   1, 1, 2, 3, 5, 8, 13, 21, 34 ....

If Fi denotes the ith Fibonacci number, Then $F_1 = F_2 = 1$ AND $F_i = F_{i-1} + F_{i-2}$; for all i greater than 2.

An algorithm for computing Fibonacci numbers that are less than 100 is given as follows :

1.   Set N1 to 0. (This is not a Fibonacci number, and is used only to start the procedure).

2.   Set N2 to 1 (This is first Fibonacci no.).

3.   Write down N2.

4.   Set N3 equal to N1 + N2.

5.   If N3 is greater than 100, then stop the calculations.

6.   Write down N3.

7.   Replace N1 by N2.

8.   Replace N2 by N3.

9.   Continue the calculations with step 4.

An algorithm exists for each computational problem that has a general solution. The solution may exist as a set of mathematical equations that must be evaluated or a set of procedural steps that satisfy a pre-established procedure such as the well-known procedure for calculating income tax liability.

Example - Consider the Euclidean algorithm stated as follows :-

Given two positive integers A and B, find their common divisor.

The algorithm involves the construction of descending sequence of numbers.

The first is the larger of the two numbers, the second is the smaller, the third is the remainder from dividing the first by the second, the fourth is the remainder from dividing the second by the third; and so forth. The process ends when there is zero remainder. The greatest common divisor is the last divisor in the sequence. For example, the descending sequence of numbers for greatest common divisor of 44 and 28 is

            44   28   16   12   4   0.

The lst divisor is 4, which is the result. The algorithm can be summarized in the following list of instructions :

1.   Write down A and B.

2.   If B is greater than A, exchange them.

3.   Divide A by B giving the remainder.

4.   If R is equal to zero, stop; B is the G. C.D.

5.   Replace A by B; (that is, B → A).

6.   Replace B by R; (that is, R → B).

7.   Go to step 3.

From the above discussion, several characteristics of an *algorithm* can be given :

1.   It consists of a finite no. of instructions, however, some instructions may be executed more than once and other may not be executed at all depending on the input data.

2.   The instructions are precise.

3.   The instructions are unambiguous.

4.   The no. of operations that are actually performed in solving a particular problem is not known beforehand; it depends on the input and is discovered only during the course of computations.

5.3 FLOWCHARTS

For many applications, a simple list of the steps that comprise an algorithm is sufficient for stating the problem in a clear and unambiguous manner, However, when procedure is complex and different options exist, then a list of instructions is hard to follow. For describing a complex process, a flow diagram (or flowchart) is prepared. A flowchart is a diagram, prepared by the programmer, of the sequence of steps, involved in solving a problem. It is like a blueprint, in that it shows the general plan, architecture, and essential details of the proposed structure. It is an essential tool for programming and it illustrates the strategy and thread of logic followed in the program. It allows the programmer to compare different approaches and alternatives on paper and often shows interrelationships that are not immediately apparent. A flowchart helps the programmer avoid fuzzy thinking and accidental omissions of intermediate steps.

Flowcharts can be divided into 4 categories as below and as such they may be likened to the geographical map with regard to the extend of detail :

1.   System outlines charts (Global map)

2.   System flowcharts (National map)

3.   Run flowcharts (State map)

4.   Program flowcharts (District Map)

1. System outline charts -These charts merely lists the inputs, files processed and outputs without regard to any sequence whatever. An example of this chart of sales order Processing is given below :

System Outline Charts

Title		Document	Sheet
Sale Order Processing (SOP)	*System S*	*3.1*	*1*
Inputs		Processes	
Customer Order Details		Order entry (clerical)	
		Order acknowledgement (computer)	
		Despatch (clerical)	
		Despatch update (computer)	
		→	
Files	→		
		Outputs	
Product Catalogue			
Customer Index Cards	←		
Doubtful Cost List		Error reports	
Delivery Cost List		Balance Order Set	
Factory Stock List		Advice Notes Set	
Customer N/A Card		Invoice Details Tape	
Product Card file			
Outstanding Order File			
Product Order Book			
Order Ledger			
Notes, Cross references			
Issue :			
Date :			

Figure 5.1

2. System flowchart - It is designed to present an overview of the data flow through all parts of a data processing system. It represents the flow of documents, the operations or activities performed and the persons or work-stations. It also reflects the relationship between inputs,

processing and outputs. In manual system, a system flowchart may comprise of several flowcharts prepared separately, such as document flowchart, activity flowchart etc. In a computer system, the system flowchart consists of mainly the following :

(i)   the sources from which input data is prepared and the medium or device used.

(ii)   the processing steps or sequence of operations involved.

(iii) the intermediary and final output prepared and the medium and devices used for their storage.
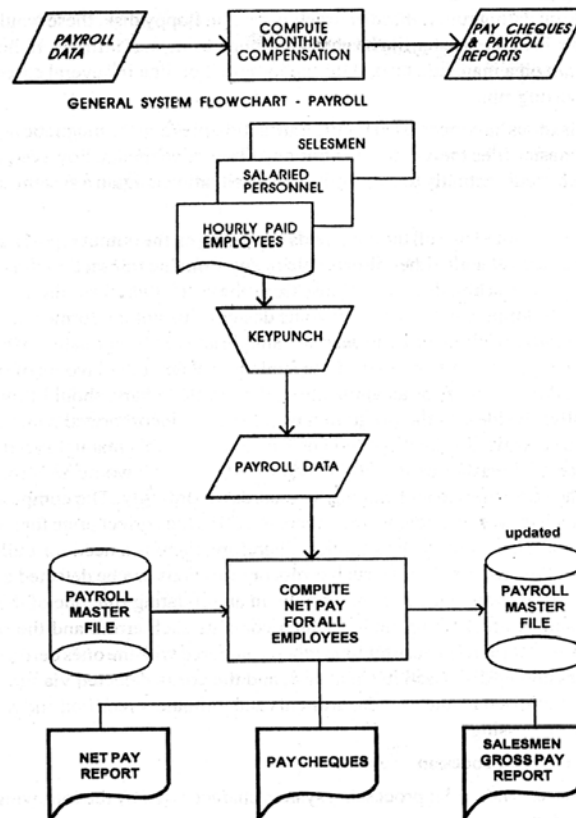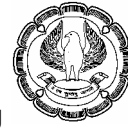
An example of a system flowchart is given below :

Fig. 5.2 System Flowchart-Payroll

3. Run Flowcharts - These are prepared from the system flowcharts and show the reference

of computer operations to be performed. The chart expands the detail of each compute box on the system flow chart showing input files and outputs relevant to each run and the frequency of each run.

The sales order processing application has been discussed in figure 5.3 by means of a run flowchart.

The transactions in these applications are keyed on floppy disk and processed periodically against the master files to produce the desired reports, summaries projections etc. in a computer step (also known as the computer run). The Transactions may have to be sorted before the file up dating run. If these transactions are on floppy disk, these would be sorted by the key in which the master file has been arranged using sort utilities. If, however, the transactions are on a magnetic tape, they can be sorted on line in several cases in what is known as a sorting run.

The floppy diskettes have been used for the transaction files and the magnetic tape has been used for the master files merely for illustration, Alternative media, however, can be employed. Which media actually to employ in a given situation is again a system analysis and design matter.

It is to be carefully noted that all the data fields appearing on the output reports, summaries, projections etc. are after all either directly picked up from the transactions/master files or derived, after some arithmetic operations, from these. If, therefore, the layouts of the outputs are well-defined and the input layouts designed to suit the former, writing of the program for a particular updating run becomes simple and can be entrusted to the programmers. Incidentally, we can also assert if the student is clear about layouts of outputs and of transactions/master files for an application, the run flowcharts should flow out of his hands naturally. Besides, in the program have also to be incorporated some checks and controls to serve as what we call, judgment. For Example, in a manual system if a clerk finds the price of a washer as Rs. 50 instead of 50 Paise, he would be suspicious, run around, get the correct price and amend the records accordingly. The computer does not possess any such judgment and it would accept Rs. 50 as the correct price for a washer and even pass the invoices sent by the supplier. Therefore, there is a need for built in checks and controls in the program so that, such errors or omissions can be detected and brought to the notice of the computer users. Invariably, in an up-dating run, one of the outputs is an error list and summary information which contains such errors and the batch totals computed by the computer. These totals are then compared with the ones derived manually prior to processing and the errors detected via the checks and controls are scrutinised by the user departments and ultimately rectified and re-submitted for computer processing.

5.3.1 Sales Order Processing system

A computer-based sales order processing system characterised by the following possibilities

of integration :

1. Sales accounting and sales analysis are integrated with accounts receivable operation and records.

2. Credit functions can be integrated as far as possible into the overall flow of automated processing.

3. The sales application is closely related to inventory control processing.

Input preparation

The sales department prepares the sales order in duplicate upon receipt of the customers purchase order or telephonic information from a salesmen or the customer after satisfying themselves that the customer's account is not delinquent. One of the outputs of a computer run to be discussed subsequently is the list of delinquent accounts which the sales department consults to establish credit worthiness of the customer. One of the copies of the sales order is sent to the customer as an acknowledgement of the receipt of his purchase order. The other copy is sent to the shipping department as an authorisation to ship the goods to the customer. The format of the sales order should be so designed that it facilitates error-free and quick entry of data from the customer's purchase order as also transcription of data from it on to floppy diskette subsequently. The sales department enters the quantity shipped and quantity back ordered against each line on the order, *i.e.,* for each stock item on order, the price having already been entered by the sales department. The Shipping department assembles the sales order in daily batches and compiles the following batch totals for it on an adding machine, perhaps : record count, financial total of the values of items shipped and hash totals of quantities shipped, quantities back ordered, customer's account numbers and stock item numbers. The batch of the sales orders together with the control slip bearing these batch totals is then forwarded to the data processing department for transcription on the floppy disk.

Likewise, the mailroom assembles the daily batch of remittance advises received from the customers and compiles the following batch totals for it : record count, financial total of the amounts remitted and the hash total of the customer account numbers. The batch together with the control slip bearing these totals is forwarded to the data preparation section.

We are dealing with only two types of transactions for this application for simplification of illustration though in practice there would also be the following inputs :

(i) Addition of new records to the file

(ii) Credits for sales returns and allowance

(iii) Account right-offs

(iv) Changes of addresses and other routine adjustment and corrections.
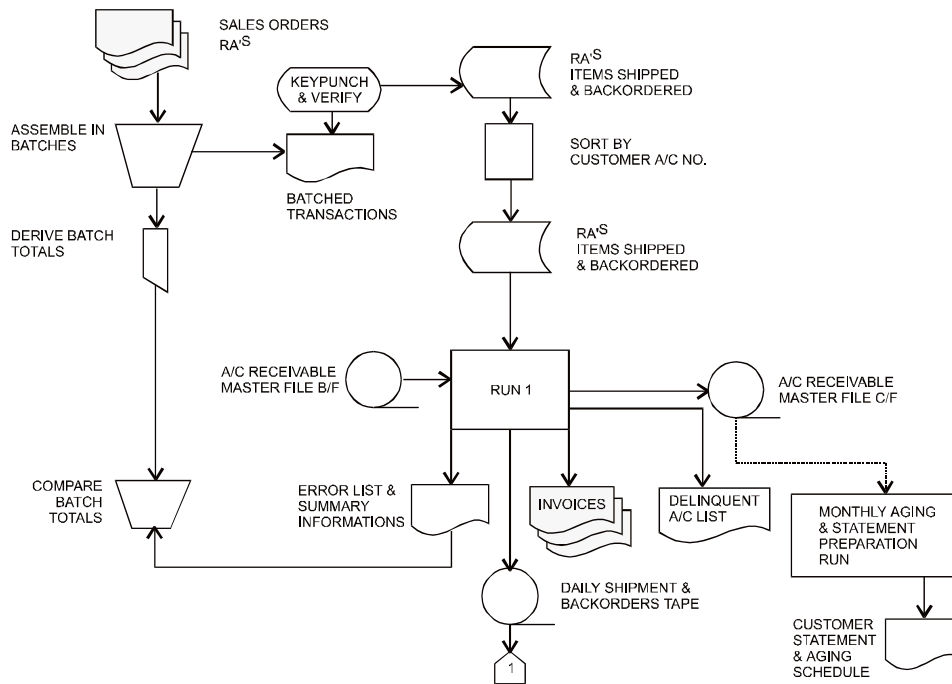
Fig. 5.3

The data preparation section of the data processing department records data on floppy disc for each item back-ordered each time shipped and each remittance advice on the data entry machine. This floppy disc is then given to the verifier operator who verifies the records by re-entering the transaction data via the verifier keyboard. For economies in verification time it may, however, be desired that just the critical data files on the records are verified.

These verified records are then sorted using SORT utility with the customer account number as the key.

The sorted file constitutes the transaction file which is used to update the accounts receivable master file by the account receivables update program in computer run. In this run, customer accounts are updated for the sales. Typically, the accounts receivable master file contains the following fields :

(i)   Customer account number (control field).
(ii) Customer name and address.
(iii) Credit rating.
(iv) Credit limit
(v)   Balance due as of last monthly statement.

Following are the particulars of each transactions :
(i)   Transaction type code.
(ii)   Documents number.
(iii) Data.
(iv)   Amount.
(v)   Current balance.

Incorporated in the programme are also the various control checks which check the accuracy of the contents of the various data fields. The outputs of this run are as follows:

(i)   The updated A/c receivable master file.

(ii)   Delinquent accounts list which contains the particulars of those customers who have crossed either the credit limit or the credit rating assigned to them.

(iii) Invoices in as many copies as desired. It has to be noted that invoice would be prepared for only the Items shipped. A specimen of the invoice is given below :

XYZ Manufacturing Company						
15, High Street, Sometown Tax .... Tel .... Invoice No						
INVOICE						
Customer Order No. Date Salesman Code Cost Acct No.						
....						
Sold to ABC Mfg. Co 13. Nehru Road Allahabad			Ship to name			
Shipper Date Shipped Invoice Date Terms of Sale						
....						
Item *Code*	*Description*	*Qty ordered*	Qty *Back- Ordered*	*Qty shipped*	*Unit Price*	*Total Price*

(*iv*) *Daily Shipment and back-orders tape* - The data stored on floppy disc is put on to magnetic tape for a subsequent speedier resorting by stock item number as well as speedier processing against inventory file.

(*v*) *Error list and summary information* - This contains the rejects *i.e.,* those transactions which could not pass the control checks. These are ultimately investigated by the user department, rectified and re-submitted to the data processing department for re-processing. The summary information consists of all the batch totals derived by the computer. These batch totals are compared with the ones derived manually prior to processing and entered into control slips travelling with the batches of the transactions.

The accounts receivable file is also processed every month to produce the customer statements and aging schedules a specimen of which is shown below.

	Statement			
	XYZ Manufacturing Company			
	15, High Street			
	Sometown			
To				
	ABC Limited	Date		Account No
	13, Nehru Road			
	Allahabad			
	Invoice			
Date	Number	Charges	Credits	
				Previous Balance
				....
				Current Account
				....
				Total Amount
	Past Due Amounts			
	Over 30 days..........			
	Over 60 days........			
	Over 90 days........			

5.4 PROGRAM FLOWCHARTS

The program flowcharts are the most detailed and are concerned with the logical/arithmetic operations on data within the CPU and the flow of data between the CPU on the one hand and the input/ouput peripherals on the other. Prior to taking up an actual program flowcharts, we first discuss below a flowchart (figure 5.4) of the morning routine of an office employee to bring out concepts and the use of the following flowcharting symbols involved.
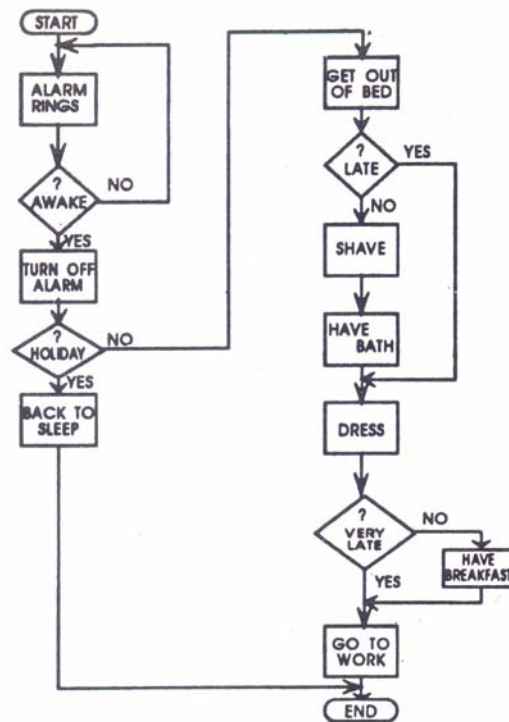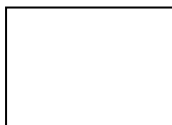

Fig. 5.4

Box   Diamond

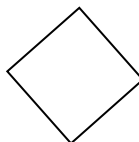Fig. 5.5   Fig. 5.6   Fig. 5.7
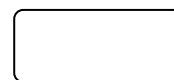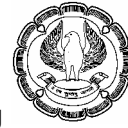
The box in Figure 5.5 is an action symbol. Such actions as "dress" etc. would be written within the box. In the context of program flowcharting, such actions would, for example, consist of the various arithmetic operations.

The diamond shown in figure 5.6 is the symbol for posing a question and it leads to two branches with yes and no as answers to the question. In program flowcharting, however, this is a comparison or conditional symbol. For example, if in an inventory control application, reorder level has reached, the program instructions for placement of the replenishment order would be executed. If it has not reached, a different path would be taken. This path may involve alternative set of instructions. Suppose that reorder level is placed in location number 536 and the stock level is placed in location number 637, the necessary comparison may be symbolised in either of the ways given in Fig. 5.8.

Figure 5.7 is the symbol for start and end of a routine.

In fig. 5. 4, the loop starting from the diamond symbol for "awakes" and enclosing the box for "alarm rings" should be of interest in view of its importance in program flowcharting. It portrays the recurrence of the alarm until the person is awake. Later, in a program flowchart, we shall encounter a loop for computing 2^7.

Some other points of relevance to program flowcharting are well brought out by this flowchart. Obviously, different people have different approaches to the routine. Likewise, a problem may be flowcharted or programmed differently by different programmers. For example, consider the problem of finding the value of the expression $2^7 \times \lfloor 7$. One programmer may compute $\lfloor 7$ first and then 2^7. Another programmer may do just the reverse. Still another programmer may work in the following fashion:

$$(2 \times 7) \times (2 \times 6) \times (2 \times 5) \times (2 \times 4)\ldots\ldots$$

Whereas in personal routines one is at complete liberty, in Program flowcharting, one of the objectives is to keep the program as simple as possible. Therefore, the third approach of computing $2^7 \times \lfloor 7$ in the fashion of

$$(2 \times 7) \times (2 \times 6) \times (2 \times 5)\ldots\ldots$$

is rather clumsy and, therefore, not sound.

Another point concerns the level of detail in flowcharting. In the Box "dress" we have implied dress including combing the hair. But someone may want to use two boxes for dressing and combing. For example, the computation $2 \times 3 \times 7 = 42$ may be shown in just one box as such or in two boxes as $2 \times 3 = 6$ and $6 \times 7 = 42$. The most detailed program flowchart would have exactly one instruction for each symbol in the flowchart *i.e.,* coding would be simple and straightforward but the flowchart being biggish would defeat its purpose of showing the flow of data at a glance.
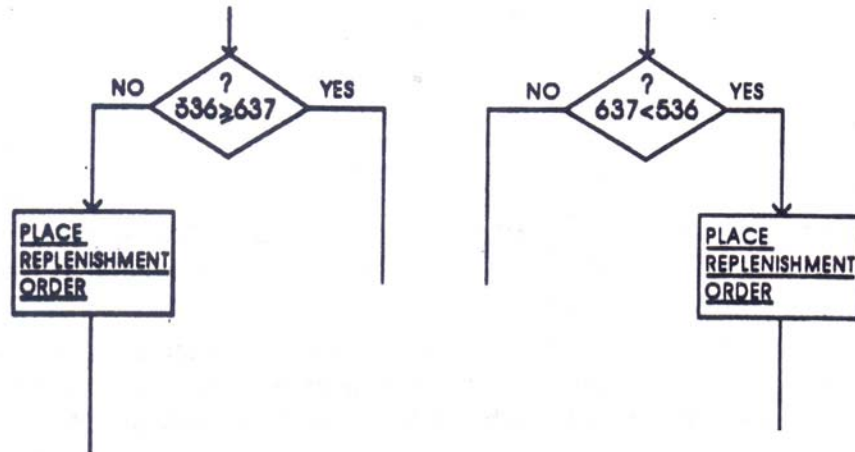
Fig. 5.8

Finally, abbreviations, annotation etc. of the various operations, comparisons etc. are desirable and, in fact, necessary to save cluttering the flowchart with long plain English expressions. For example, in figure 5.8 "637 < 536" is the abbreviation for "Are the contents of location 637 less than those of location 536"?
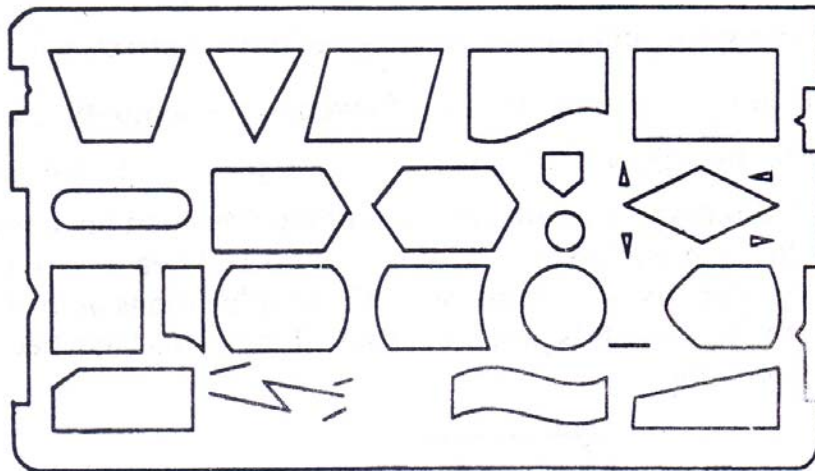
Fig. 5.9

COMPUTER FLOWCHARTING SYMBOLS
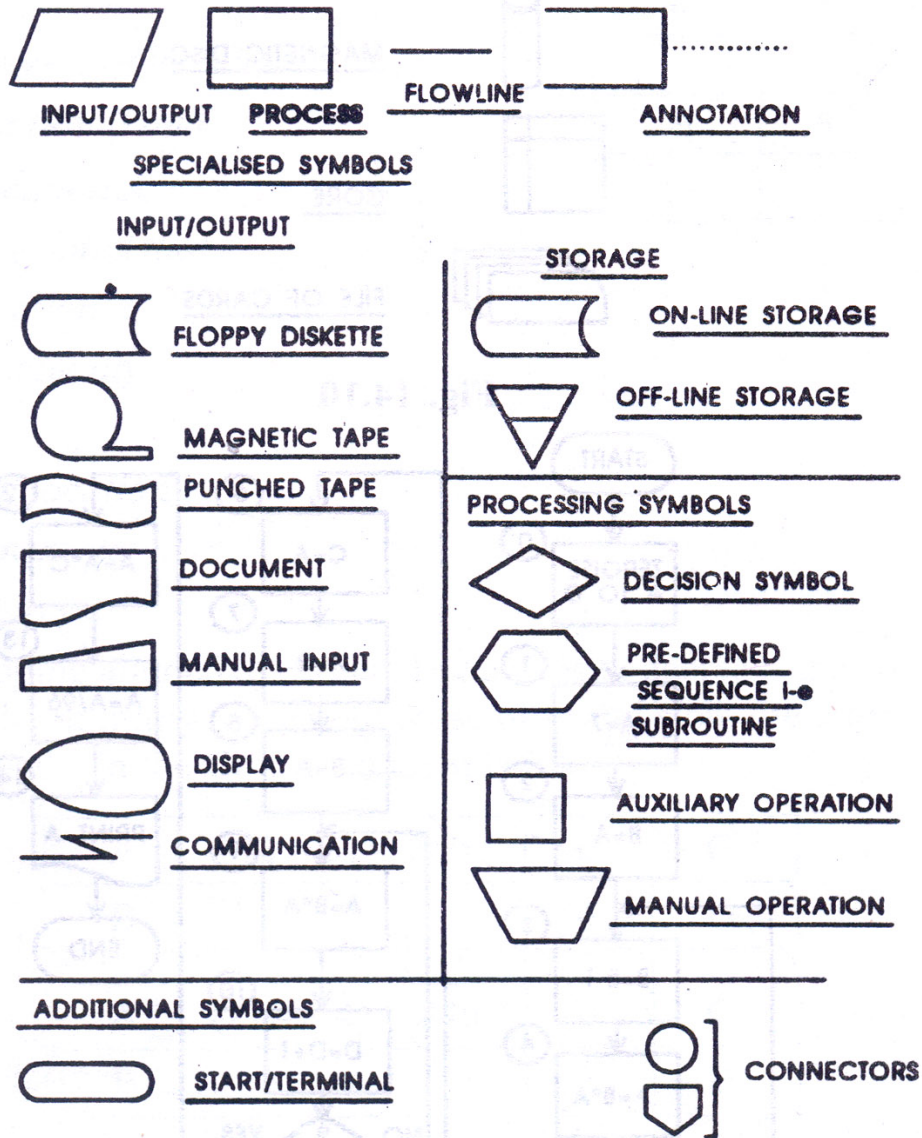
Fig. 5.10

More flowcharting symbols are explained in Fig. 5.10. There are being marketed flowcharting stencils (figure 5.9) but neither they are readily available nor really necessary for the student whom we would rather encourage to draw these symbols in free hand.

Let us now introduce a problem on program flowchart for computing and printing the result of $\dfrac{22x\lfloor 7}{96}$ The flowchart for this is shown in figure 5.11. The serial numbers in circles against the various symbols are not a part of the flowchart but are merely intended to facilitate the following explanation to the flowchart. At each serial number in this explanation, we have also given the contents of the four locations of the CPU, 001 to 004 which have been used to solve this problem. These 4 locations have been symbolised as A, B, C and D respectively.

PREPARATION

MAGNETIC DRUM

MAGNETIC DISC

CORE

FILE OF CARDS
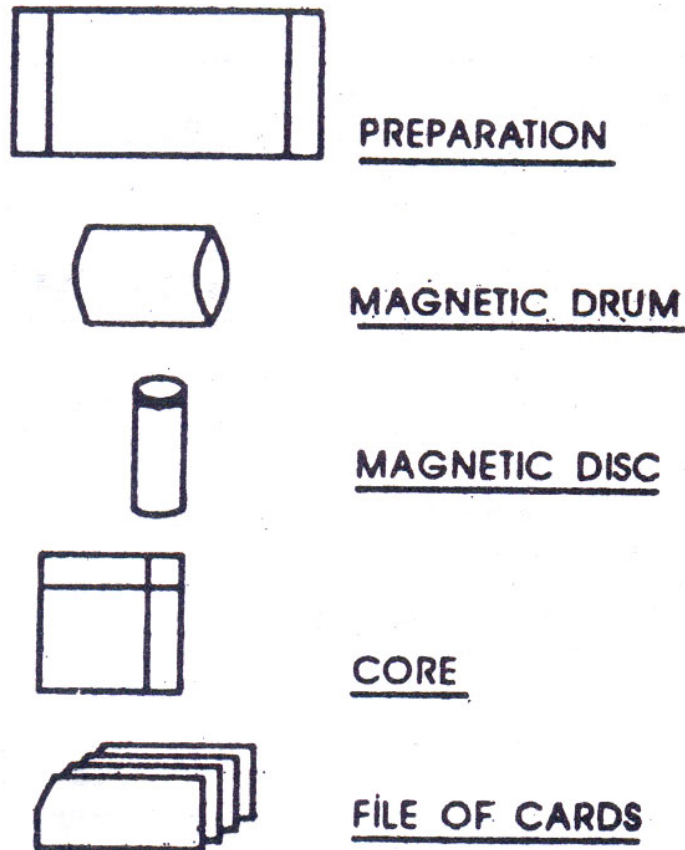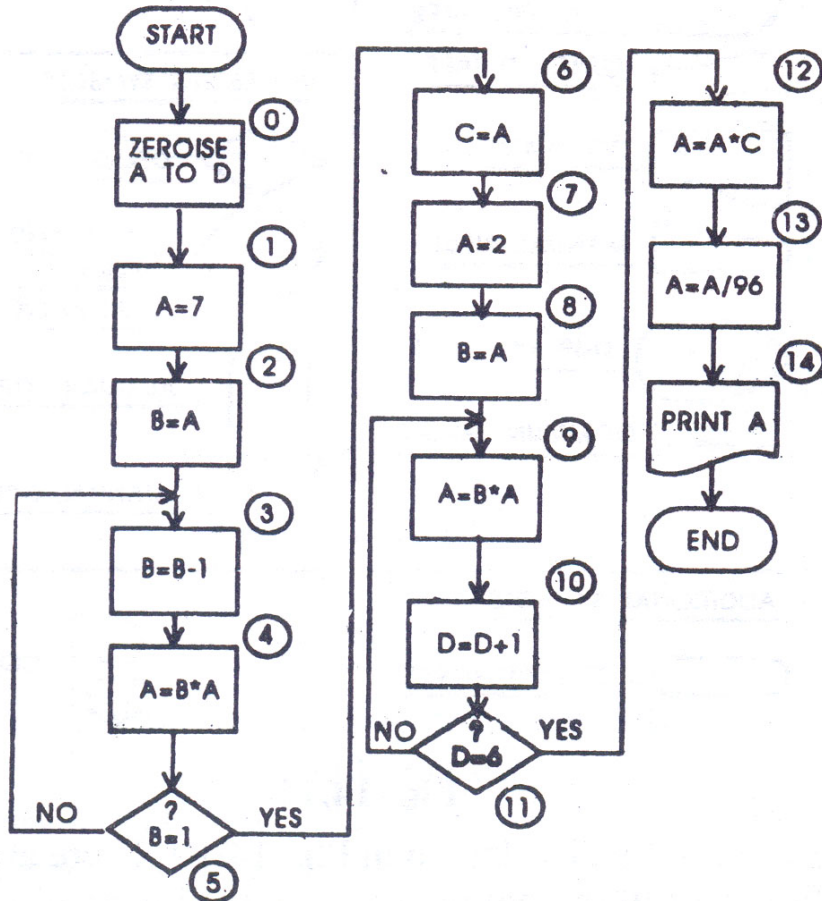
Fig. 5.10

Fig. 5.11

The = sign should be interpreted as "becomes" and not equal to, e.g. in step 3, B = B-1 means contents of location B becomes one less than its original contents.

Serial Number   *Contents of CPU*

1 *Zeroise A to D (i.e.,* clear all
working location.

A	0	0	C
B	0	0	D

2 *Put 7 in location A*

This is with the view to start
computation of ⌊7)

A	7	0	C
B	0	0	D

3. *Transfer the contents of location*

A to location B

(Transfer here implies copy)

A	7	0	C
B	7	0	D

4. *Subtract one from the contents of*

location B.

5. *Multiply the contents of location*

A with those of location B and

put the result in location A.

(It is to be carefully noted that

42 has come in location A, 7

having been automatically

erased).

A	7	0	C
B	6	0	D

A	42	0	C
B	6	0	D

6. *If the contents of location B equal 1, go to*

the next step, otherwise go back to step 3.

This amount to looping alluded to earlier. The idea is to decrease the contents of location B by 1 successively, multiply these with those of A and store the intermediate results in A. Intermediate results in the CPU are shown below).

A	(42x5) = 210	0	C
B	5	0	D

A	(210x4) = 840	0	C
B	4	0	D

A	(840x3) = 2520	0	C
B	3	0	D

A	(2520 x2) = 5040	0	C
B	2	0	D

A	(5040x1) = 5040	0	C
B	1	0	D

(Thus, at the end of step 5 we have $\lfloor 7 = 5040$ in location A).

7. *Transfer the contents of location A to location C.*

A	5040	5040	C
B	1	0	D

(It is to be noted that transfer really means copy *i.e.,* we transfer the contents of location A to location C and also they are retained, and are not erased, in location A).

8. *Put 0002 in location A*

A	2	5040	C
B	1	0	D

(This, of course, erased 5040 held earlier by location A. This has been done with the view to start the computations of 2^7).

9. *Transfer the contents of location A to location B.*

A	2	5040	C
B	2	0	D

10. *Multiply the contents of location A with those of location B and put the results in location A.*

A	4	5040	C
B	2	0	D

(Note that we have to multiply the contents of A six times to obtain the value of 2^7. We have done this once at this stage.)

11. *Add 1 to the contents of location D.*

A	4	5040	C
B	2	1	D

(This is with the view to "remember" that the aforesaid multiplication has been carried out once. This is quite similar to men doing the counting on their finger tips as to how many times the multiplication has been done. In the loop to follow at the next step we shall go on incrementing the contents of location D by 1 until it equals 6. In the technical jargon, we have "set a counter" in location D to keep track of the number of times this multiplication has been carried out).

12. *If the contents of location D equal 6, go to the next step, otherwise go back to step 9.*

(This is the loop to carry out the multiplication six times. The intermediate results are shown below.)

A	(4×2)=8	5040	C
B	2	2	D

(Multiplication 2 times)

A	(8×2) = 16	5040	C
B	2	3	D

(Multiplication 3 times)

A	(16×2) = 32	5040	C
B	2	4	D

(Multiplication 4 times)

A	(32 × 2) = 64	5040	C
B	2	5	D

(Multiplication 5 times)

A	(64 × 2) = 128	5040	C
B	2	6	D

(Multiplication 6 times)

The final result 128 is retained in location A.

13. *Multiply the contents of location A with those of location C and put the results in location A*

A	645120	5040	C
B	2	6	D

14. *Divide contents of location A with 96 and put the results back in A.*

A	6720	5040	C
B	2	6	D

15. Print the contents of location A on the continuous stationary.

Several points emerge from the discussion on flowcharting and allied matters above.

(*a*)   In the above explanation to the program flowchart, the unbracketed sentence against each serial number is instruction in plain English, *viz.,* "Put 7 in location 001″ is an instruction. The serial number gives the instruction number. There are 15 instructions, the flowchart being detailed to the maximum extent *i.e.* each symbol in it corresponds to

one instruction. These plain English instructions are quite amenable to codification in the assembly language. The student must not confuse the expressions in the various symbols in this flowchart of Fig. 5.11 as these are codified instruction in the assembly language. They are usually arbitrarily devised by the programmers.

The program flowchart is basically intended to facilitate encoding *i.e.,* writing the program instructions. And it is a function of the language in which coding is desired *i.e.,* it may differ from one language to another. Sometimes, especially when the problem is small or simple, coding can be carried out directly without flowcharting; but, it is highly desirable to first draw the flowchart.

(*b*)   The flowcharts, except for loops, should ordinarily proceed top to bottom and from left to right.

(*c*)   As mentioned earlier, different programmers may approach the same problem in different ways. During the last few centuries in the history of engineering, a design principle has emerged, "Simple engineering is the best engineering". This is as much applicable to program design *i.e.,* flowcharts and systems design.

(*d*)   Another objective of programming, aside from its simplicity, is to use the minimum possible storage space. In this example, we have used 4 CPU locations for computations, another 15 would be needed by the instructions *i.e.,* a total of 19 locations have been used. Considering that practical problems are much larger, it is highly desirable to conserve the CPU storage space.

(*e*)   The third objective of programming is to ensure that processing time is the least. In this regard, it may be pointed out that divisions, multiplications, subtractions, additions, transfers and comparisons take decreasing computer time in this order.

(*f*)   These three objectives of programming are conflicting. For example, the programmer would get several opportunities where he can save on storage space by approaching a problem in rather complex way and *vice versa i.e.* he may economise on computer time by using the storage space lavishly, etc. He has to reconcile the three conflicting objectives. If, for example, the storage space is at premium *i.e.,* the CPU is small and the program is likely to require slightly more or less space that it can make available, the programmer may sacrifice the other two objectives of simplicity and least processing time and keep the emphasis on economising on storage space.

Program flowcharting, to some extent, is a function of the language in which the program will be ultimately coded *i.e.,* it will vary to some extent from one language to another. Therefore, it also depends upon the instruction repertoire or mix of the computer on hand.

Nevertheless the variations are minor. The following hypothetical instruction mix (say, for computer X) will be utilised throughout as a basis for drawing the flowcharts.

5.4.1 Logical/Arithmetic operations

1. Addition

(*i*)   Add the contents of two locations, say A and B, and put the results in A or B either or any other location. An example follows :

C = A + B	Means add the contents of two locations A and B, and put the
or	results in location C. However, this interpretation is assembly
C = B + A	Language oriented. The compiler language orientation would be "C becomes the sum of A and B". In this interpretation by '=' is meant 'becomes' and not "equal to". Also in this interpretation C, A and B are treated as if they are variables. Most flowcharting in this chapter is compiler language oriented. However, we shall use assembly language interpretations at places though rather sparingly.
A = A + B	A assumes the sum of the previous value of A and the value of B
or A = B + A	
B = A + B	B assumes the sum of the value of A and the previous value of B.
or B = B + A	

(*ii*)   Add a constant to the contents of a location or the value of a variable

C = A + 13	C becomes the value of A plus 13.
A = A + 13	A becomes the previous value of A plus 13.

2. Subtraction

The student can interpret these on the lines of interpretations of the addition operations above.

    B = A - B
    C = B - A
    A = A - B
    A = B - A
    B = A - 14
    A = A - 14

3. Multiplication

The multiplication is best represented by an asterisk in flowcharting so that it does not confuse with the widely used letter, ×. The student can interpret the following operations himself.

C = A *B

C = B * A

A = A * B

A = B * A

A = A * 7

B = A * 7

4. Division

Two types of division can be carried out. Suppose for example, that we divide 7 by 4. In one type, we get 1.75. In the other type, we just get the quotient 1 and the remainder 3 is consigned to a location reserved for remainder by the computer manufacture say, REM. We shall use the same format for the two types as below :

Type 1 Results in the location on L.H.S.	Type 2 Only the Quotient in the location on the L.H.S. The remainder is consigned to standard location symbolised by REM.	
		Remainder i
C = A/B	C = A/B	REM
C = B/A	C = B/A	REM
A = A/B	A = A/B	REM
A = B/A	A = B/A	REM
A = A/131	A = A/131	REM
B = A/131	B = A/131	REM

Though we are not using in the study note any symbol for exponentiation (raising to power) the student may use ** *e.g.* **3 means cube x.

5. Transfer

Transfer the contents of one location into another location. In other words, the variable of the R.H.S. becomes (or assumes) the value of the variable on L.H.S. Examples follow:

A = B   If B were 13 and A were 7 or whatever, A would now become 13.

               The value of B remains 13 with this operation.

A = 17   A, whatever its previous value, becomes 17.

               All these operations 1 to 5 above are depicted in the flowchart in a box. For example, A = A - 14 would be depicted as below :

$$A = A - 14$$

It may also be desired to designate a location or a variable by a suggestive symbol. Thus the step below means that we want to increment "COUNT" by 1.

| Count = Count + 1 |

Count becomes the previous value of Count plus 1.

Desirably the length of symbols should not exceed six characters. Also, they must start with an alphabet, letter and never with a numeric or a special character. However, the remaining five characters could be of any kind. These symbols are devised by the person who draws the flowchart. Alphabets must be in capitals.

6. Comparison

In it, the value of two variables (*i.e.* contents of two locations are compared and one action is taken if the answer to the comparison is "yes" and other action if the answer is 'no'. A comparison is always shown in a diamond as below in which ROL (the symbol for reorder level) is compared with PHY (the symbol for the physical balance). If ROL is greater than PHY, we would place the replenishment order, otherwise not.
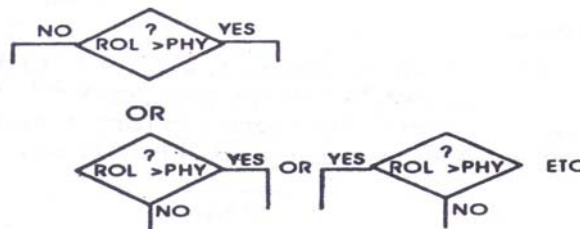
The following types of comparisons are possible in most instructions repertoirs.

Variables on R.H.S.	Constant on R.H.S.	
$A > b$	$A > 13$	Instead of constants
$A < B$	$A < 13$	alphabetic character (s)
$A = B$	$A = 13$	or special symbol (s)
$A = B$	$A \neq 13$	can be had on R.H.S.

7. Print

The following types of print operation formats are available.

(*i*)   Print (Material) at position....(literally)

e.g., Print "Ramu, 28" at 005.

We want to print RAMU, 28 which constitutes the material. The continuous stationery usually can accommodate 160 characters. Thus, there are 160 print positions from 001 to 160. In the example above, we want to start printing at position 005.

(*ii*) Print (Location or Variable) at position.....*e.g.,* Print A at 010, with which we want to print the value of the variable (or the contents of location) A starting at position 010.

8. Feed

This means raising the continuous stationery by 1 or more lines for printing the next line.

The format is as in the examples below :

1   Line C.S. feed

3   Line C.S. feed

We shall write other input/output instructions (*viz.,* read a record) in plain English. With some exceptions to be explained where the use is made.

5.4.2 Examples on program flow charting

Numerous examples on program flowcharting follow. The student should, however, familiarise himself with example on $\dfrac{2^7}{96} \times \lfloor 7$ this stage before proceeding with the following material.

Example 1. Draw the program flowchart for finding the sum of first 100 odd numbers.

Solution. The flowchart is drawn as Figure 5.12 and is explained step by step below. The step numbers are shown in the flowchart in circles and as such are not a part of the flowchart but only a referencing device.

Our purpose is to find the sum of the series 1, 3, 5, 7, 9.....(100 terms.) The student can verify that the 100th term would be 199. We propose to set A = 1 and then go on incrementing it by 2 so that it holds the various terms of the series in turn. B is an accumulator in the sense that A is added to B whenever A is incremented. Thus B will hold
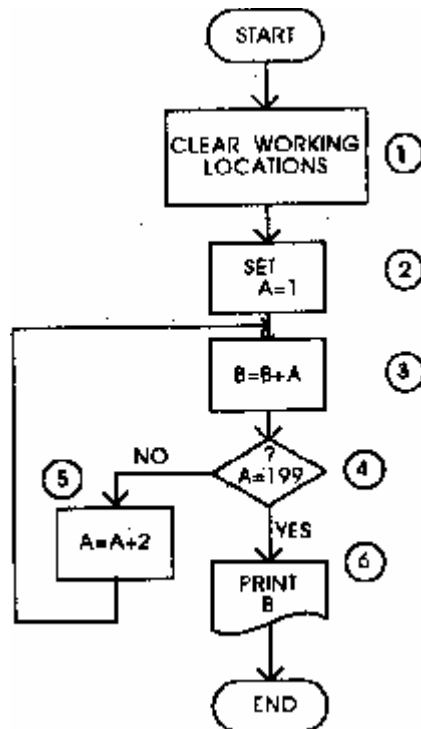
Fig. 5.12

1

1 + 3 = 4

4 + 5 = 9,

9 + 7 = 16, etc. in turn.

Step 1 - All working locations are set at zero. This is necessary because if they are holding some data of the previous program, that data is liable to corrupt the result of the flowchart.

Step 2 - A is set at 1 so that subsequently by incrementing it successively by 2, we get the wanted odd terms : 1,3,5,7 etc.

Step 3 - A is poured into B *i.e.,* added to B. B being 0 at the moment and A being 1, B becomes 0 + 1 = 1.

Step 4 - In step 5, we shall increment A by 2. So that although at the moment A is 1, it will be made 3 in step 5, and so on. Since we have to stop at the 100th terms which is equal to 199, step 4 poses a question. "Has A become 199 ?" If not, go back to step 3 by forming loop. Thus, A is repeatedly incremented in step 5 and added to B in step 3. In other words, B holds the cumulative sum upto the latest terms held in A.

When A has become 199 that means the necessary computations have been carried out so

that in step 6 the result is printed.

Perhaps more suggestive symbols for A and B could be ODD and SUM respectively.

Example 2 - Draw the flowchart for finding the value of ⌊K where K represents an integer greater than one whose value will be read into the computer each time the program is run.

The flowchart is drawn as figure 5.13. It may be recalled that we drew a flowchart for computing factorial of 7 but here we intend to generalise for any value designated by K. Thus, the number for which the factorial is needed, is read into the CPU (via, Keyboard) and this number is held in a location which is designated as K. Thus, K may be given any integral value, *viz.*, 7, 17, 20 etc. This is done in step 1.

Fig 5.13	Fig. 5.14

Step 2 - A and B are both equated to K. In the following steps, we shall repeatedly decrement B by 1 and go on multiplying it with A successively so that A holds K(K-1), K(K-1)(K-2) etc. in turn and B becomes K,(K-1), (K-2), etc. in turn.
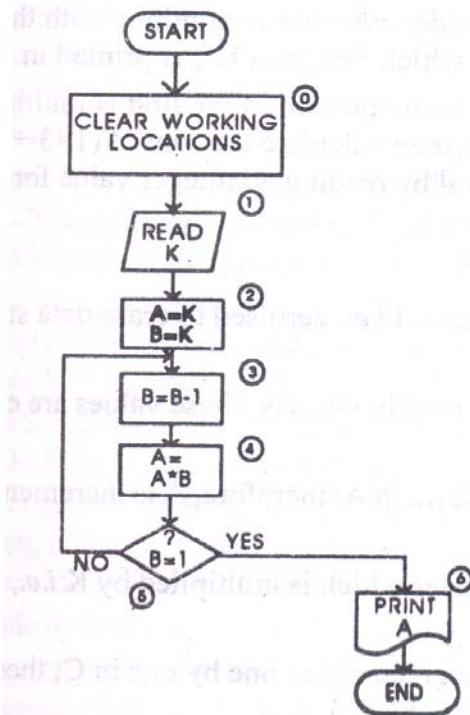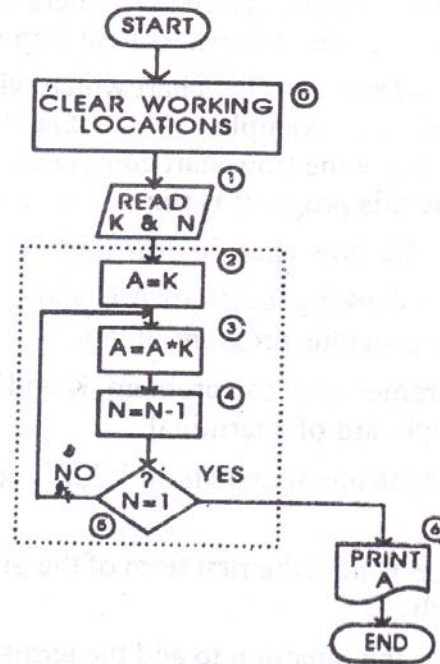
Step 3 - As already stated above, B is brought down from K to K-1.

Step 4 - A becomes the product of A and B i.e., K(K-1).

Step 5 - It is a comparison step for looping. Obviously the factorial would have been computed when B, after having been successively decremented by 1, becomes 1. But since at the moment B has come down to K-1 and not 1, by looping we go back to step 2 where B becomes (K-2) and A, in step 3, becomes K(K-1)(K-2); so on until A holds the value of the $\lfloor$K, which is printed in step 6.

Example 3 - Draw the flowchart for finding the value of K^N where K and N are read into the computer each time the program is run, N has to be >1.

Solution : The flow chart in given in Figure 5.14. (Please ignore dotted lines. They are referenced in a subsequent examples).

Step 0 - We zeroise all working locations.

Step 1 - Values of K and N are read, say, these values are entered through keyboard of a terminal.

Step 2 - A is equated to K. We shall subsequently go on multiplying A by K successively via a loop so that A is made A^2, A^3, etc. in turn.

Step 3 - A becomes AK *i.e.,* A^2 since K is equal to A.

Step 4 - We have to carry out the multiplication of A by K, (N-1) times to get the value K^N. In this step, therefore, we decrease N by 1. Via the loop we shall continue to decrement it by 1 until it is brought down to 1.

Step 5 - This is a comparison step where it is decided whether to continue with the loop or not. When N comes down to 1 (in step 4). A, which becomes K^N, is printed in step 6.

Example 4 - Draw the flowchart which will calculate the sum of the first N multiples of an integer K. (For example, if K = 3 and N = 10), then calculate the sum of ($1\times3 + 2\times3 + ...+ 10\times3$). Make the flowchart completely general by reading an integer value for N and K each time this program is run.

Solution : The flow chart in drawn in Fig. 5.15.

Step 0 - The working locations A,B and C are cleared *i.e.,* zeroised to erase data sticking in from the previous program, if any.

Step 1 - Parameters of the problem, K and N are read in via, say, these values are entered through keyboard of a terminal.

Step 2 - It is the intention to hold 1,2,3,... etc., in turn, in A; therefore, A is incremented by 1.

Step 3 - In B is held the first term of the given series which is multiplied by K *i.e.,* $1 \times K$, to start with.

Step 4 - It is the intention to add the terms of the given series one by one in C; therefore, the first term, to start with, is accumulated in C.
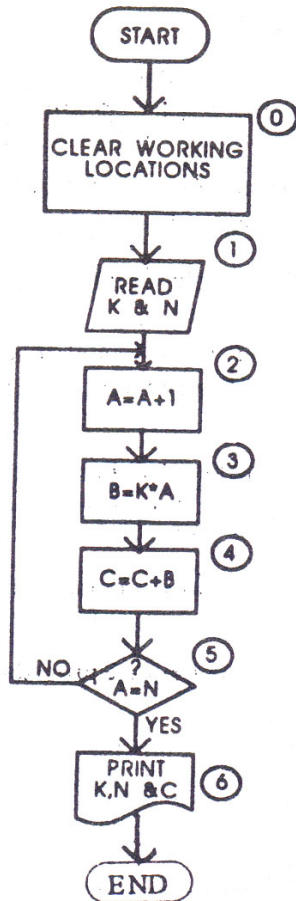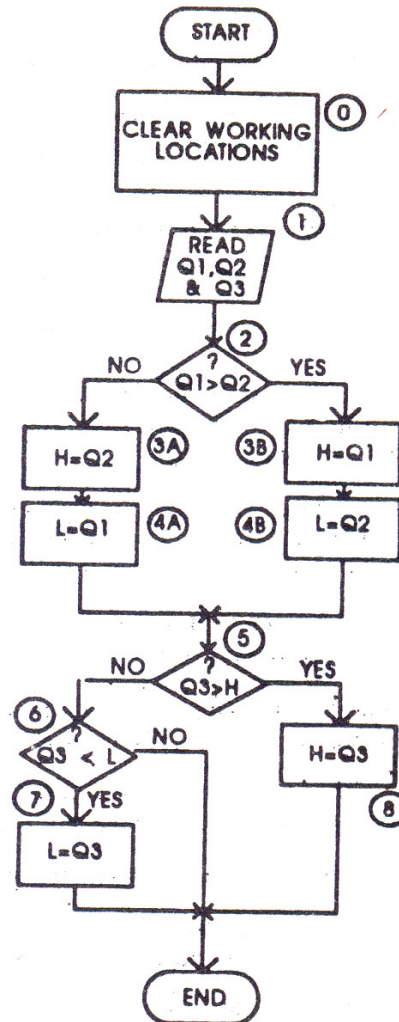
Fig 5.15   Fig. 5.16

Step 5 - When A becomes equal to N we would print K, N, C as per step 6 but at the moment we form a loop back to step 2 so that A is made $1 + 1 = 2$ to prepare the 2nd term in the subsequent steps.

Example 5 - There are three quantities; Q_1 Q_2 and Q_3. It is desired to obtain the highest of these in location H and lowest of these in location L.

Solution : The flow chart is given in figure 5.16.

Step 1 - The three quantities Q_1, Q_2 and Q_3 are read in via, say, these values are entered through keyboard of a terminal.

Step 2 - Any two quantities, say Q_1 and Q_2 are compared. If Q_1 is greater than Q_2, we tentatively make H = Q_1 and L = Q_2 in Steps 3B and 4B: otherwise, in Steps 3A and 4A, we make H = Q_2 and L = Q_1.

At Step 5, we are holding the higher of Q_1 and Q_2 in H and the lower of these in L. In Step 5, we see if Q_3 is greater than H. If it is so, obviously in Step 8, H is made equal to Q_3. If Q_3 is not greater than H, we compare Q_3 with L in Step 6.

In Step 6, if $Q_3 < L$, we go to Step 7 and make L = Q_3, otherwise, the job has already been done prior to Step 5.

Example 6 - The square root of a number can be computed by an iterative procedure. The following computational steps are performed.

1. Select a first guess for the desired square root. A reasonable value for the first guess might be obtained by dividing the given number by 2.

2. Divide the given number by the assumed square root.

3. If the quotient and divisor are sufficiently close, then the desired square root has been obtained to a sufficient degree of accuracy and the computation ceases.

4. If the quotient and divisor do not agree, then a new guess must be obtained for the square root and the procedure repeated. The new guess is obtained by calculating the arithmetic average of the most recent divisor and quotient. The computation then returns to step. 2.

    Say, N = the given number whose square root is desired.

    D = the divisor.

    Q = the quotient.

    R = the desired square root.
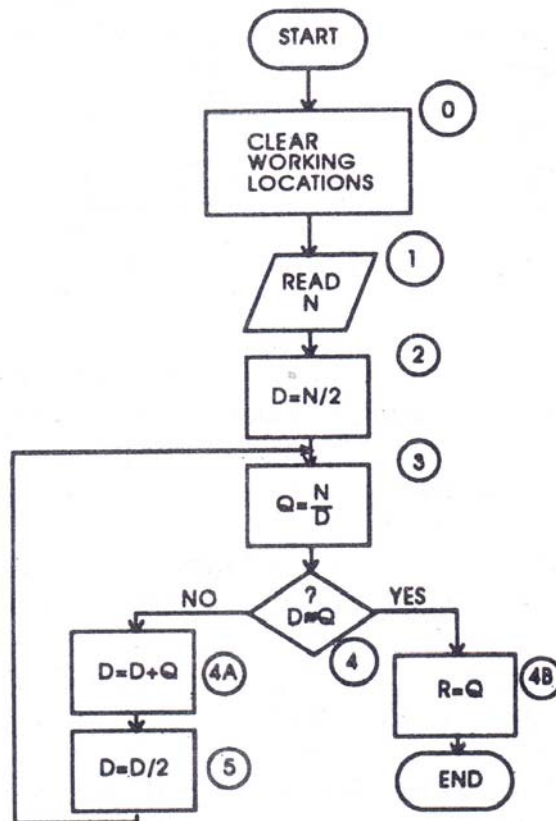
Fig. 5.17

(Let us now apply this method to a problem namely, computing the square root of 8. The computation will proceed in the following steps.

(a) $D_1 = \frac{1}{2}(8) = 4$ $\qquad\qquad$ $Q_1 = 8 \div 4 = 2$

(b) $D_2 = \frac{1}{2}(4 + 2) = 3$ $\qquad\qquad$ $Q_2 = 8 \div 3 = 2.6666$

(c) $D_3 = \frac{1}{2}(3 + 2.6666) = 2.83333$ $\qquad$ $Q_3 = 8 \div 2.83333 = 2.82353$

(d) $D_4 = \frac{1}{2}(2.83333 + 2.82352)$ $\qquad$ $Q_4 = 8 \div 2.83843 = 2.8242$

$\qquad = 2.82843$

Solution : The flowchart is given above in Fig. 5.17.

Step 1. N, the number for which the square root is wanted.

Step 2. D is made half of N as the initial estimate of square root of N (=8 may be imagined).

Step 3. N(= 8) is divided by the estimate D to get Q.

Step 4. If D is approximately equal Q, we have computed the square root which however, is not the case as yet (since D = N/2 = 4 and Q = N/2 = 8/4 = 2 and D ≠ Q); therefore, go to steps 5 and 6. In these two steps, we find the average of D and Q and put it in D. This average [= (2 + 4)/2 = 3] is taken in D as the new estimate of the square root and we loop back to step 3.

*In fact, there does not exist any instruction in any computer by which we can compare if two quantities are roughly equal. What therefore, would actually be done is to find the difference between D and Q and if it is ≤ prescribed difference, say 0.001, we accept as equal.

Example 7 - Draw the flowchart for deriving the sum of the squares of first 20 odd numbers.

Solution : The flowchart is shown in Fig. 5.18.
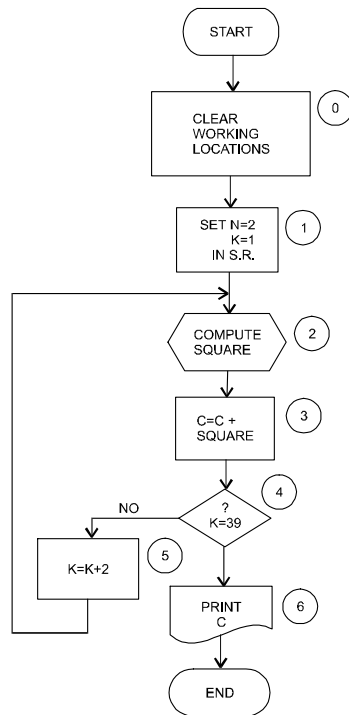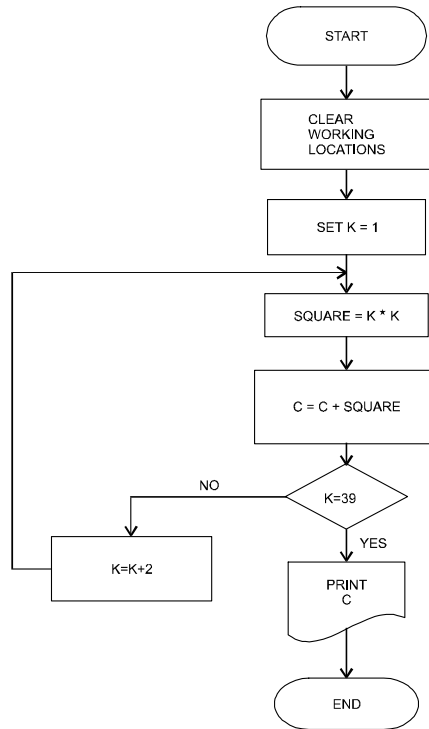
Fig. 5.18   Fig. 5.18A

Step 0 - All working locations are zeroised.

Step 1 - The first odd number is 1 so we set K = 1

Step 2 - The square of first odd number is computed by multiplying K with K and the result so obtained is stored in location SQUARE.

Step 3 - We accumulate the first term *i.e.* square of the first odd number 1 in location C.

Step 4 - The 20th odd number is 39, therefore in this step we see if K has become 39 or not (by step 5)

Step 5 - K is increment by 2 *i.e.,* it becomes 1+2 = 3.

Note - The problem can be solved using a subroutine as depicted in figure 5.18A. The procedure for the same is given below :

Step 0 - All working locations are zeroised.

Step 1 - In step 2, we employ the square subroutine (which is the set of steps enclosed in the dotted box in Figure 5.14 for computing K^2). Therefore, we set N = 2 for ever in this program and K = 1.

Step 2 - K^N *i.e.,* 1^2 is computed by the aforesaid subroutine (S.R.) AS.R. is being depicted in the hexagonal symbol in program flowcharting.

Step 3-5 - Remaining the same as discussed above.
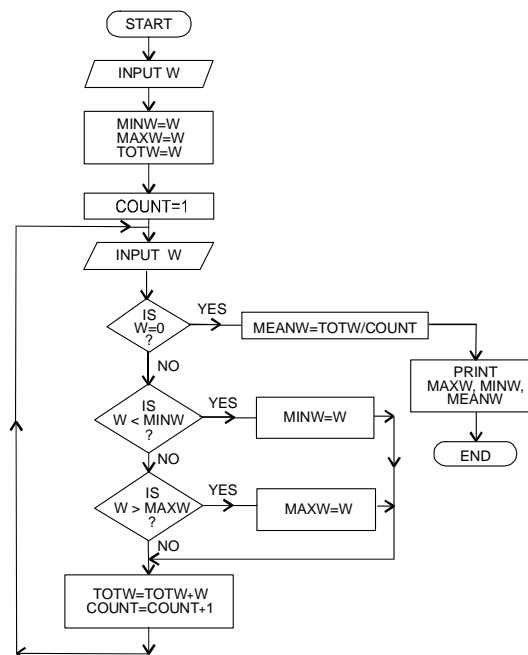
Fig. 5.19

Example 8 - The weights of newly born babies in a hospital are input to computer. The hospital incharge is interested to find the maximum, minimum and mean weights of all the weights of the babies.

Draw a suitable flow chart for his problem. A value of zero can be used at the end of the list of baby weights. This denotes the end of the list.

Solution - The required flowchart is given in Figure 5.19.

Explanation - The weight of the first baby is inputted through console and stored in location W. This value is assigned to three locations *viz.,* MINW, MAXW and TOTW. MINW is a location in which minimum of all weights will be stored. MAXW location will be used for storing maximum of all weights and TOTW for accumulating all the weights.

COUNT is a counter used for keeping a track of the number of transactions read. It is set at 1 after reading the first transaction. Next transaction is then read. Since W = 0 will indicate end of the list of baby weights, check whether the value of W is equal to zero or not.

If W = 0, then calculate the mean of all weights by dividing the TOTW by COUNT and storing the result in location MEANW; and print the values of MXW, MINW and MEANW.

If W is not equal to zero, then check whether the value of W is less than the value of MINW. If yes, then assign MINW = W. If not, then check whether W is greater than MAXW or not. If yes, then assign MAXW = W.

Accumulate totals of all weights in location TOTW and increase the value of the counter COUNT by 1. Then go back to read the next transaction.

Example 9 - Draw the program flowchart for computing the annual acquisition, inventory carrying and total costs for lot sizes of 100,200... 2400. The various variables of interests are supposed to be there in the locations symbolized below :

REQ	Annual requirements of the item
ACQ	Procurement costs/order
COST	Cost per unit
Rate	Inventory-carrying rate, I.

Solution : The flowchart is drawn in Fig 5.20. The following symbols represent the working locations that are put to use by this flowchart.

LOTSIZ	Lot size
IVCOST	Annual inventory-carrying cost
AQCOST	Annual acquisition cost
TOCOSTS	Annual total costs

Example 10 : Draw the flowchart for finding the amount of an annuity of Rs. A in N years. Rate of interest = r %, R = (1 + r). This amount is given by the following series :

$A + AR + AR^2 + ...AR^{N-1}$.

The flowchart is drawn in Figure 5.21. The following symbols are employed:

TERM	To hold A, AR, etc. (i.e., the various terms) in turn.
SUM	In it is accumulated the sum of term.
COUNT	Counter to count the number of terms accumulated.
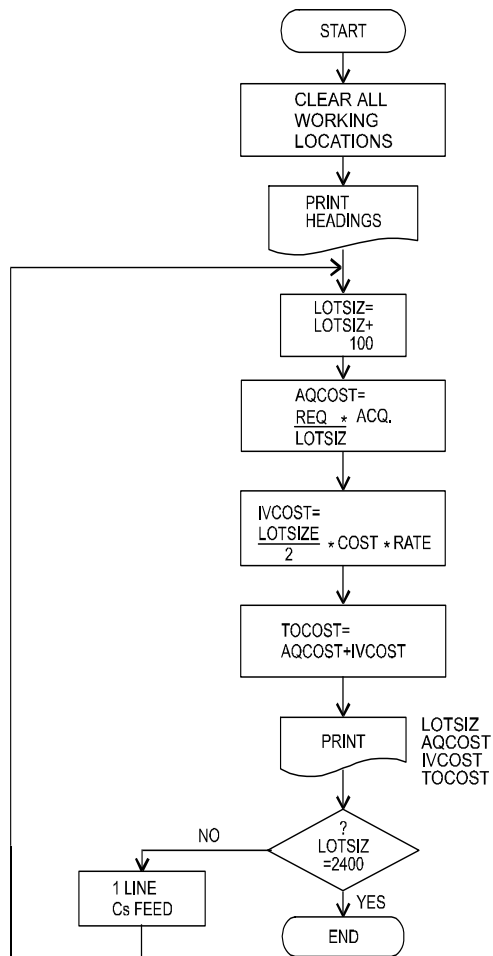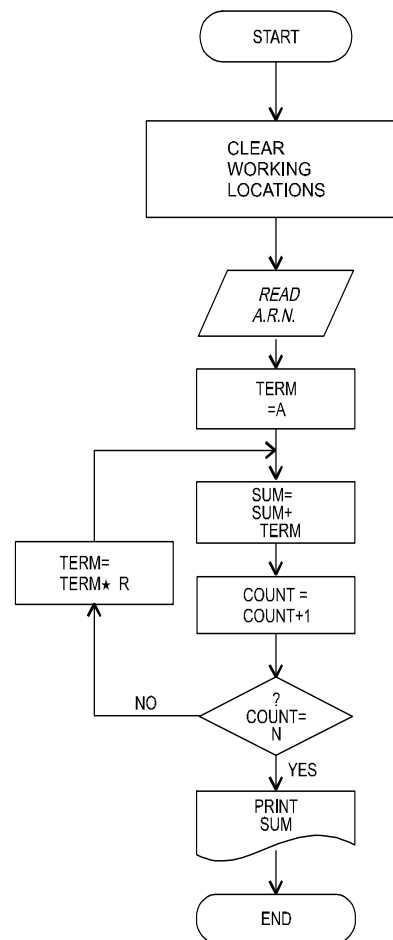
Fig. 5.20   Fig. 5.21

Example 11 : (On computing Customs Duties) : Assume that imported goods from foreign countries are classified into 4 categories for the purpose of levying customs duty. The rate for each category is as follows :

Class No. (K)	Class of Goods	Customs duty (%), on Values of Goods V
1	Foods, beverages	10
2	Clothing, footware	15
3	Heavy machinery	17½
4	Luxury items	40

Draw the flowchart for computing the appropriate customs duty :

Solution : The required flowchart is given in Figure 5.22.
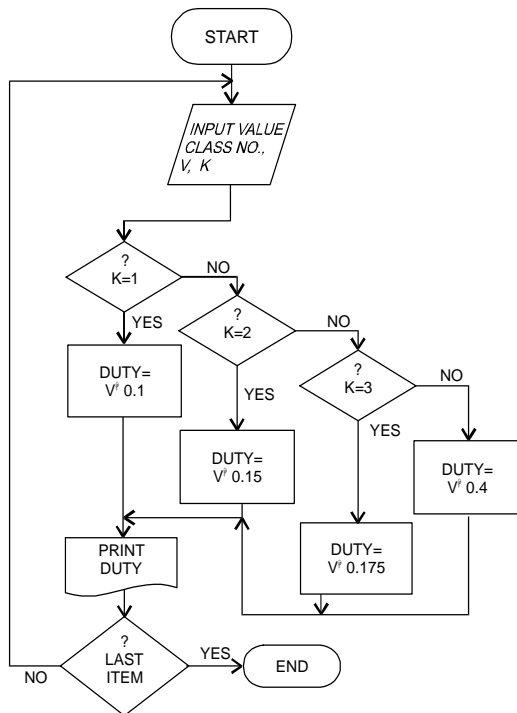
Fig. 5.22   Fig. 5.23
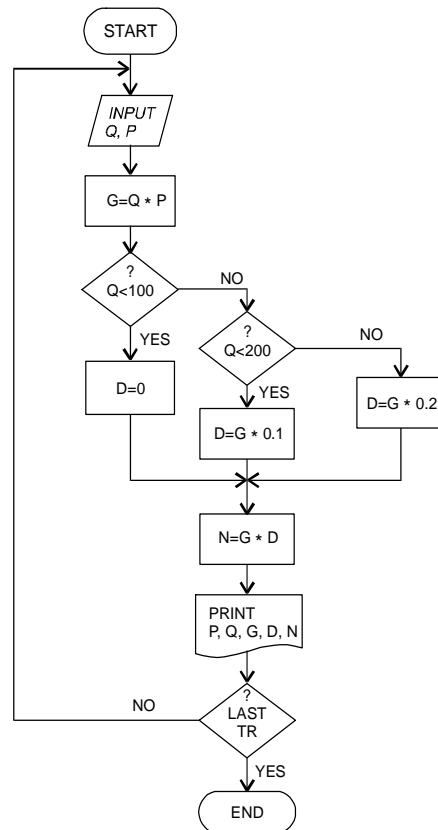
Example 12 : The problem is to compute, for a series of transactions, the gross sales (G), the quantity discounts, (D), if any; and the net sales (N). The raw data to be supplied in the program includes the quantity sold (Q) and unit price (P). The quantity discount schedule is as follows :

If quantity sold is :	*The discount rate would be :*
less than 100 units	none
100 to less than 200	10%
200 and over	20%

Solution : The flowchart is drawn in Figure 5.23

Example 13 : A bicycle shop in Delhi hires bicycles by the day at different rates as shown in the following table :-

Season	*Charges per day*
Spring (March - May)	*Rs. 8.00*
Summer (June - August)	*Rs. 9.50*
Autumn (Sept - Nov.)	*Rs. 5.00*
Winter (Dec. - Feb.)	*Rs. 6.00*

To attract his customers, the proprietor also gives a discount on the number of days a bicycle is hired for. If the hire period is more than 10 days, a reduction of 15% is made. For every bicycle hired, a deposit of Rs. 20 must be paid. Develop a flowchart to print out the details for each customer such as name of customer, number of days a bicycle is hired for, hire-charges and total charges including the deposit.

It is also assumed that there are 25 customers and complete details for each customer such as name of customer, season and number of days the bicycle is required for is inputted through console.

Solution : The required flowchart is drawn in Figure 5.24.

In this example, N is a counter used for keeping a track of the number of customers for whom data is read and processed. In the beginning it is initialized so that its value is 0.

A transaction is then inputted through console and the value of the counter N is increased by 1.

The season code is then checked. If the season is 'SPRING', the rate of hire charges is Rs. 8 per day and we go to check the No. of days for which a bicycle is hired. If the season is not 'SPRING', check whatever it is 'SUMMER' and so on.....

Once the rate for hire charges is decided, check whether the No. of days for which a bicycle is hired is greater than 10 days or not. If 'days' is greater than 10, the rate is increased by 15% otherwise not. Then hire charges are calculated by multiplying the rate by No. of days.

The hire charges are then added to Rs. 20 and stored in a location TCHG to calculate the total of hire charges for a customer. Details of a customer namely his name, No. of days, hire charges, and total hire charges are then printed.

Since there are in all 25 customers, then check counter N to see if details for all the customers have been read and processed or not. If not, then go back to read the next transaction. If yes, then stop.

Example 14 - Given the following set of data :

Account No.	Age of customer	Sex	Unpaid Balance
			Rs.
13466	28	M	145.23
4156	20	F	49.50
33215	45	F	89.24
44178	19	M	115.23
56723	28	F	75.95
47892	33	F	25.78
24567	19	M	54.75
56783	55	M	24.78
43579	39	F	67.85
56782	30	M	150.97
79134	18	F	39.95
63423	29	F	69.95
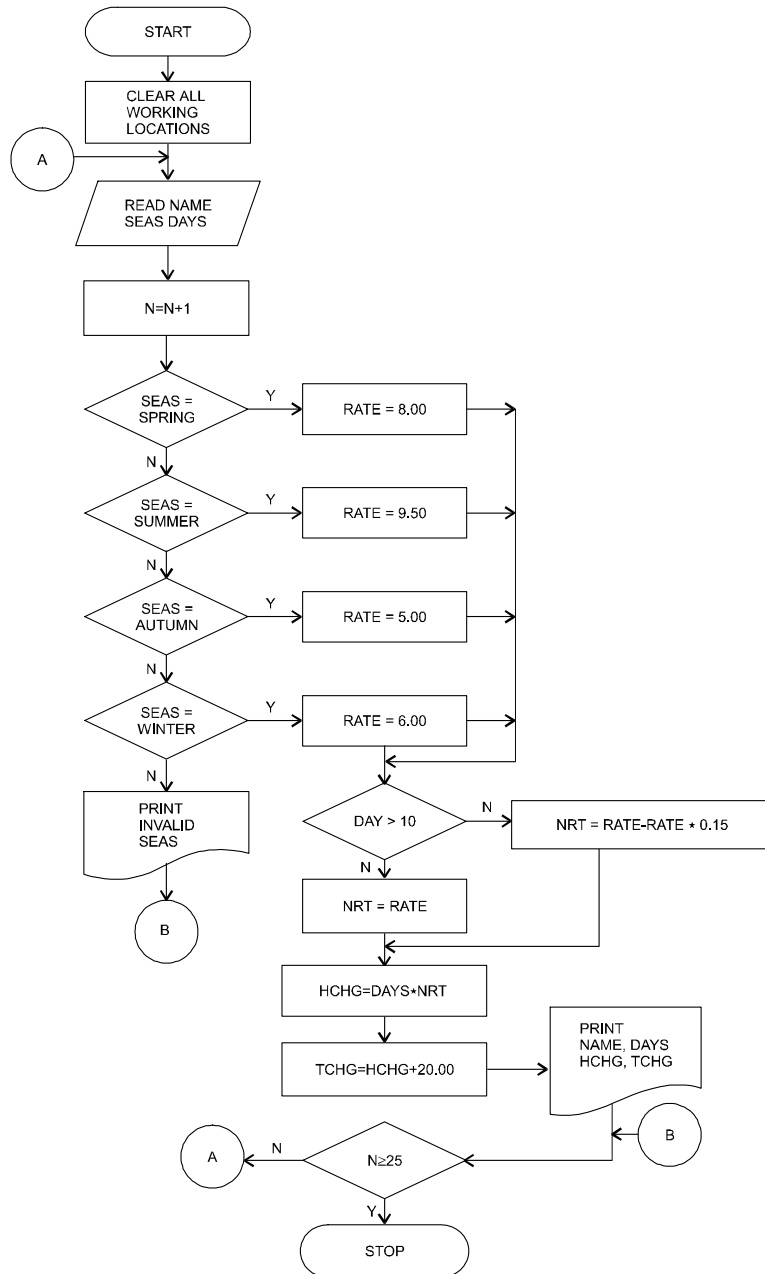
Fig. 5.24

Draw the flowchart to compute and print out the following :

Average			Unpaid Balance		
Customer Age		Males			Females
Under 20	Rs.	XXX.XX		Rs.	xxx.xx
20 to Under 30		XXX			XXX
30 to Under 40		XXX			XXX
40 and over		XXX			XXX

Solution : The program flowchart is given in Fig. 5.25. M1 to M4 accumulate balances for the 4 age groups of male customers and likewise F1 to F4 for the female customers. Age is symbolised by A, balance by B and Sex is codified as M or F. The last record is dummy.
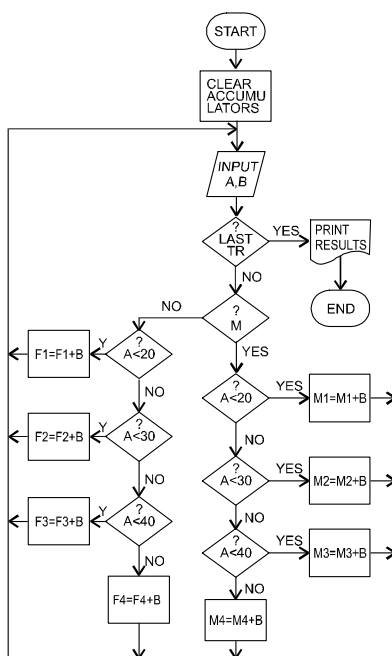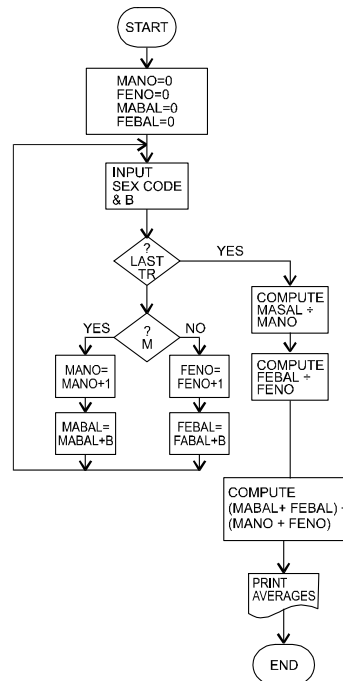
Fig. 5.25   Fig. 5.26

Example 15 : Using the data of the previous example, draw a flowchart for computing and printing out the following statistics :

Sex	Average Unpaid Balance
	Rs.
Male	XXX.XX
Female	XXX.XX
Overall	XXX.XX

Solution : The program flowchart is shown in Fig. 5.26 above. The following Symbols are used:

MANO	Counter for males	FENO	Counter for females
MABAL	Sum for male balances	FEBAL	Sum for female balances

Example 16 - Flowchart Binary Search, (Re. Magnetic Disc)

Solution : The required flow chart is given in fig. 5.27.
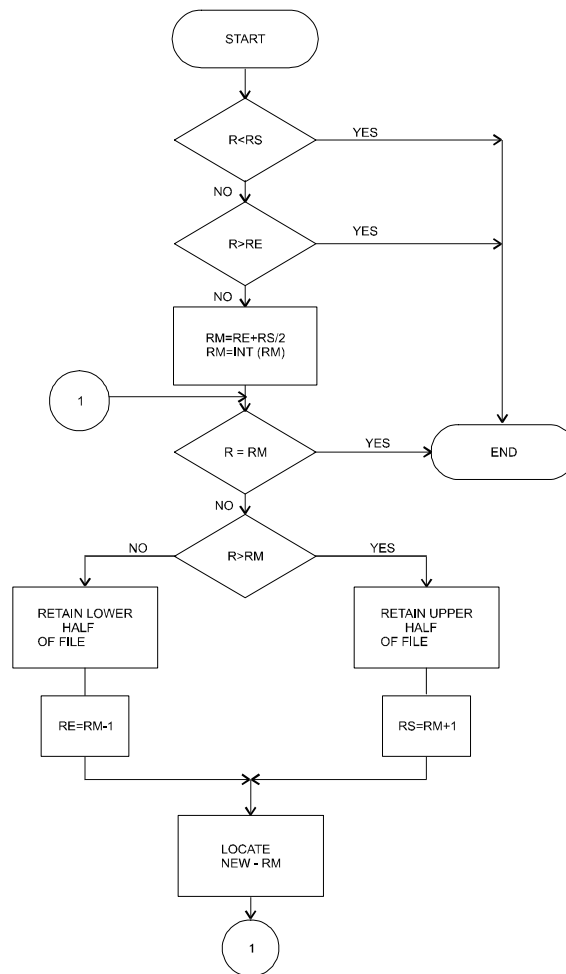
Fig. 5.27

Modification/Initialisation Instructions

These Instructions can change the value of a variable location number in an existing instruction during the program execution process. The initiatlisation instruction can set or reset the value of this variable to any desired number. The modification instruction can increment/decrement this variable during the loop execution by any constant (*viz.,* 12,30).

Example 17 : Marks on each student (in a class) in 12 papers are entered through keyboard of a terminal and are read into the CPU locations MARKS 001 to MARKS 012. You are required to draw the flowchart for computing and printing the average marks of each student.

Solution : MARKS 001, MARKS 002....MARKS 012, are holding the marks in 12 papers of a student. We propose to accumulate them as ACCUM. This could be accomplished in 12 instructions as below :

    ACCUM   = ACCUM + MARKS 001

    ACCUM   = ACCUM + MARKS 002, etc. to...

    ACCUM   = ACCUM + MARKS 012

But we do not do this way. We all shall adopt a cleverer approach which is made possible by the facility of what is known as the "modifying" instructions in the instruction repertoire.

It is to be seen that the 12 instructions above can be generalised as

    ACCUM   = ACCUM + MARKS (X)

We have to start with X = 1 and then go on incrementing it by one to generate the above 12 instructions. This we do as below :
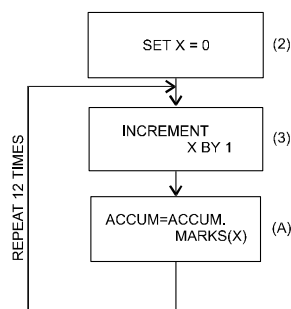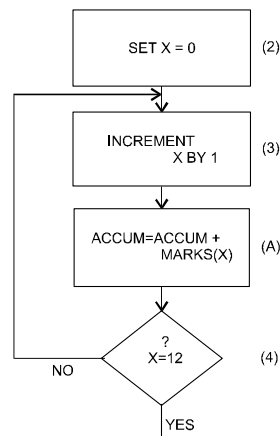
Fig. 5.28   Fig. 5.29

Set X   = 0 in (A)

Increment X by 1 in (A)

ACCUM   = ACCUM + MARKS (X)

By step (2), we made X in step (A) = 0 and by step (3), we incremented it by 1 so that MARKS (X) in A has been made MARKS (1) which is the same thing as MARKS001. If we repeat step (3) and (A) 12 times as per the left flowchart segment above, we, in effect, will have performed the aforesaid 12 instructions.

But, how do we repeat this loop 12 times ? This is accomplished by including the comparison step (4) as per R.H.S. segment above. In this step, we pose the question if X has become 12?
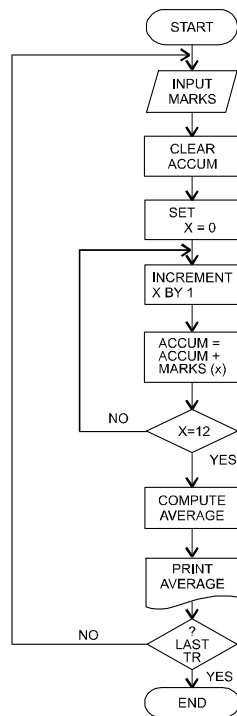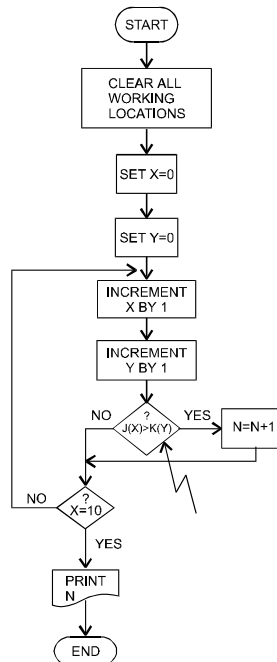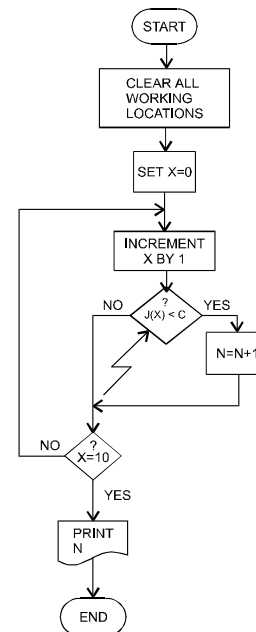
Fig. 5.30   Fig. 5.31   Fig. 5.32

The complete flowchart is shown in Fig. 5.30.

Step (3) in Fig. 5.29 corresponds to what is known as the modifying instruction since it modifies the instruction corresponding to step (A). The step (2) is a sort of initialisation step or instruction since it sets the value of variable X at 0 for each student's 12 papers.

Modification of the 'Comparison' Step.

Example 18 : Prices for ten commodities in the current year are designated by J(X), X varying from 1 to 10. Likewise, their last year's prices are designated by K(Y), Y varying from 1 to 10. Draw the flowchart for finding the number, N of commodities of which prices have increased.

Solution : The flowchart is drawn in Figure 5.31

The *crooked arrow shows the comparison step that is initialised and modified for looping. The following is the comprehensive list of comparisons of this type that are valid:

$$J(X) > K(Y)$$
$$J(X) = K(Y)$$
$$J(X) \neq K(Y)$$
$$J(X) < K(Y)$$

Example 19 : Prices of commodity in ten major cities are designated by J(X), X varying from 1 to 10. The price prevailing in the capital is designated by C. Find the number of cities having the price less than that in the capital.

Solution : The flowchart is drawn in Figure 5.32. With the crooked arrow showing the comparison step that is initialised and modified for looping. The following is the comprehensive list of this type of comparisons possible in flowcharting.

$$J(X) < C$$
$$J(X) = C$$
$$J(X) > C$$
$$J(X) \neq C$$

Example 20 : A company has 2,500 employees. Their salaries are stored as J(s), 1, 2, ---- 2500. The salaries are divided in four categories as under :

(*i*) Less than Rs. 1,000   (*ii*) Rs. 1,000 to Rs.2,000

(*iii*) Rs. 2,001 to Rs. 5,000   (*iv*) Above Rs. 5,000.

Draw a flow chart for finding the percentage of the employees in each category.

Solution : The flow chart is drawn in Figure 5.33.
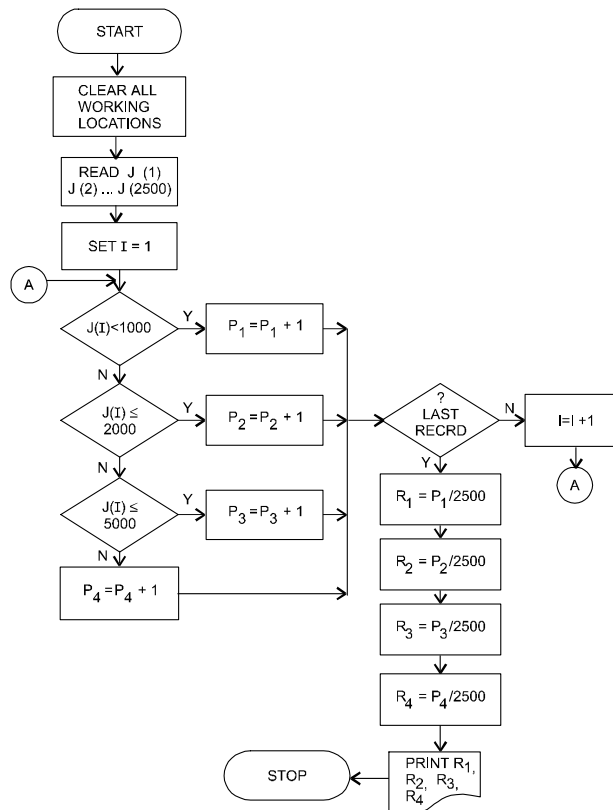
Fig. 5.33

Example 21 : A file contains 1000 records of students who appeared for an examination. Each record consists of the roll number of a student, his name and marks obtained by him in 10 papers. Records are read into the CPU one by one for finding for each student the number of papers, N in which he scored distinction by obtaining 75 out of 100 or more marks. Name is held by NAME, Roll number by ROLL NO and marks by $J(X)$, $X = 1, 2, 3 \ldots 10$.

Solution : The flowchart is shown in Figure 5.34 the crooked arrow shows the comparison step of major interest. This comparison involves a constant 75. The following is the comprehensive list of this type of comparisons valid in flowcharting.

$J(X) < 75$ (On R.H.S., alphabetics of

$J(X) = 75$ special symbols can also be had).

$J(X) \neq 75$

$J(X) > 75$
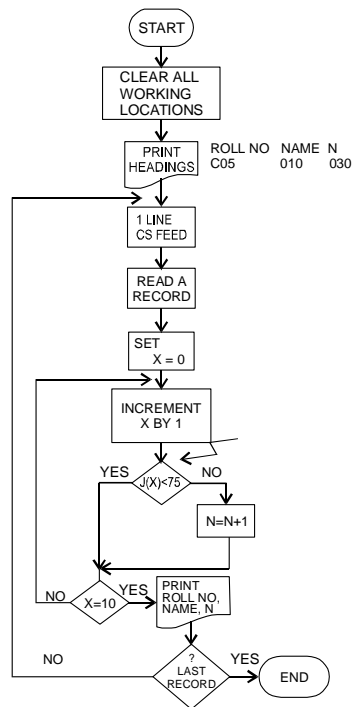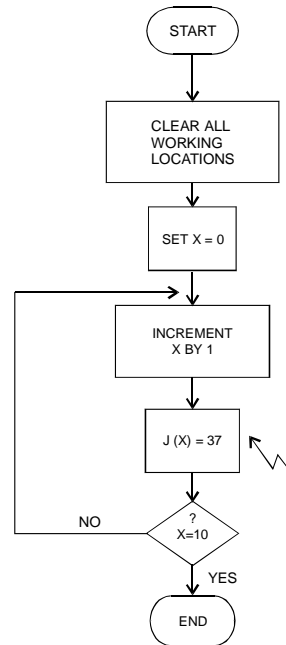
Fig. 5.34   Fig. 5.35

Modification of the "Transfer step"

Example 22 : Assign a value of 37 to each of the array, J(X), X = 1, 2...10.

The crooked arrow in the flowchart of Fig. 5.35 shows the "transfer" step of interest wherein 37 is put in each of the 10 locations designated in general by J(X).

Example 23 : Transfer the contents of locations J(X), X = 2,4, 8, 10...20 to K(Y) = 1, 2, 3...19.

The flowchart is shown in Figure 5.36. The crooked arrow shows the step of major interest wherein K(Y)'s are successively equated to J(X)'s.

Example 24 : Transfer the contents of location J(0) to each of the following 10 locations.

The flowchart is shown in Figure 5.37 for transferring the content of J(0) to each of J(1), J(2), J(3)...J(10). The crooked arrow shows the step of major interest.
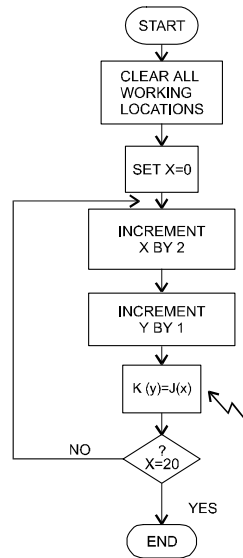
Fig. 5.36
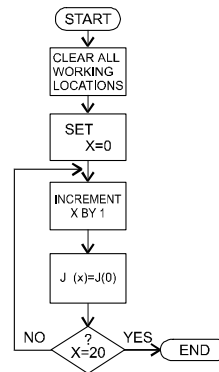
Fig. 5.37
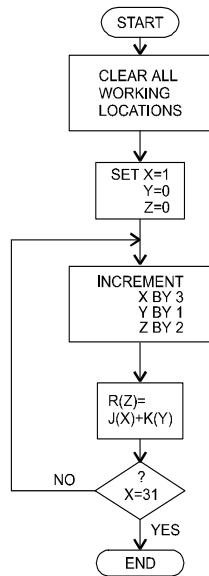
Fig. 5.38
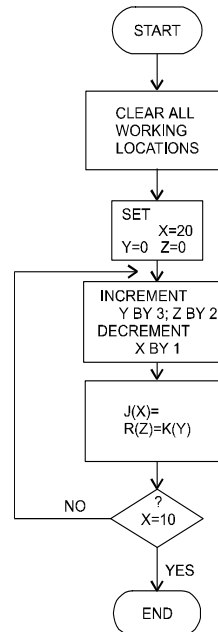
Fig. 5.39

Modification of Arithmetic Steps

Example 25 : It is desired to add contents of 10 locations J(X), X = 4, 7, 10...31 and K (Y), = 1, 2, 3...10 on a one to one basis and put the results in R(Z),Z = 2, 4, 6...20.

Solution : The flowchart is shown in Figure 5.38. The step of major interest has a crooked arrow to it. The following is the comprehensive list of such types of steps.

R(Z) = J(X) + K(Y)	Such types are
R(Z) = J(X) - K(Y)	also valid :
R(Z) = J(X) * K(Y)	R(Z) = R(Z) + J(X)
R(Z) = J(X) / K(Y)	R(Z) = R(Z) / J(X), etc.

More Examples on Modification of Arithmetic operations

Example 26 : Multiply R(Z), Z = 2,4,6....20 and K(Y), Y = 3,6,9,...30 on a one to one basis and put the results in J(X), X = 19,18,17...10

Solution : The flowchart shown in Figure 5.39. It is the intention here to bring out the fact that decrementing of L.H.S.J(X) (in general even one or both designations R.H.S.) is also valid by one (in particular and general any integer).

Example 27 : Add Rs. 45 (a constant) to the wages of 10 persons designated by J(X), X = 1,2...10.

Solution : The flowchart is drawn in Figure 5.40. The crooked arrow shows the step for adding a constant to the contents of a location. Other permissible steps of this type are as below:

J(X) = J(X) - 45
J(X) = J(X) * 45
J(X) = J(X) / 45
J(X) = J(X) + 45, etc.
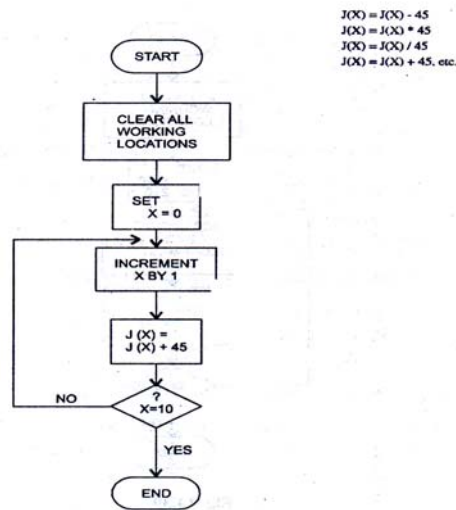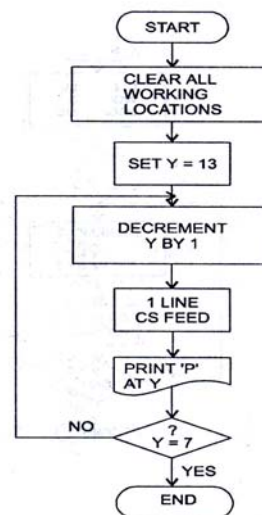
Fig. 5.40   Fig. 5.41

Example 28 : Print 6 'P's in the pattern given below.

012(print position)

p

p

p

p

p

p

007 (print position)

Solution : The flowchart is drawn in Figure 5.41. The print instruction has the following two formats. Printing is done in one line by an instruction.

1. Print (Given material as 'P' here) starting at print position (001 to 160). We want to print 'P' at starting print position 012; therefore, we give the instruction "Print 'P' at Y". Y is the print position on the continuous stationery which usually can accommodate 160 characters in one line. We want to print 'P' at the Y the position. In the given pattern 'p' in the first line is to be printed at position 12; therefore, we set Y at 13 and then it is decremented by 1. This is followed by "1 line CS feed" which means program instructs the printer to raise the continuous stationery by one line so that it is set for printing the 2nd 'P' in the 2nd line. By means of the loop, Y is decremented from 012 position by one so that 'P's are printed at positions 012, 011, 010, 009, 007 in successive lines.

2. Print (contents of a location at starting print position) (001 to 160).

This type is illustrated in the following example.

Example 29 : 64 locations J(X), X = 1, 2...64 hold 64-3 digit quantities. It is required to draw the flowchart for printing these in an 8×8 martix as below :

412 331 602 400 405 403 408 421

424 425 423 422 421 420 419 426

:

:

:

531 310 410 212 111 402 124 429
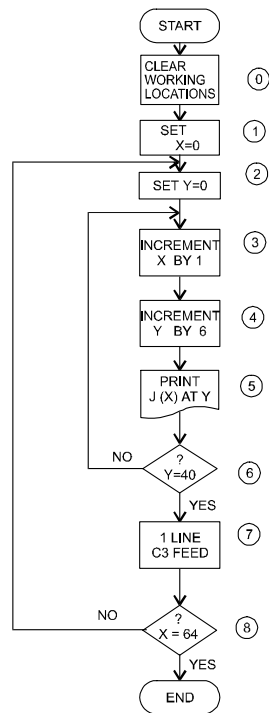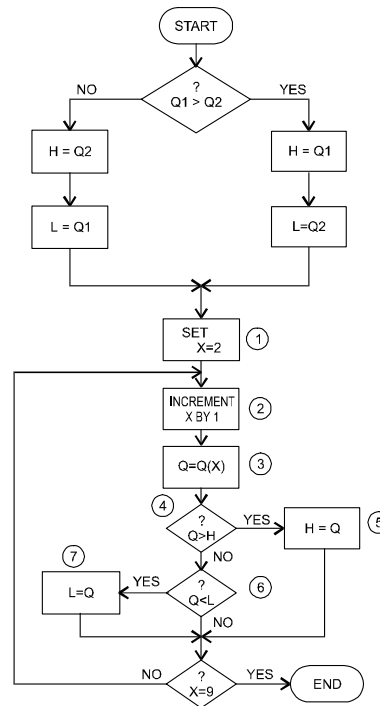
Fig. 5.42   Fig. 5.43

Solution : The flowchart is drawn in Figure 5.42. The first row figures in the above matrix are the contents of J(1) to J(8). The second row figures in the above martix are the contents of J(9) of J(16). Moving this way, the figures of the last row are the contents of J(57) to J(64).

The first column is printed at start position Y = 005, and 2nd column at Y = 010 and so on, so that the 8th column has the print position, Y = 040. Thus, in the flowchart, when Y becomes 040, it is a signal that the printing of a line is over, therefore, the continuous stationery is raised by a line, Y reset at 005 for commensing the printing of the next line.

We are giving an increment of 5 to Y which is the minimum necessary. It could be more but it should not be less because the three digits and the sign (for say, debit/credit as + or -) would require 4 print positions and the fifth position would be left blank as a gap between two quantities.

Example 30 : Q(X) holds 9 quantities Q1, Q2...Q9. Obtain the highest quantity in location H and the lowest quantity in location L.

Solution : The flowchart is shown Figure 5.43. In addition to the given symbols, another symbol Q [which is the same as Q (O)] is used to hold Q3, Q4...Q9 in turn.

We start in the manner of example 5. Having put that way the higher of Q1 and Q2 in H and the lower in L tentatively, from step 1 onwards, we want to compare Q3, Q4...Q9 in turn with H and L. In fact, steps 4 to 7 are similar to the later part of the flowchart of example 5.

In steps 1 and 2, we prepare X = 3 for step 3 which now reads "Q = Q(3)". What we have done is that we have put the contents of Q(3) in Q and in steps 4 to 7 we work on Q instead of Q(X). Why are we reluctant to work with Q(X) straight in steps 4 to 7? Well we could do so and we would get the wanted results. But by working with Q(X) directly in step 4 to 7, these steps would read as below on the L.H.S. 'rather than on the R.H.S. as in the flowchart.

Step 4	Q(X) > H		Q > H
Step 5	H = Q (X)	rather	H = Q
Step 6	Q (X) < L	than	Q < L in the flowchart
Step 7	L = Q(X)		L = Q

So, if we work with Q(X) straight in steps 4 to 7, we shall have to set X = 3 in each of these steps. But by having equated Q with Q(X) we can work with Q and we do not have any problem of setting X in steps 4 to 7.

Example 31 : In locations J(X), X = 1, 2....200 are held 200 quantities. Draw flowchart for finding the ratio of the total number of quantities indivisible by 10 to that of divisible by 10.

Solution : The flowchart is shown in Figure 5.44. The following symbols are used in it.

NONTEN	Total number of items not divisible by 10
TENNER	Total number of items divisible by 10
RATIO	Ratio NONTEN/TENNER

J(X), X = 1,2...200 are used to hold the last digit of a quantity.

Partial transfer (as we have down in this flowchart) of one or more consecutive digits from one location into another location is valid.

Example 32 : It is required to compute the geometric mean of six past prices for each commodity in an inventory of 50 commodities. The 6 prices having been entered through a keyboard of a terminal which are read into the CPU in locations designated by VALUE001 to VALUE006. Draw the flowchart. Use would be made of a S.R. to compute the 1/6 powers.

Solution : Here again in Fig. 5.45, Modification instruction is put to use, which is always the case whenever an array or a list of variables are to be processed similarly.

<div style="text-align:center">
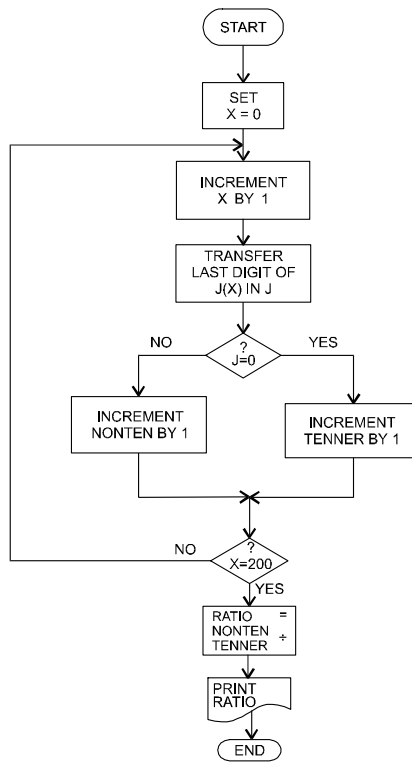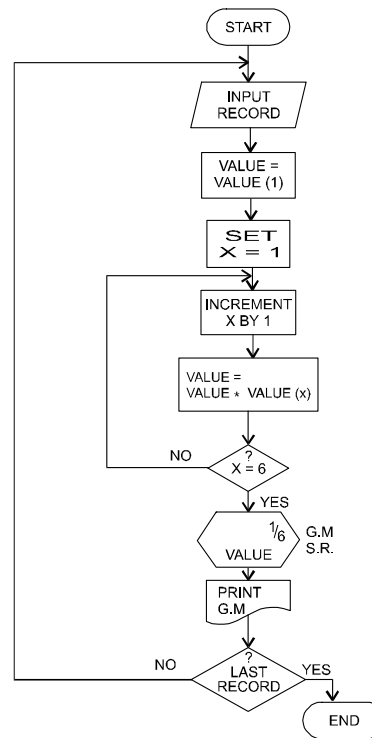
Fig. 5.44   **Fig. 5.45**

</div>

Example 33 : It is desired to sort 5 quantities in a list held in the CPU locations symbolised by LIST001 TO LIST005. Draw the program flowchart.

Solution : Switching or Exchange method of Sorting within the CPU

The LIST X to be sorted is assumed to be as follows :

    LIST X (1)

    LIST X (2)

    LIST X (3)

    LIST X (4)

    LIST X (5)

The logic of method depicted in the flowchart in Fig. 5.46 may be summarised as follows:-

1. Check the first pair of values in the LIST X that is, compare X(1) and X (2). If they are in the right order, X(1) ≤ X(2), leave them alone and proceed to check the next pair of values. If however, X(1) > X(2), they are in the wrong order and need to be switched *i.e.* exchanged before proceeding to a check of next pair, X(2) and X(3).

2. After one pass through comparing each neighbouring pair of the value of X, it is necessary to go through another pass to ensure that each pair of values is now in the right order (that is if no switching occurs during the pass) another pass is still required to ensure that a sorted list is being achieved.

For illustration of how the sorting logic works, the LIST X is assumed to be as follows before sorting begins :

$$LIST\ X\ (1) = 1$$
$$LIST\ X\ (2) = 5$$
$$LIST\ X\ (3) = -2$$
$$LIST\ X\ (4) = 7$$
$$LIST\ X\ (5) = 4$$

The values of the elements of X during the first pass through the list are summarised below :

LIST	VALUE OF X DURING 1ST PASS				AFTER 1 LOOP
	I=1	I=2	I=3	I=4	
X(1)=	1	1	1	1	1
X(2)=	5	5	-2	-2	-2
X(3)=	-2	-2	5	5	5
X(4)=	7	7	7	7	4
X(5)=	4	4	4	4	7
? STITCHING	NO	YES	NO	YES	
VALUE OF S	0	1	1	2	2

The value of I only goes from 1 to 4 since when I = 4, the last pair of values of X, X (4) and X (5), will be compared.

As demonstrated above, after one pass through the list, the value in LIST X are not all in the right order since two switches occurred during the pass. Hence, a second pass through list is required. The value of the elements of X during the second pass are as follows :

	VALUE OF X DURING 2nd PASS				AFTER 1
LIST	I = 1	I = 2	I = 3	I = 4	LOOP
X(1) =	1	-2	-2	-2	-2
X(2) =	-2	1	1	1	1
X(3) =	5	5	5	4	4
X(4) =	4	4	4	5	5
X(5) =	7	7	7	7	7
? SWITCHING	YES	NO	YES	NO	
VALUE OF S	1	1	2	2	2

In the third pass no switching would be there *i.e.* S = 0 meaning that the list is sorted.

The steps for the flowchart drawn in Fig. 5.46 are explained below :

Step 1. The switch counters is set equal to zero.

Step 2. This step initialises the loop to follow.

In steps 4 and 5, we are using LIST (X) as the general symbol for the five locations :

LIST(1), LIST(2), LIST(3), LIST (4) and

LIST (5) holding the five numbers to be sorted in the ascending order. Naturally, therefore, if LIST(X) is made LIST (0) by setting X = 0 in step 2 under explanation, LIST (X + 1) would mean LIST (1). Thus having set X = 0 in steps 4 and 5, LIST (X) means LIST (0) and LIST (X + 1) means LIST (1). Surely LIST (0) is not one of the five locations holding the five numbers. This is set right in step 3.

Step 3. X is incremented by 1 in the following steps, 4 and 5. This makes LIST (1) of LIST (X) and LIST (2) of LIST (X + 1).

Step 4. LIST (1) is compared with LIST (2).

Since we know LIST (1) = 1 and LIST (2) = 5 are in the right (ascending) order, no switching is needed; therefore, steps 5 and 6 are bypassed.

Step 7. Since X = 1 and not 4 therefore, the program flowchart loops back to step 4.
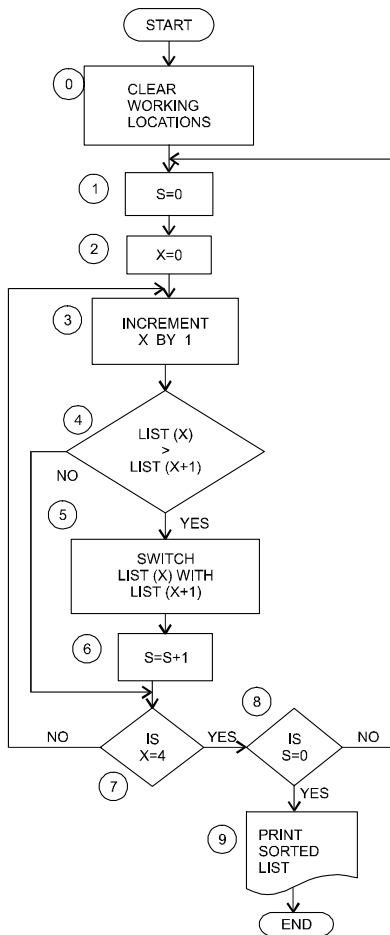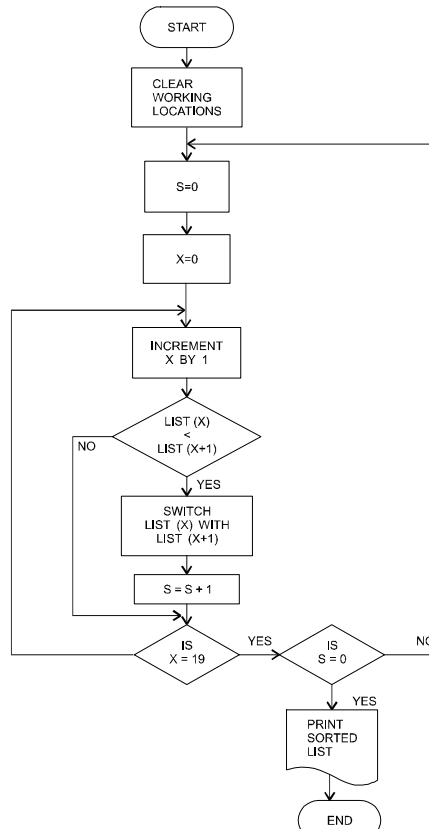
Fig. 5.46   Fig. 5.47

Step 3. X is incremented by 1 so that step 4 reads "Is LIST (2) > LIST (3) ?" Since we know LIST (2) = 5 and LIST (3) = -2 and as such the answer to the question of step 4 is in affirmation. We, therefore, proceed with step 5 and switch the contents of the two locations. In step 6, the switch counter is incremented by 1 to count that one switching has taken place.

In this manner, the loop is executed 4 times (X = 4 in step 7) and then we take up step 8 which poses the question. "Is S, switch counter = 0 ?". We know S ≠ 0: therefore, the flowchart loops back to step 1 for the 2nd pass.

Note 1 - If it were required to draw the flowchart for sorting these quantities in the descending order the above flowchart with step 4 modified as below would serve the purpose.

LIST (X) < LIST (X + 1)

Ref. to example 33 (B)

Note 2 - In the above flowchart, we have condensed the printing step 9. Supposing the list were to be printed in the format below, expand step 9 as an exercise.

-2 (Start print position 035)

1

4

5

7

Example 33B : Write a computer programming flowchart to arrange 20 Members in descending order.

Solution : *See Figure* 5.47

Benefits of flowcharts

The benefits of flowcharts are elucidated below :-

(*i*)   *Quicker grasp of relationships* - Before any application can be solved, it must be understood, the relationship between various elements of the application must be identified. The programmer can chart a lengthy procedure more easily with the help of a flowchart than by describing it by means of written notes.

(*ii*) *Effective Analysis* - The flowchart becomes a blue print of a system that can be broken down into detailed parts for study. Problems may be identified and new approaches may be suggested by flowcharts.

(*iii*) *Communication* - Flowcharts aid in communicating the facts of a business problem to those whose skills are needed for arriving at the solution.

(*iv*) *Documentation* - Flowcharts serve as a good documentation which aid greatly in future program conversions. In the event of staff changes, they serve as training function by helping new employees in understanding the existing programs.

(*v*)   *Efficient coding* - Flowcharts act as a guide during the system analysis and program preparation phase. Instructions coded in a programming language may be checked against the flowchart to ensure that no steps are omitted.

(*vi*) *Orderly check out of problem* - Flowcharts serve as an important tool during program debugging. They help in detecting, locating and removing mistakes.

(*vii*) *Efficient program maintenance* - The maintenance of operating programs is facilitated by flowcharts. The charts help the programmer to concentrate attention on that part of the information flow which is to be modified.

Limitations of flowcharts

The limitations of flowcharts are as given below :

(*i*) *Complex logic* - Flowchart becomes complex and clumsy where the problem logic is complex.

(*ii*) *Modification* - If modifications to a flowchart are required, it may require complete re-drawing.

(*iii*) *Reproduction* - Reproduction of flowcharts is often a problem because the symbols used in flowcharts cannot be typed.

(*iv*) *Link between conditions and actions* - Sometimes it becomes difficult to establish the linkage between various conditions and the actions to be taken there upon for a particular condition.

(*v*) *Standardisation* - Program flowcharts, although easy to follow, are not such a natural way of expressing procedures as writing in English, nor are they easily translated into Programming lauguage.

(*vi*) The essentials of what is done can easily be lost in the technical details of how it is done.

(*vii*) There are no obvious mechanisms for progressing from one level of design to the next *e.g.,* from system flowchart to run flowcharts, program flowchart etc.

EXERCISES SET 1

1. Draw flowcharts, one each for summing up the following series

(*i*) $1A + 2A^2 + 3A^3 + 4A^4 + ...$ N terms

(*ii*) $\dfrac{1}{2.3} + \dfrac{2}{3.4} + \dfrac{3}{4.5} + \dfrac{4}{5.6} + ...$N terms

(*iii*) $\dfrac{1}{\lfloor 2} + \dfrac{2}{\lfloor 3} + \dfrac{3}{\lfloor 4} + \dfrac{4}{\lfloor 5} + ...$N terms

(*iv*) $\dfrac{1.3}{2.4.5} + \dfrac{2.4}{3.5.6} + \dfrac{3.5}{4.6.7} + ...$N terms

(*v*) $1A - 2A^2 + 3A^3 - 4A^4 + ...$N terms

2.   Draw a flowchart for finding the 16th root of a number.

3.   Draw a flowchart for computing and printing the simple interest for 10, 11, 12, 13, and 14 years at the rate of 3% per annum on an investment of Rs. 10,000.

MISCELLANEOUS SOLVED EXAMPLES
(After having gone through these the student may want to redraw these by closing the book.)

Example 1 : Draw a flow chart to calculate the local taxes as per the following details :

Code No.	Type of Goods	Tax Rate
001	Perishable	15%
002	Textiles	10%
003	Luxury Items	20%
004	Machinery	12%

Solution : The required flowchart is drawn below :
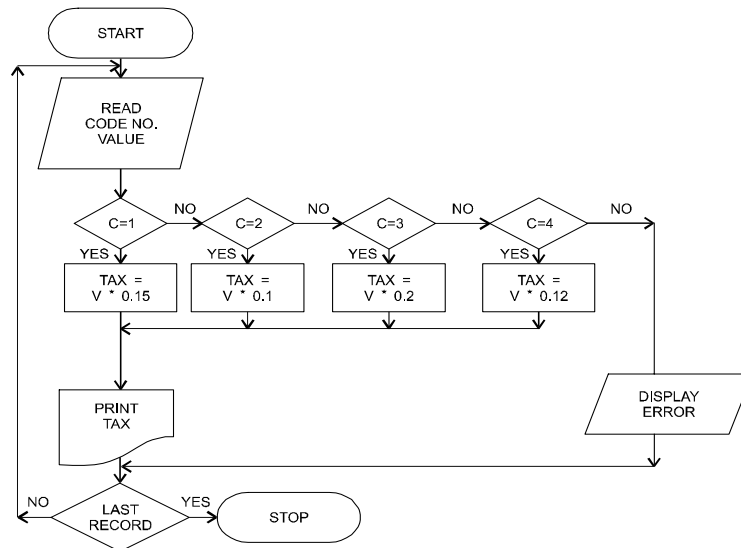
Fig. 5.48

Example 2 : Draw a flow chart to illustrate the following situation. Vishnu Limited calculates discounts allowed to customers on the following basis :

Order Quantity	Normal Discount
1-99	5%
100-199	7%
200-499	9%
500 and above	10%

These discounts apply only if the customer's account balance is below Rs. 500 and does not include any item older than three months. If the account is outside both these limits, the above discounts are reduced by 2%. If only one condition is violated, the discounts are reduced by 1%. If a customer has been trading with Vishnu Limited for over 5 years and conforms to both of the above credit checks, then he is allowed an additional 1% discount.

Solution : The required flowchart is drawn in Figure 5.49.
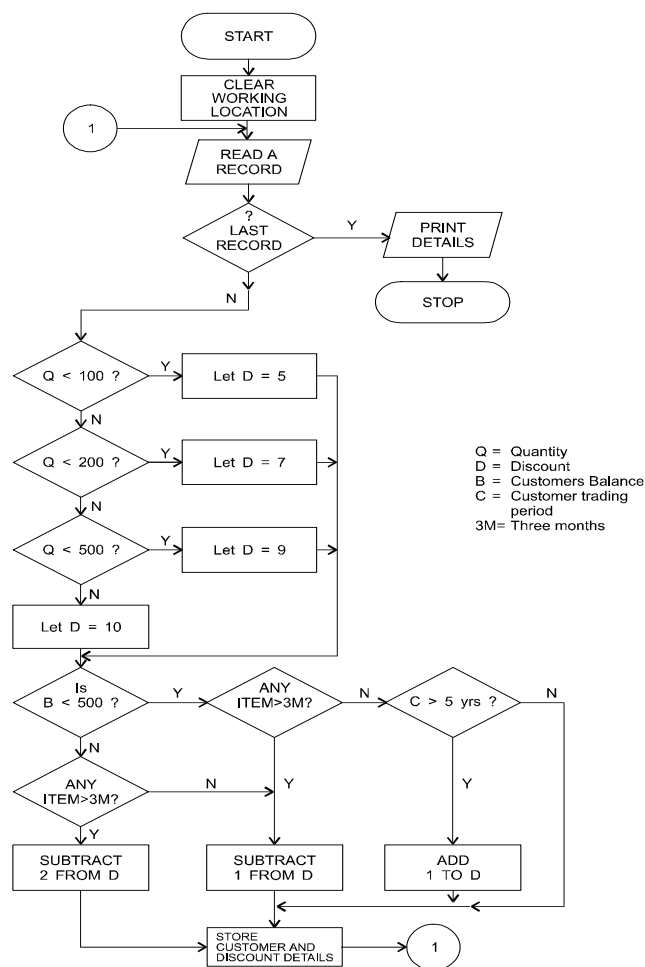
Fig. 5.49
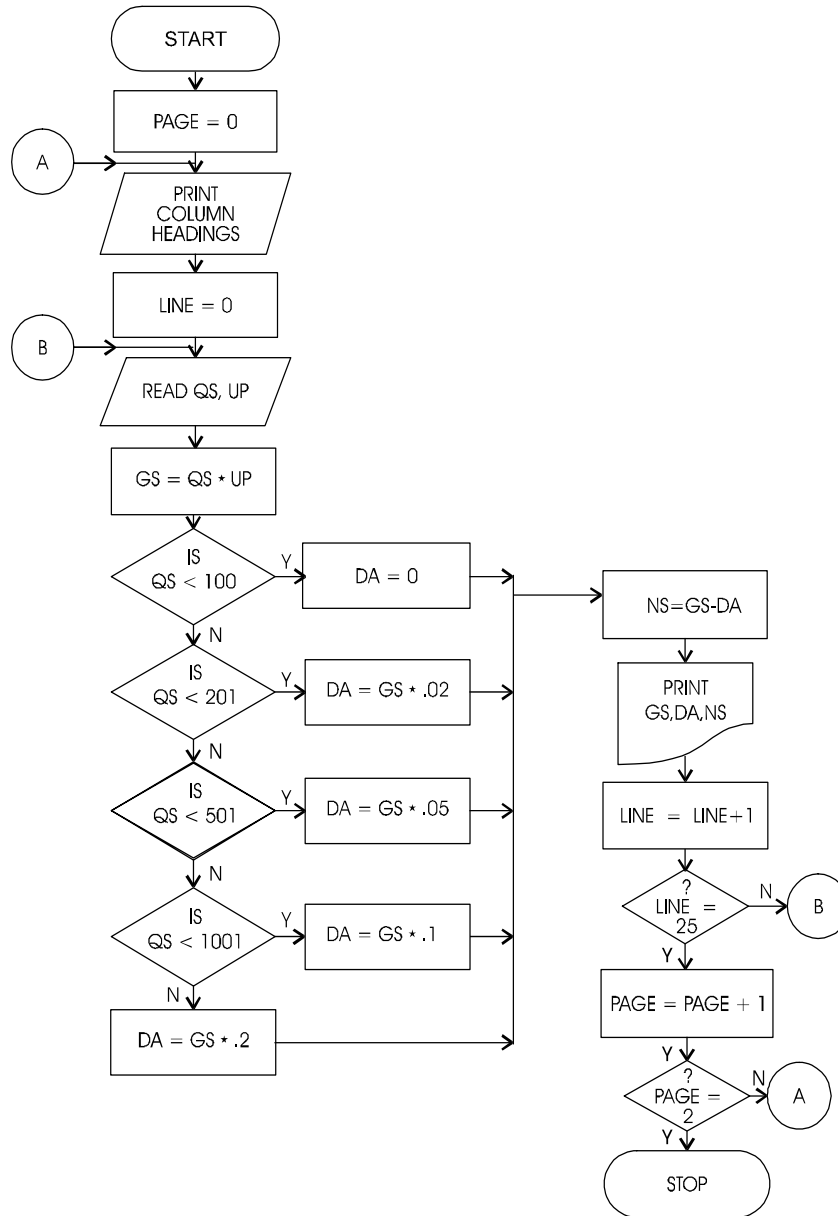
Fig. 5.50

Example 3 : Draw a flow chart to compute and print for 50 transactions (assuming all are correct).

The Gross Sales (GS)

Discount Allowed (DA), and

Net Sales (NS).

The input document shall provide the Quantity Sold (QS) and the Unit Price (UP). The discount is allowed as under :

No. of units sold	Discount admissible
Less than 100	Nil
100-200	2%
201-500	5%
501-1000	10%
More than 1000	20%

It should also be noted that 25 transactions must be printed on one page. Suitable column headings such as Gross Sales, Discount allowed and Net Sales must be printed on every page.

Solution : The required flowchart is drawn in **Figure 5.50.**

Example 4 : Salaries of 100 persons are designated by J(S), S = 1, 2, 3...100. Draw flowchart for finding % age of the following salary range.

< Rs. 1500 (per month)

1500 to 3000

> 3000

Solution : The flowchart is drawn in **Figure 5.51**
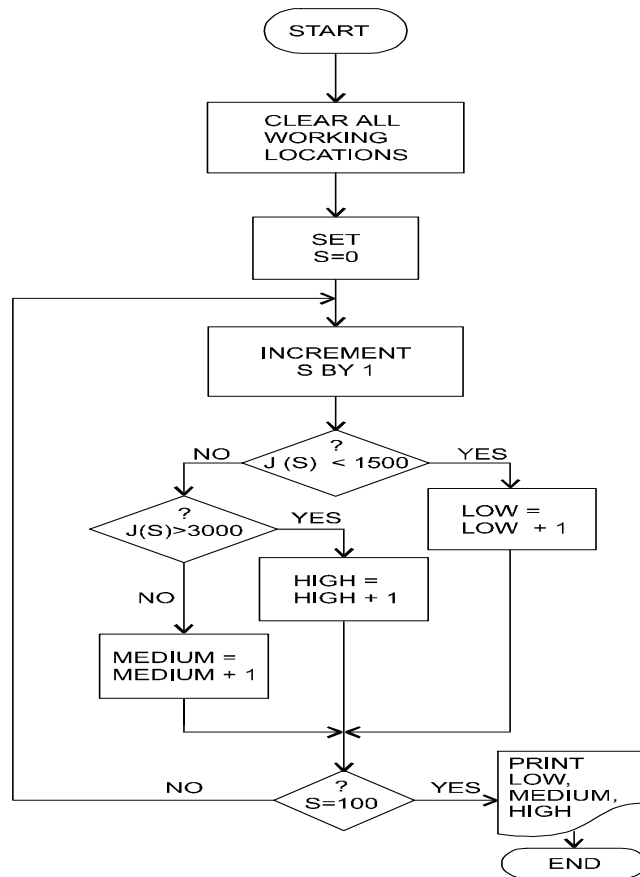
Fig. 5.51

Example 5 : Draw a program flowchart to compute and print the sum of squares of the following ten numbers:

3, 5, 10, 17, 26, 37, 50, 65, 82, 101

Solution : The required flowchart is drawn in **Fig. 5.52.**

Example 6 : A Nationalised Bank has the following policy to its depositors :

On deposits of Rs. 5,000 or above and for three years or above, the interest payable is 10%, on deposits for the same amount and for less than three years, the interest is 8% and on deposits below Rs. 5,000, the interest rate is 7% irrespective of the period.
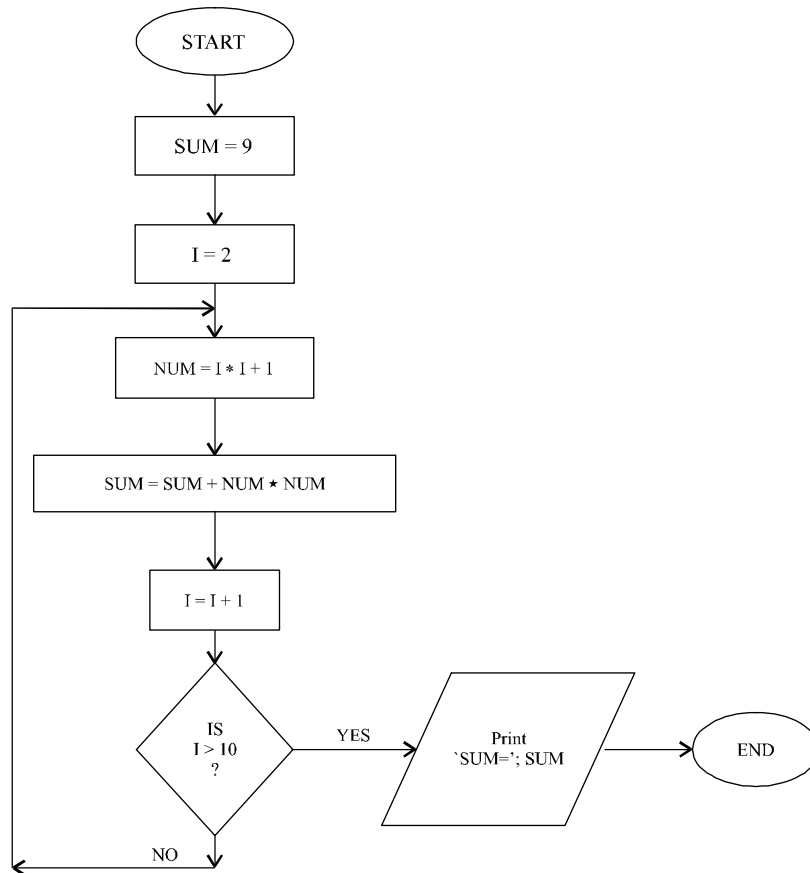
Fig. 5.52

Draw a flow chart to compute the interest for the above given information and print the same.

Solution : The flowchart is given in **Fig. 5.53.**

Example 7 : Draw a flow chart to compute and print income-tax and surcharge on the income of a person, where income is to be read from terminal and tax is to be calculated as per the following rates :
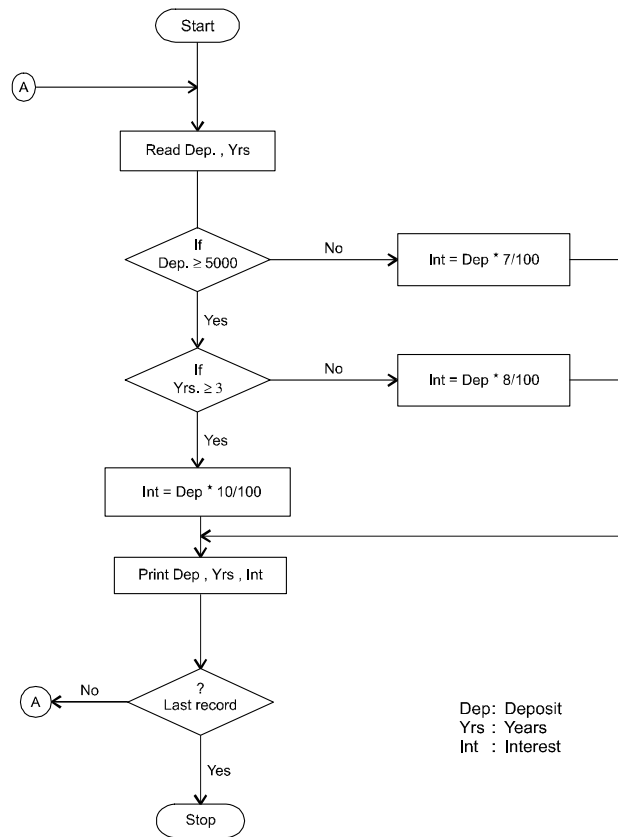
Fig. 5.53

Upto Rs. 40,000	No tax
Upto Rs. 60,000	@ 10% of amount above Rs. 40,000
Upto Rs. 1,50,000	Rs. 2,000 + 20% of amount above Rs. 60,000
Above Rs. 1,50,000	Rs. 20,000 + 30% of amount above Rs. 1,50,000

Charge surcharge @ 2% on the amount of total tax, if the income of a person exceeds Rs. 2,00,000.

Solution : The required flow chart is given in **Fig 5.54 :**

Example 8 : Acme India is engaged in selling of electrical appliances to different categories of customers. In order to promote its sales, various types of discounts are offered to various customers. The present policy is as follows :
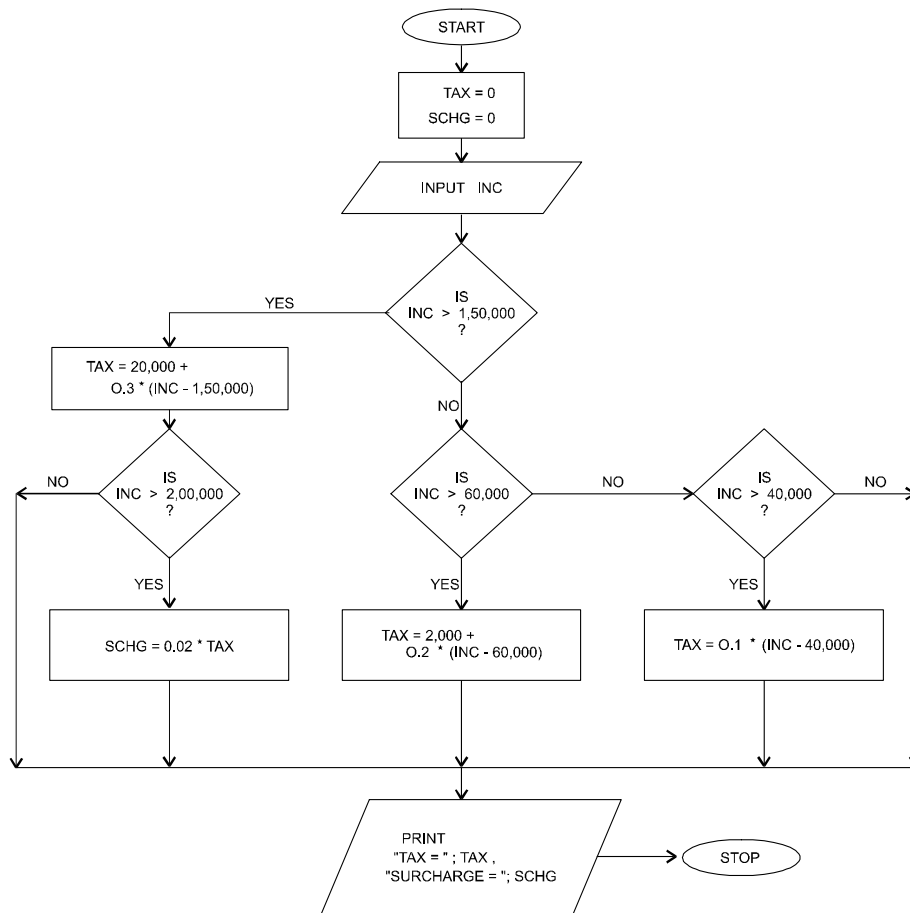
Fig. 5.54

(*i*)   On cooking range, a discount of 10% is allowed to wholesaler and 7% to retailers if the value of the order exceeds Rs. 5000. The discount rates are 12% and 9½%, if the value of the order is Rs. 10,000 and above.

(*ii*)   A discount of 12% is allowed on washing machine irrespective of the class of customer and value of the order.

(*iii*)   On decorative items, wholesalers are allowed a discount of 20% provided the value of the order is Rs. 10,000 and above. Retailers are allowed a discount of 10% irrespective of the value of the order.

Draw a program flowchart for the above procedure.

Solution : *See* Figure 5.55.

Fig. 5.55

First flowchart (M)

- M
- Decision: AMT > 10000 ?
  - Y → DISC = AMT ★ .095
  - N ↓
- Decision: AMT > 5000 ?
  - Y → DISC = AMT ★ .07
  - N ↓
  - B
- PRINT DISC
- B

Second flowchart (L)

- L
- Decision: AMT > 10000 ?
  - Y → DISC = AMT ★ .12
  - N ↓
- Decision: AMT > 5000 ?
  - Y → DISC = AMT ★ .10
  - N ↓
  - B
- PRINT DISC
- B
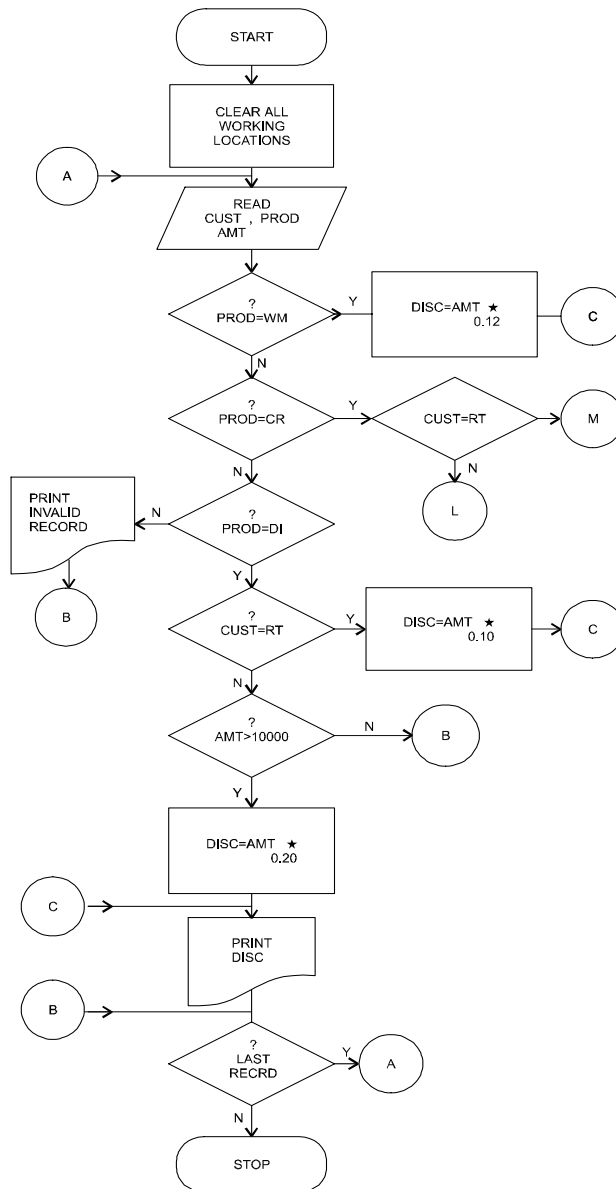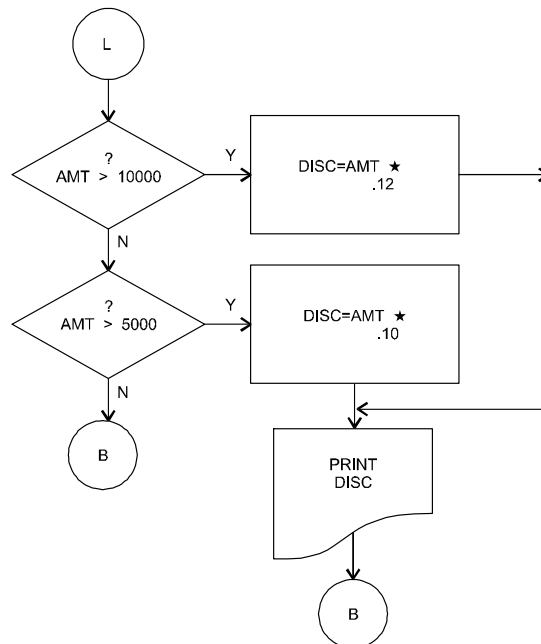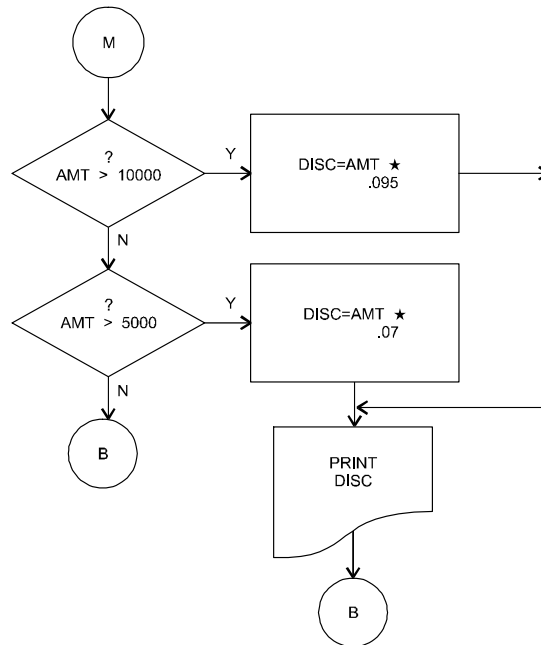
5.4.3 *Dry Run and Debugging the Program* - In Chapter 6, we stated that any program of some scope even written with great care is likely to contain some mistakes known as bugs in the technical jargon. There, therefore, is a need to remove these mistakes or to debug the program. Debugging should start with the review of the flowchart through review of the Program code and finally testing the program with fictitious data in one or more computer set-ups.

Review of the flowchart is also carried out by means of fictitious data and as such is known as the dry run since no computer setup is involved. We shall take up the flowchart of example 5 to elucidate the means to carry out the dry run. This flowchart is concerned with picking up the highest and the lowest of three quantities: Q1, Q2, and Q3 putting them in locations designated by H and L respectively.

The flowchart of Fig 5.16 is reproduced below in Fig. A except for the deliberate mistakes indicated by the crooked arrows in this Fig (A). "Yes" and "No" have been interchanged, *i.e.,* bugs have been deliberately introduced. Now let us see how these bugs are detected by means of the dry run.

We shall try three sets of values for Q1, Q2 and Q3 as below :

	Q1	Q2	Q3	
Set 1	6	2	14	Q3 > Q1 > Q2
Set 2	3	7	15	Q3 > Q2 > Q1
Set 3	2	4	3	Q2 > Q3 > Q1
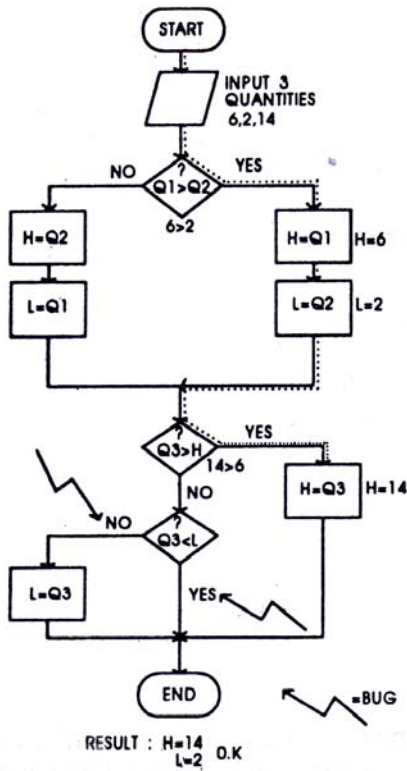
Fig. A
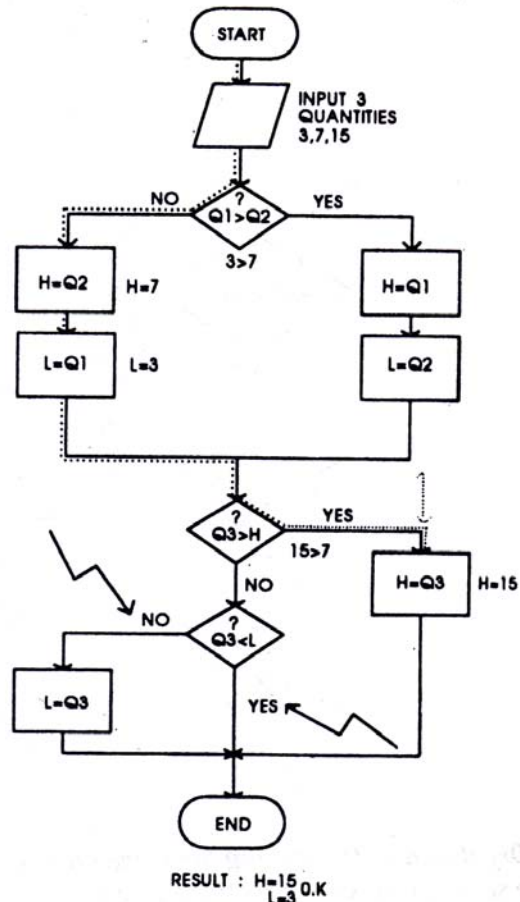
Fig. B

In Fig. A, the data of the 1st set have been 'flown' in the flowchart and it flows across the dotted lines in the flowchart. Ultimately, we end up with 14 in H and 2 in L. This is correct since we can see for ourselves that in the first set 14 is the highest and 2 is the lowest.

In Fig. B, the data of the 2nd set is flown and it flows across the dotted lines in this flowchart. Again, we end up with the correct result, 15 as the highest and 3 as the lowest in H and L respectively.
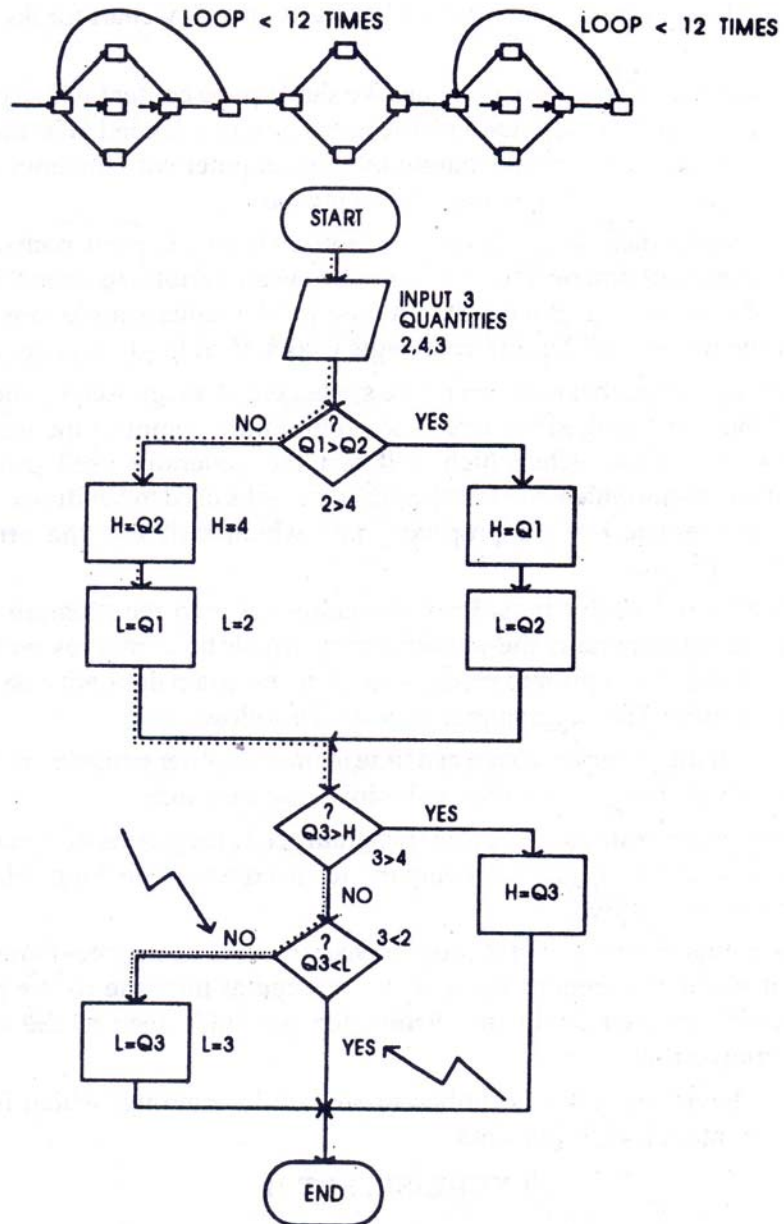
Fig. C -

In Fig. C the data of the 3rd set is flown. Here we end up with 4 in H and 3 in L which is wrong since we can see that 2 is the lowest in the 3rd set where as we are getting 3 as the lowest. This arouses our suspicion and we would carefully scrutinise the lower portion of the flowchart until we detect the bugs.

Following this up we shall rectify the flowchart and the program code.

[By means of such dry runs student may want to verify the flowchart for the exercises he draws].

In larger flowchart with many more branches we shall not be content with a mere dry run. We shall actually set up the computer with the given program loaded in its memory, input the test data, and compare the results output by the computer with the ones computed in longhand. The task of debugging is formidable indeed.

In complex programs there may be tens of thousands of different paths through the program. It is simply not practical (and may not be even possible) to trace through all the different paths during testing. Boehm determined for the rather simple looking program flowchart that the number of the different paths is as astoundingly high as 10^{20}.

It is to be noted; however, that removal of the syntax errors diagnosed by the compiler is not the part of the debugging procedure. The programmer complies the test data which should contain (1) typical data which will test the generally used program paths; (2) unusual but valid data which will test the program paths used to handle exceptions; and (3) incorrect, incomplete, or inappropriate data which will test the error handling capabilities of the program.

The programmer, after the dry runs, loads the computer with the program to be tested, inputs the test data and obtains the output results which he compares with the results derived by him in long hand prior to processing. If the program does not pass the test, *i.e.,* the results do not tally, The programmer may do the following :

1. Trace through the program, a step at a time at the computer console : but this facility is, usually, available with smaller and mini computers only.

2. Call for a trace program run. The trace program prints the results of execution of each instruction in detail. It is thus comparable to console checking. However, less machine time is required.

3. Call for a storage dump when the program hangs up (*i.e.,* computer hums) *i.e.,* obtain a printout of the contents of the primary storage at the time of the hangup. The programmer can then study this listing for possible clues to the cause of the programming errors.

However, more bugs may come to notice upon parallel running, which is done upon program implementation with live data.

EXERCISE, SET II

(The student must do these. Mere understanding of examples is not enough).

1. Wages of 500 workers are held in J(W), W = 1, 2 ...500. Draw the program flowchart for compiling the frequency distribution and printing it in the following formats :

Class Interval	Frequency
<300	
300<400	
400<500	
500<600	
600<700	
700<800	
800<900	
>900	

2. Out of an array of number J(N), N = 1, 2...100, 5 numbers are known to be zeros. You have to draw the program flowchart for squeezing the zeros out *i.e.,* rearrange the 95 non-zeros number in location J(N), N = 1, 2...95.

   Also, extend the flowchart for printing these 95 numbers in a 19 × 5 matrix: assume that a number is at most of six digits.

3. J(E), E = 1, 2...42 contains 42 quantities of 7 × 6 matrix. Draw the program flowchart for printing its transpose; assume that a number is at most of 5 digits.

4. Names of eleven cricket players are held in J(X), X = 1, 3, 5.... 21 and their respective batting average in J(X), X = 2,4...22. You are to arrange the eleven players in the descending order of their batting averages.

5. Draw the program flowchart for summing up 1, 11, 111, 1111,...(10 terms)

6. J(X), X = 1, 2...200 designate numbers. Draw the program flowchart for computing the following :

   1. The % ages of negative, zero and positive numbers.

   2. The sum of the -ve and +ve numbers separately.

   3. The sum of the absolute number.

   4. The sum of squares of all the numbers.

7. Draw the program flowchart for printing the following pattern on the continuous stationery.

```
        M                                               M
          M                                           M
            M                                       M
              M                                   M
                M                               M
                  M                           M
                    M                       M
                      M               M
                        M
```

8. Assume that you opened a savings account with a local bank on 1-1-2000. The annual interest rate is 11.75%. Interest is compound at the end of each month. Assuming that your initial deposit is X rupee, draw a flowchart to print out the balance of your account at the end of each month for two years.

9. Write a program flowchart to compute the mean and S.D. of Numbers denoted by J(X), X = 1, 2...N.

10. The Median of a list of numbers is defined to be that item in the list which has as many items greater than it as less than it. If there are an even number of items in the list, the median is the average of the two middle items. Draw a Program flowchart to read a list of numbers and print the median.

(Hints: Sort the list first)

11. A + ve integer is called "perfect" if it equals the sum of its proper divisors. For example, the numbers 6 and 28 are perfect because,

$$6 = 1 + 2 + 3$$

$$28 = 1 + 2 + 4 + 7 + 14$$

Write a flowchart to decide whether a given + ve integer is perfect.

CHAPTER 6

DECISION TABLE

INTRODUCTION

A decision table is a table which may accompany a flowchart, defining the possible contingencies that may be considered within the program and the appropriate course of action for each contingency.

Decision tables are necessitated by the fact that branches of the flowchart multiply at each diamond (comparison symbol) and may easily run into scores and even hundreds. If, therefore, the programmer attempts to draw a flowchart directly, he is liable to miss some of the branches.

A decision table is divided into four parts :

(1) *Condition Stub* - (which comprehensively lists the comparisons or conditions);

(2) *Action Stub* which comprehensively lists the actions to be taken along the various program branches;

(3) *Condition entries* which list in its various columns the possible permutations of answer to the questions in the conditions stub); and

(4) Action entries (which lists, in its columns corresponding to the condition entries the actions contingent upon the set of answers to questions of that column)

A decision table is given below as an example :—

		Granting Credit Facility	R1	R2	R3	
Part 1	C1	Credit limit Okay	Y	N	N	Part 3
	C2	Pay experience Favourable	-	Y	N	
Part 2	A1	Allow Credit Facility	X	X		
	A2	Reject Order			X	Part 4

There are two conditions: C_1 and C_2 in this table and two actions: A_1 and A_2. According to R_1 (a set of rules), if there is a "Yes" to C_1 and C_2 is to be bypassed, action A_1 will be taken, that is, "Allow credit facility". Under R3, Nos to both C_1 and C_2 requires action A_2 to be taken. With this example, we give below the components of the decision table in more detail.

(*a*) *Condition Statement* - Statement which introduce one or more conditions (*i.e.,* factors to consider in making a decision)

(*b*) *Condition Entries* - Entries that complete condition statements.

(*c*) *Action Statements* - Statements which introduce one or more actions (*i.e.,* steps to be taken when a certain combination of conditions exist)

(d) Action Entries - Entries that complete the action statements.

(*e*) *Rules* - Unique combinations of conditions and actions to be taken under those conditions.

(f) Header - Title identifying the table.

(g) Rule Identifiers - Code (R1, R2, R3,) uniquely identifying each rule within a table.

(h) Condition Identifiers - Codes (C1, C2, C3,...) uniquely identifying each condition statements/entry.

(*i*) *Action Identifiers* - Codes (A1, A2, & A3...) uniquely identifying each action statement/entry

These items are contained within the body of the table which is divided into four major sections by double or heavy vertical and horizontal lines as in the table above.

6.1 TYPES OF DECISION TABLE

Limited Entry Tables - In a limited entry table the condition and action statements are complete. The condition and action entries merely define whether or not a condition exists or an action should be taken. The symbols used in the condition entries are :

Y: Yes, the condition exists

N: No, the condition does not exist.

— : Irrelevant, the condition does not apply, or it (or blank) makes no difference whether the condition exists or not.

The symbols used in the action entries are:

X : Execute the action specified by the (or blank) action statement.

— : Do not execute the action specified by the (or blank) action statement.

Extended Entry Table : The condition and action statements in an extended entry table are not complete, but are completed by the condition and action entries.

Example :

	Granting Credit Facility	R1	R2	R3
C1	Credit Limit	OK	Not OK	Not OK
C2	Pay Experience	-	Favourable	Unfavourable
A1	Credit Facility	Allow	Allow	-
A2	Credit Action	-	-	Reject Order

Mixed Entry Table : The third type of decision table is the mixed entry form which combines both the limited and extended entry forms. While the limited and extended entry forms can be mixed within a table, only one form may be used within a condition statement/entry or an action statement/entry.

Example :

	Granting Credit Facility	R1	R2	R3
C1	Credit Limit Okay	Y	N	N
C2	Pay Experience	-	Favourable	Unfavourable
A1	Credit	Allow	Allow	-
A2	Reject Order			X

A systematic approach to the development of a limited entry decision table is presented below

6.2 STEPS IN PREPARING A LIMITED ENTRY DECISION TABLE

1. List conditions and actions.

2. Combine conditions which describe the only two possibilities of a single condition. In other words, delete conditions which can be derived from the responses of the other conditions.

3. Make yes or no (Y or N) responses and mark actions to be taken for each rule with X.

4. Combine redundant rules to simplify table.

5. Check for completeness.

    An example will be used to explain and illustrate the procedure.

6.2.1 Solved Examples

Example 1 : A shop owner allows credit facility to his customers if they satisfy any one of the

following conditions :

1. Holding the present job for more than 3 years and residing in the same place for more than 5 years.

2. Monthly Salary exceeds Rs. 1500 and holding the present job for more than 3 years.

3. Residing in the same place for more than 5 years and monthly salary exceeds Rs. 1500.

The facility is rejected for all other customers.

Solution : *Step 1 is to write down all of the conditions and actions :*

Conditions involved in the problems are :

1. Holding the present job for more than 3 years.

2. Holding the present job for 3 years or less than 3 years.

3. Monthly salary exceeds Rs. 1500.

4. Monthly salary equals Rs. 1500 or less than Rs. 1500.

5. Residing in the same place for more than 5 years.

6. Residing in the same place for 5 years or less than 5 years.

Actions involved in the problem are :

1. Allow credit facility.

2. Reject credit facility.

Step 2 is to combine conditions which only describe the two possibilities of a single condition :

"Holding the present job for more than 3 years" and "Holding the present job for 3 years or less than 3 years" can be combined. A single condition "holding the present job for more than 3 years" can represent both because a "No" answer means holding the present job for more than 3 years or less than 3 years. The same reasoning allows the combination of 3 & 4 and also 5 & 6.

There are thus only three conditions :

1. Holding the present job for more than 3 years.

2. Monthly salary exceeds Rs. 1500.

3. residing in the same place for more than 5 years.

Step 3 is to prepare the Yes and No responses using Y and N for all possible combinations of conditions and for each set of conditions, mark the actions to be taken with an X.

No. of rules = $2^{\text{no of conditions}}$

In the example, there are three conditions, so there will be 2^3 or 8 rules. The Y's and N's can be inserted in any order, but a systematic method will reduce the effort of filling in the table and reduce the chance of error. Start with the bottom row of the condition entries and fill in the row starting with Y and then alternating between N and Y. The row above this is filled in by writing two Y's, two N's, two Y's etc. The third row from the bottom uses sets of four Y's and four N's. This doubling of the sets of Y's and N's continues until the table is complete. Then analyse each rule and fill in the action entries. The Figure below shows the completed table at this stage.

	Allowing Credit Facility	R1	R2	R3	R4	R5	R6	R7	R8
C1	Holding the present job for more than 3 years	Y	Y	Y	Y	N	N	N	N
C2	Monthly salary exceeds Rs. 1500	Y	Y	N	N	Y	Y	N	N
C3	Residing in the same place for more than 5 years	Y	N	Y	N	Y	N	Y	N
A1	Allow credit facility	X	X	X		X			
A2	Reject credit facility				X		X	X	X

Step 4 is to combine rules where there are redundancies :

Two rules can be combined into a singie rule if :

(*i*) all of the conditions except one have the same Y or N (or—) condition entries and

(*ii*) the actions are the same for both.

Rule with impossible combination of condition entries can be combined with any other rule if

(*iii*) all of the conditions except one have the same Y or N (or—) condition entries. (see Example 2)

Combine the two rules into one and replace the condition entry of Y and N with a dash (–), which means the condition does not affect the action to be taken. Using this procedure, rule R1 and R2 can be combined. In other words, if holding the present job for more than 3 years and monthly salary exceeds Rs. 1,500, then the credit facility is allowed without regard to the third condition *viz.* residing in the same place for more than 5 years. Rules R7 & R8 (or R4 & R8) can be combined. The resulting table, after redundancies removed, is shown below :

	Allowing Credit Facility	R1	R2	R3	R4	R5	R6
C1	Holding the present job for more than 3 years	Y	Y	Y	N	N	N
C2	Monthly salary exceeds Rs. 1500	Y	N	N	Y	Y	N
C3	Residing in the same place for more than 5 year	—	Y	N	Y	N	—
A1	Allow credit facility	X	X		X		
A2	Reject credit facility			X		X	X

Step 5 is to check for completeness of the rules :

(1) Count number of dashes in the condition entries for each rule. The number of rules "represented" by each rule are 2^m where m is the number of dashes. Where there are no dashes, the number represented is 2^0 or 1. A single dash means 2 rules have been combined etc.

(2) Sum the number of rules represented by the different rules as computed above.

(3) Compare the number of rules represented by the reduced table with the number to be accounted for, which is 2^n (n no of conditions) If they are equal (and all other features are correct), the table is complete.

In the example, rules R1 & R6 have one dash and rules R2, R3, R4 and R5 have no dashes. The sum of the rules represented by the rules in the reduced table is 2+1+1+1+1+2 which is equal to 2^3 or 8.

Therefore, the reduced table is complete.

Example 2 : Select the largest of three distinct numbers A,B,C

Solution : *Step 1* - Conditions involved in the problem are :

1. A > B

2. A > C

3. B > A

4. B > C

5. C > A

6. C > B

Actions involved in the problem are :

1. A is largest

2. B is largest

3. C is largest

Step 2 - Conditions 1 & 3 can be combined

Conditions 2 & 5 can be combined

Conditions 4 & 6 can be combined

Therefore, there are only three conditions :

1. $A > B$

2. $A > C$

3. $B > C$

Step 3 - No. of rules $\quad = 2^{nd}$ conditions

$= 2^3 = 8$

	Select Largest	R1	R2	R3	R4	R5	R6	R7	R8
C1	$A > B$	Y	Y	Y	Y	N	N	N	N
C2	$A > C$	Y	Y	N	N	Y	Y	N	N
C3	$B > C$	Y	N	Y	N	Y	N	Y	N
A1	A is largest	X	X						
A2	B is largest					X		X	
A3	C is largest				X				X

*R3 & R6 contain impossible combination of condition entries.

Step 4 - R1 & R2 can be combined

R3 & R4 can be combined

R5 & R7 can be combined

R6 & R8 can be combined

	Select largest	R1	R2	R3	R4
C1	A > B	Y	Y	N	N
C2	A > C	Y	N	—	—
C3	B > C	—	—	Y	N
A1	A is largest	X			
A2	B is largest			X	
A3	C is largest		X		X

Step 5 - All the rules in the reduced table have one dash. Therefore, the sum of the rules represented by rules in the reduced table is $2^1 + 2^1 + 2^1 + 2^1$ which is equal to 2^3 or 8. No. of conditions is 3 and hence the No. of rules to be accounted for is 2^3 or, 8. Therefore the reduced table is complete.

If problem has many conditions, the decision table may become quite large and difficult to follow. Since the objective of the table is to show the logic of the procedure as clearly and as simply as possible, a large, complex table should be avoided. In most cases, a large problem with many conditions can be subdivided into two or more tables. One or more of the actions of the first table will specify that the user should proceed to another table to complete the logic. An example is given to illustrate this use of more than one table.

Example 3 : A sales organisation is seeking to hire some salesmen and sales-women having special characteristics. They need only unmarried personnel between the age of 18 and 30. If male, they want the salesman to be over 5½ ft in height but less than 75 Kg. in weight and not bald. If female, the saleswoman is to be less than 5½ ft. in height and less than 55 kg. in weight and is to have shoulder-length hair.

Solution : This problem has nine conditions, which would mean a table with 2^9 = 522 rules before reduction. But the problem fits logically into three parts : the overall criteria, male criteria, and female criteria. This suggests that three decision tables should be used-initial screening, male selection and female section. The result of this use of three tables is shown below. All tables have redundancies removed.

	Initial screening	R1	R2	R3	R4
C1	Unmarried	Y	Y	Y	N
C2	Age between 18 & 30	Y	Y	N	—
C3	Male	Y	N	—	—
A1	Go to male selection table	X			
A2	Go to female selection table		X		
A3	Reject			X	X

	Male selection	R1	R2	R3	R4
C1	Over 5½ ft. in height	Y	Y	Y	N
C2	Less than 75 Kg. in weight	Y	Y	N	—
C3	Not bald	Y	N	—	—
A1	Hire	X			
A2	Reject		X	X	X

	Female selection	R1	R2	R3	R4
C1	Under 5½ ft. in height	Y	Y	Y	N
C2	Less than 55 kg. in weight	Y	Y	N	—
C3	Shoulder-length hair	Y	N	—	—
A1	Hire	X			
A2	Reject		X	X	X

As a reader develops some skill, he may be able to arrive more directly at the final table. However, the beginner should proceed carefully.

6.2.2 Exercises

1. Analyse the completeness of the following decision table :

	Table X	R1	R2	R3	R4	R5
C1	Condition A	Y	N	N	N	N
C2	Condition B	Y	Y	N	N	N
C3	Condition C	—	N	—	Y	N
C4	Condition D	—	—	—	N	N
A1	Action 1	X		X	X	
A2	Action 2		X			X

3. Prepare decision table for each of the following.

A cheque is presented at a bank. The cashier has to decide what to do. The rules state that "on presentation of a cheque the cashier is required to ensure that there are sufficient funds in the account to meet the amount specified and to check that there exist no reasons why the cheque should not be honoured. Those cheques accepted and which are of outstation are charged a handling fee, otherwise a charge at standard rates will be made".

4. A University has the following criteria for deciding whether or not to admit a student for its graduate school :

2.   Complete and simplify the following decision table.

Reservation procedure	RULES															
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16
C1 Request for I Class																
C2 Requested Space available																
C3 Alternate Class acceptable																
C4 Alternate Class available																
A1 Make I Class reservation																
A2 Make tourist reservation																
A3 Name on I Class wait list																
A4 Name on tourist wait list																

Admit a student who has undergraduate grades of B or better, has test scores of the admission tests of over 550 and has a grade average of B or better for the past two years. Also, admit if overall grade average is less than B but the last two years average is B or better and the test scores is over 550. Admit on probation if the over all and 2 years grade averages are B or better and test scores is 550 or less. Admit on probation if overall grades are B or better and test score is above 550 but last 2 years grade averages are below B. Also, admit on probation if overall grade average are less than B and test score is 550 or less, but grades for past two years are B or better. Refuse to admit all others.

Prepare a decision table for the above criteria.

6.3 FLOWCHART FOR A DECISION TABLE

Example : Below is given the decision table on the wage calculation in an organisation. Gross Pay (G.P.) is derived from the Guaranteed Minimum (G.M.) as follows:

$$\begin{aligned} G P \quad &= \quad 1.05 \text{ GM when quantity produced,} \qquad Q \geq 100 \\ &= \quad 1.15 \text{ GM when} \qquad\qquad\qquad\qquad\quad Q \geq 120 \\ &= \quad 1.25 \text{ GM when} \qquad\qquad\qquad\qquad\quad Q \geq 130 \end{aligned}$$

Also awarded is the quality bonus if a certain level of quality has been attained by the worker. However, in case $Q \geq 130$ and the worker also attains the aforesaid quality level, his gross pay GP = 1.25 GM + Quality bonus is subject to an overall maximum check which is performed by means of subroutine, SR 2 with the details of which we would not concern ourselves for the limited purpose ahead. In the programme also incorporated is SR 3 which validates the Wage No. in a transaction *i.e.,* it checks if the wage No. is correct. Here again we would not be concerned with the details of the subroutine which are beyond the scope of this discussion. The exist from the program is made to a subroutine, SR4, the details of which we

ignore. The description has been captured in the first two parts of the decision table below :

Part I   Contains all the possible questions, 5 in number.

Part II   Lists all the possible actions.

Part III Lists the 9 feasible sets of answers. For example, the first set has 'Yes' to all the 5 questions and the last set has 'No' to the first question and it bypasses the other questions which is noted by dots in its column.

Part IV   Indicates, by means of crosses (X) the actions to be taken for each set of condition entries. For example, under the set of answers, 1 (all yes) there are four actions to be taken as noted by 4 crosses in the action entry column below it.

The systems analysts/programmer will first compile this decision table and therefrom draw the flowchart because he can set out the table without any likelihood of ignoring an answer set. In this section, our endeavour is to explain how the flowchart is drawn from a given table. We shall take this table as an example.

N.B., Often the flowchart for a decision table (when it is small) can be drawn by common sense by comprehending its items.

	Conditions		Rules									
		1	2	3	4	5	6	7	8	9	
	Valid wage No. ?	Y	Y	Y	Y	Y	Y	Y	Y	N	
Part I	Qty. produced³100?	Y	Y	Y	Y	Y	N	N	N	-	
	Qty. produced³120?	Y	Y	Y	Y	Y	N	-	-	-	Part III
	Qty. produced ³130?	Y	Y	N	N	-	-	-	-	-	sets of
	Quality bonus ?	Y	N	Y	N	Y	N	Y	N	-	Answer
	Gross pay = GP	-	-	-	-	-	-	X	X	-	
	GP = 1.05 GM	-	-	-	-	X	X	-	-	-	
	GP = 1.15 GM	-	-	X	X	-	-	-	-	-	
Part II	GP = 1.25 GM	X	X	-	-	-	-	-	-	-	Part IV
	Add quality bonus	X	-	X	-	X	-	-	-	-	sets of
Actions	do max. check	X	-	-	-	-	-	X	-	-	Answer
	SR. 2										
	do invalid wage										
	No SR 3	-	-	-	-	-	-	-	-	X	
	go to this table	-	-	-	-	-	-	-	-	X	
	do deductions										
	calculations	X	X	X	X	X	X	X	X		

In Fig. E, we draw the segment of the flowchart for answers and actions of column 1 in the table.

In Fig. F, we endeavour to superimpose the segment of column 2 (shown in dotted line in Fig. F) on Fig. E. But we see for the question "quality bonus" ?, for both 'yes' and 'no' to it we find

GP = 1.25 G.M.

Obviously then we should first compute

GP = 1.25 G.M.

and then pose this question *i.e.* Fig. F needs modification which has been done in Fig G.

In Fig. H, we have superimposed the segment for col. 3 (in crosses) onto that of fig. G and we notice that the question "quality bonus ?" has to be posed once again.

In this manner, we continue column-wise superimposition of segments until we end up with final flowchart as in Fig. I below,

This shows that the flowchart is drawn by trial and error from the given table and quite a few erasures and rework would be involved. Also, when the final flowchart has been drawn, it can be verified against the given decision table.
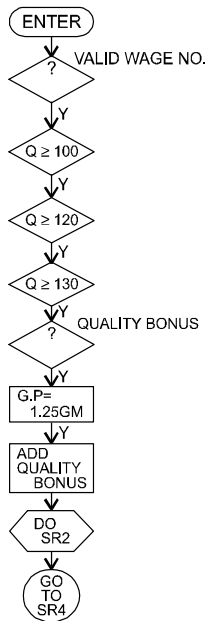
Fig. E
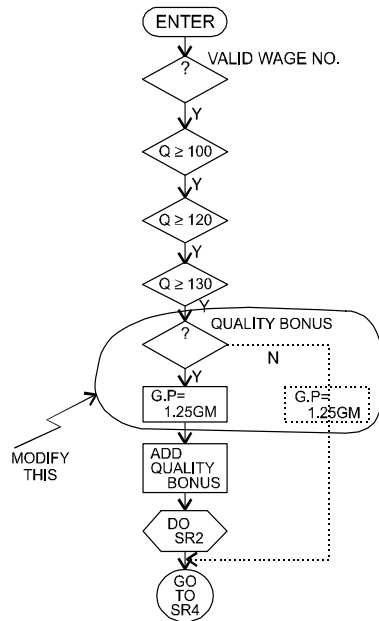
Fig. F
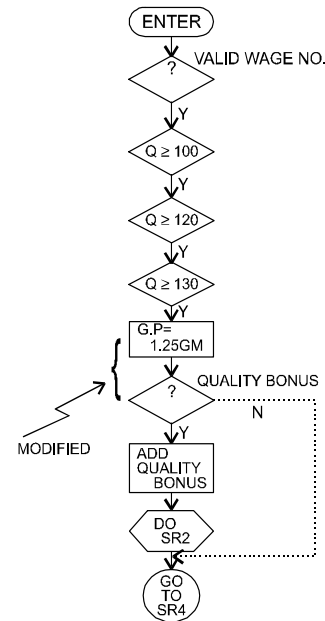
Fig. G
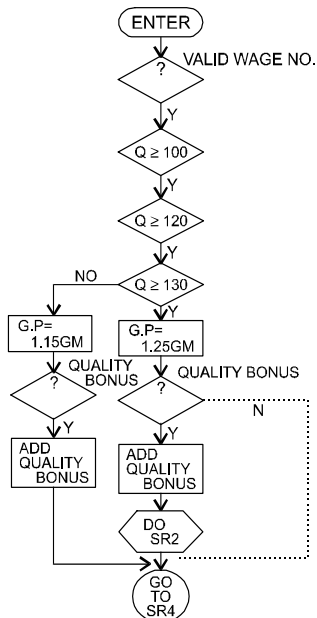
Fig. H
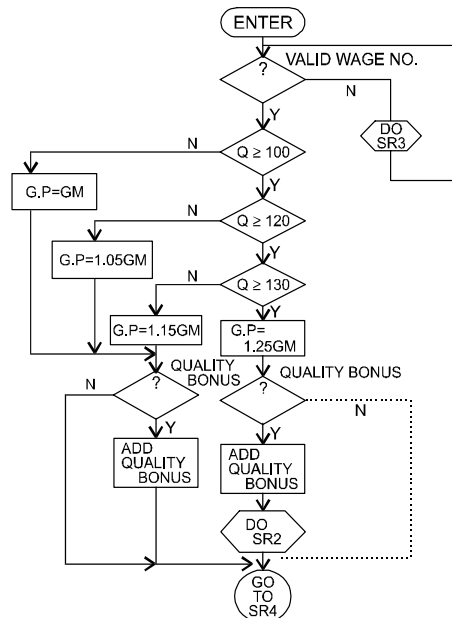
Fig. I

6.4 ADVANTAGES AND DISADVANTAGES OF DECISION TABLES

*A decision table has a number of **advantages** which are stated below :*

(*i*) A decision table provides a framework for a complete and accurate statement of processing or decision logic. It forces a discipline on the programmer to think through all possible conditions.

(*ii*) A decision table may be easier to construct than a flow chart.

(*iii*) A decision table is compact and easily understood making it very effective for communication between analysts or programmers and non-technical users. Better documentation is provided by it.

(*iv*) Direct conversion of decision table into a computer program is possible. Software packages are available which take the statement specifying a decision table and compile it into a program.

(*v*) It is possible to check that all test combinations have been considered.

(*vi*) Alternatives are shown side by side to facilitate analysis of combinations.

(vii) The tables show cause and effect relationships.

(*viii*) They use standardised format.

(*ix*) Typists can copy tables with virtually no question or problems.

(*x*) Complex tables can easily be split into simpler tables.

(*xi*) Table users are not required to possess Computer knowledge.

Disadvantages of using decision tables are as follows :

(*i*) *Total sequence* - The total sequence is not clearly shown *i.e.,* no overall picture is given by decision tables as presented by flow charts.

(*ii*) *Logic* - Where the logic of a system is simple, flowcharts nearly always serve the purpose better than a decision table.

6.5 MISCELLANEOUS EXERCISES

Question 1

The details of procedure for dealing with delivery charges for goods bought from ABC Company is given below :

For calculating the delivery charges, customers are divided into two categories, those whose sales region code is 10 or above and those with the code of less than 10.

If the code is less than 10 and the invoice amount is less than Rs. 10,000, the delivery charge

to be added to the invoice total is Rs. 200. But if the invoice value is for Rs. 10,000 or more, the delivery charge is Rs. 100.

If the code is equal to or greater than 10, the corresponding delivery charges are Rs. 250 and Rs. 150 respectively.

Required :

i. Prepare a decision table of the above procedure

ii. Prepare a program flowchart segment of the above procedure.

Question 2

While invoicing each customer, the invoice clerk has to work out the discounts allowable on each order. Any order over Rs. 20,000 attracts a "bulk" discount of 8%.

A   customer within the trade is allowed 10%. There is also a special discount of 5% allowed for any customer who has been ordering regularly for over 5 years.

Construct :- (*i*) A Flow Chart (*ii*) A decision table; to illustrate the clerical procedure for working out this management policy.

Question 3

A hire-purchases scheme has adopted the following criterion for its customers. The customers will get the credit facility if they satisfy any of the following conditions :

(*i*)   The customer must hold the present job for more than 5 years and reside in the same place at least for 3 years. In this case, the customer will get credit upto rupees three thousand.

(*ii*)   The monthly salary of the customer must exceed rupees two thousand and must hold the present job for more than 5 years. In this case credit will be given upto rupees four thousand.

(*iii*)   The monthly salary must exceed rupees two thousand and reside at the same place at least for 3 years. In this case credit will be given upto rupees four thousand.

(*iv*)   In the case, the customer's monthly salary exceeds rupees two thousand, holds the present job for more than 5 years and also reside in the same place at least for the 3 years, the credit facility will be upto rupees five thousand.

The credit facility is rejected for all other customers. Prepare a decision table for this hire-purchase scheme.

Question 4

A.   computer file has customer name, type, bill number, bill date, amount and the date of

payment. If the customer is a dealer and pays his bills within 30 days, 10% discount is allowed. If it is 30 to 45 days, discount and surcharge is zero. If he pays after 45 days, he has to pay 10% surcharge. The corresponding percentages for a manufacturer are 12½%, 0, 12 ½%.

a. Write a decision table for the above problem.

b. Write a flowchart to calculate the discount, surcharge and net amount of each customer and print.

Answer 1:   Decision Table

	Rules			
	1.	2.	3.	4.
Conditions	Condition entries			
Sales region code = 10.	Y	Y	N	N
Invoice amount < Rs. 10,000	Y	N	Y	N
Action Stub	Action entry			
Delivery charges				
Add Rs. 100 to invoice total			X	
Add Rs. 150 to invoice total	X			
Add Rs. 200 to invoice total				X
Add Rs. 250 to invoice total		X		

The flowchart is given below.
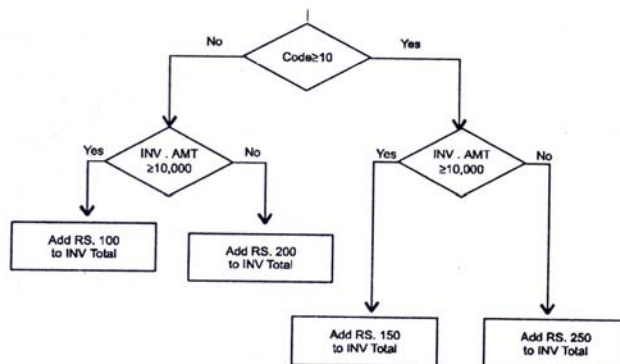
Answer 2 :

The flowchart is given below :

```
                    ┌─────────────────┐
                    │      START       │
                    └────────┬────────┘
                             │
    ┌────────────────────────┤
    │               ┌─────────────────┐
    │              ╱  READ  OV,  TC,    ╲
    │             ╱         YOR          ╲
    │             ╲                      ╱
    │              ╲────────────────────╱
    │                       │
    │                       ▼
    │                  ╱─────────╲
    │                 ╱   OV  >    ╲      NO
    │                 ╲  Rs. 20,000╱────────┐
    │                  ╲    ?     ╱         │
    │                   ╲───────╱           │
    │                    │ YES              │
    │                    ▼                  │
    │            ┌───────────────┐          │
    │            │ DISC = 0.08 × │          │
    │            │           OV   │          │
    │            └───────┬───────┘          │
    │                    ▼◄─────────────────┘
    │                 ╱─────────╲
    │                ╱    IS      ╲      NO
    │                ╲ HE  A  TC  ╱────────┐
    │                 ╲    ?     ╱         │
    │                  ╲───────╱           │
    │                   │ YES              │
    │                   ▼                  │
    │           ┌───────────────┐          │
    │           │ DISC = DISC +  │          │
    │           │   0.1 × OV     │          │
    │           └───────┬───────┘          │
    │                   ▼◄─────────────────┘
    │                ╱─────────╲
    │               ╱    IS      ╲      NO
    │               ╲ YOR > 5 YRS╱────────┐
    │                ╲    ?     ╱          │
    │                 ╲───────╱            │
    │                  │ YES               │
    │                  ▼                   │
    │          ┌───────────────┐           │
    │          │ DISC = DISC +  │           │
    │          │   0.05× OV     │           │
    │          └───────┬───────┘           │
    │                  ▼◄──────────────────┘
    │   NO      ╱─────────╲      YES   ┌────────┐
    └──────────╲  LAST     ╱──────────│  STOP   │
               ╲ RECORD   ╱           └────────┘
                ╲   ?    ╱
                 ╲──────╱
```
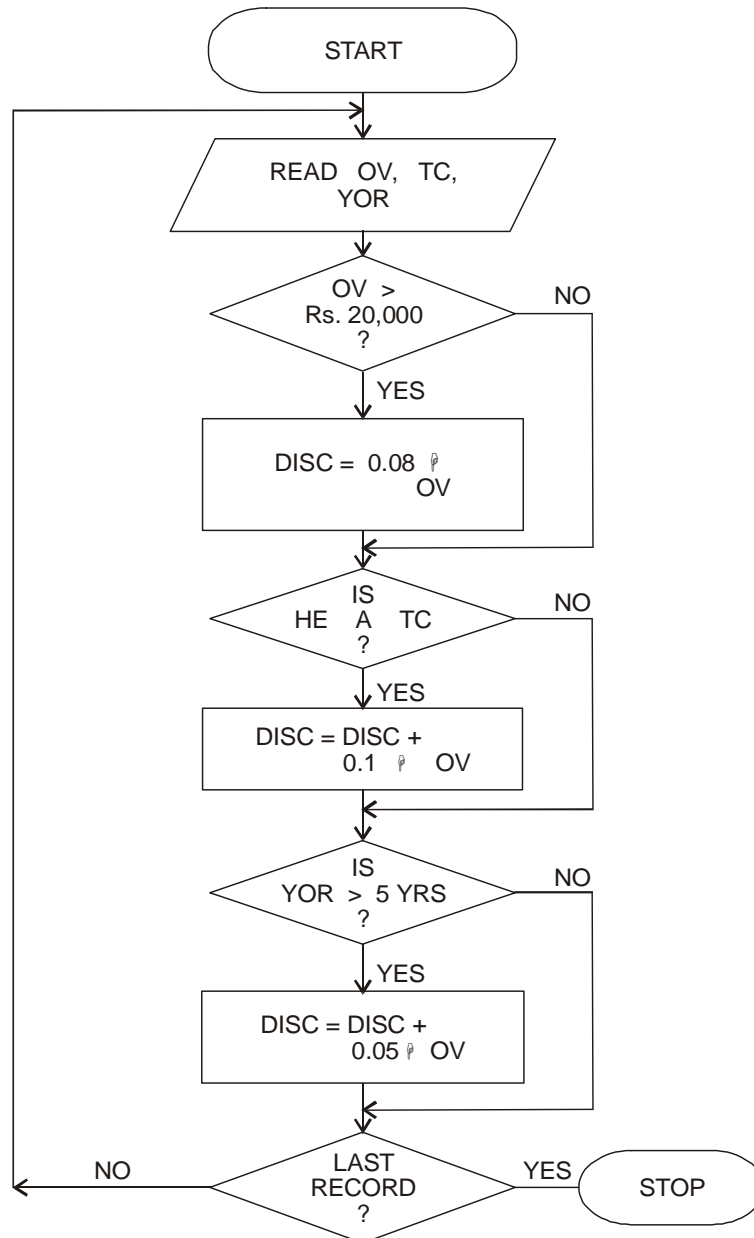
Decision Table is given below :

Conditions:	RULES						
	1	2	3	4	5	6	7
1. Order - Value Rs. 20,000	Y	Y	Y	Y	N	N	N
2. Trade - Customer	Y	Y	N	N	Y	Y	N
3. Year – Ordering Regularly > 5 Years	Y	N	Y	N	Y	N	Y
Actions :							
Nil Discount							X
5% "						X	
8% "				X			
10% "						X	
13% "							
15% "			X		X		
18% "							
23% "	X	X					

KEY : Y = YES, N = NO, X = ACTION TO BE TAKEN

Answer 3 :

Hire Purchase Scheme	R1	R2	R3	R4	R5	R6	R7
1. Customer holds the present job for more than 5 years	Y	Y	Y	Y	N	N	N
2. Resides in the same place at least for 3 years	Y	Y	N	N	Y	N	N
3. Monthly salary of the customer exceeds Rs. 2000	Y	N	Y	N	Y	N	—
1. Give credit upto Rs. 3000			X				
2. Give credit upto Rs. 4000				X		X	
3. Give credit upto Rs. 5000		X					
4. Reject credit				X		X	X

Answer 4 (a) : The decision table is given below :—

Decision – table

RULES	R1	R2	R3	R4	R5	R6	R7	R8
C_1 Customer Dealer	Y	Y	Y	N	N	N	Y	-
C_2 Payment Days >30 Days	Y	N	-	Y	N	N	Y	N
$C_3 \geq 30$ & ≤ 45 days	-	Y	N	-	Y	N	Y	Y
$C_4 > 45$ days	N	-	Y	-	-	Y	Y	N
Actions								
A_1 Discount 10%	X							
A_2 Discount & Surcharge 0		X						
A_3 Surcharge 10%			X		X			
A_4 Discount 12½%				X				
A_5 Surcharge 12½%						X	X	X

(*b*) The flowchart is given below :
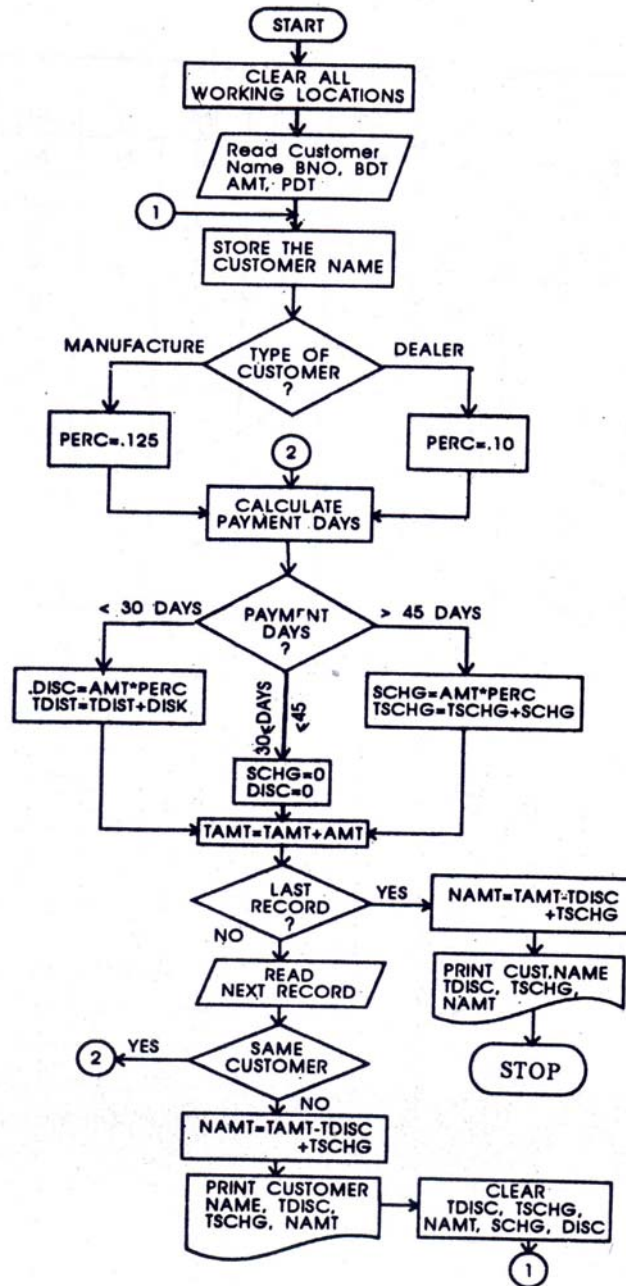
GLOSSARY 1

IMPORTANT COMPUTER TERMS

Access Time - The time interval between the instant when a computer or control unit calls for a transfer of data to or from a storage device and the instant when its operation is completed. Thus, access time is the sum of the waiting time and transfer time. Note: In some types of storage, such as disc, the access time depends upon the location specified and/or upon preceding events; in other types, such as core storage, the access time is essentially constant.

Acoustic Coupler - This is a portable version of a device called a modem which is used to convert the digital signals which a computer can understand into analog, or voice signals which can then be transmitted through a telephone system. At the receiving end, the analog signal is converted back into a digital format. Acoustic couplers have what appear to be two large rubber ears or suckers. The ear and mouth pieces of the telephone receiver are inserted into these 'ears' when transmitting or receiving computerised information. They can be battery operated and are, therefore, extensively used for electronic mail and similar communication links.

Address - A name, numeral, or other reference that designates a particular location in storage or some other data source or designation Note: Numerous types of addresses are employed in computer programming; for example; direct address, symbolic address.

ALGOL (Algorithmic Language) - A standard procedure oriented language for expressing computational algorithms developed as a result of international cooperation. ALGOL is designed to serve as a means for communicating computational procedures among humans, as well as to facilitate the preparation of such procedures for execution on any computer for which a suitable ALGOL compiler exists. Note: The basic elements of ALGOL are arithmetic expressions containing numbers, variables and functions. These are combined to form self-containing units called assignment statements. Declarations are non-computational instructions which inform the compiler of characteristics such as the dimensions of an array or the class of a variable. A sequence of declarations followed by a sequence of statements, all enclosed within "begin" "and" end instruction, constitutes an ALGOL program block. ALGOL is very popular in Europe.

Analog Transmission - There are two ways that 'Information' can travel along a telecommunications network: either as an analog or a digital signal. Analog signals are like the spoken word - the signal is continuous and carried by a changing wavelength (pitch) and

amplitude (loudness). A digital signal, on the other hand, is like the binary information which is stored in a computer. The signal consists of discrete on-off (1 and 0) bits. Although analog and digital information cannot be changed in form, the electronic signal the network uses to transmit it can. Analog information can be transmitted directly or encoded into digital bits; digital information can be transmitted directly or modulated into analog form. The choice between transmission systems depends upon the relative volumes of analog and digital information, the relative costs of codes (analog to digital coders-decoders) and modems (digital to analog modulators - demodulators) and the relative efficiencies of digital and analog transmission.

Application Package - A computer routine or set of routines designed for a specific application *e.g.*, inventory control, on line savings accounting, linear programming, etc. Note: In most cases, the routines in the application packages are necessarily written in a generalized way and must be modified to meet each user's own needs.

Assemble - To prepare a machine language from a program written in symbolic coding by substituting absolute operation codes for symbolic operation codes and absolute or relocatable addresses for symbolic addresses. For example, the symbolic instruction ADD TAX might be assembled into the machine instruction 24 1365, where 24 is the operation code of addition and 1365 is the address of the storage location labeled TAX. Contrast with compile.

Assembler - A computer program that assembles programs written in symbolic coding to produce machine language programs. Note: Assemblers are an important part of the basic software for most computers and can greatly reduce the human effort required to prepare programs.

Asynchronous Communication - Transmission system in which the speed of operation is not related to any frequency in the system to which it is connected. In the transmission system each character is preceded by a start signal and succeeded by a stop signal. This means that 'asynch', as it is usually referred to, is rather slow.

Audit Trails - Means (such as a trail of documents, batch and processing references) for identifying the actions taken in processing input data or in preparing an output. By use of the audit trail, data on a source document can be traced to an output (such as a report), and an output can traced back to the source items from which it was derived.

Autodial - This is an automatic dialing facility now available on many telephones. A telephone number can be fed into a memory on the telephone and, by pressing a single or two keys, the telephone will automatically dial that number. This system is also used for view data systems and telex/teletex transmission.

Auxiliary Storage - Storage that supplements a computer's primary internal storage. Note, In general, that auxiliary storage has a much larger capacity but a longer access time than the primary storage. Synonymous with mass storage. Same as secondary storage.

Accumulator - A Storage area in memory used to develop totals of units or of amounts being computed.

American Standard Code for Information Interchange (ASCII) - Byte - oriented coding system based upon the use of seven-bit codes and used primarily as formats for data communication.

Background Communication - This means that while an operator is using a computer, terminal or word processor, the machine can, at the same time, receive a message from another source and store it for later access. No action is required by the operator to set up the machine to receive information. See also Foreground Communications.

Back-to-Back Communication - Direct communications link between two terminals.

Basic (Beginner's All-purpose Symbolic Instruction Code) - A programming language developed in the mid - 1960's as an easy-to learn, easy-to-use language to teach students how to program. The language contains a limited set of powerful commands designed especially for use in a time sharing environment.

Backup - Pertaining to equipment or procedures that are available for use in the event of failure or overloading of the normally used equipment or procedures. Note: The provision of adequate backup facilities is an important factor in the design of all data processing systems and is especially vital in the design of real-time systems, where a system failure may bring the entire operation of a business to virtual standstill.

Bar Codes - These are the vertical black lines you see on many goods in shops. They are called bar codes because they comprise 'bars' of different thickness. Each bar represent some kind of information, such as the price of the product, stock code number, etc. bar codes are read by a laser reader and many shops now use them as a point-of-sale transaction medium.

Batch file - It is like a mini program, a series of commands that are given to the personal computer to execute in sequence.

Batch processing - A technique in which items to be processed are collected into groups (batched) to permit convenient and efficient processing. Note: Most business applications are of the batch processing type; the records of all transactions affecting a particular master file are accumulated covering a period of time, (*e.g.*, one day); then they are arranged in sequence and processed against the master file.

Batch Total - A sum of a set of items in a batch of records which is used to check the accuracy of operations involving the batch.

BCD (Binary Coded Decimal) - Pertaining to a method of representing each of the decimal digits zero through 9 by a distinct group of binary digits. For example, in the "8-4-2-1" BCD notation, which is used in numerous digital computers, the decimal number39 is represented as 0011 1001 (whereas in pure binary notation it would be represented as 100111)

Bidirectional Printing - A printer types the first line from left to right and the second line from right to left and so on throughout the page. This speeds up the printing sequences.

Binary - Pertaining to the number system with a radix of 2, or to a characteristic or property involving choice or condition in which there are two possibilities. For example, the binary numeral 1101 means: $(1 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0)$ which is equivalent to decimal 13. Note: The binary number system is widely used in digital computers because most computer components, *e.g.*, vacuum tubes, transistors, and integrated chips) are essentially binary in that they have two stable states.

Bit - A binary digit; a digit (0 or 1) in the representation of a number in binary notation.

Buffer - A storage device used to compensate for differences in the rates of flow of data or in the times of occurrence of events when transmitting data from one device to another. For example, a buffer holding the characters to print one line is associated with most line printers to compensate for the difference between the high speed at which the computer transmits data to the printer and the relatively low speed of the printing operation itself.

Buffer Memory - This is the internal memory of a microcomputer or word processor. Data is stored in this memory until transferred to its permanent store on a disk system. Buffer memories also hold the software used by the system.

Bug - A mistake in the design of a program or a computer system, or an equipment fault.

Byte - A group of adjacent bits operated on as a unit and usually shorter than a word: Note in a number of important current computer systems, this term stands specifically for a group of eight adjacent bits that can represent one alphanumeric character or two decimal digits.

Cassette Storage - Many home computers use the conventional audio tape cassette system, which was developed by Philips for use on tape recorders and stereo systems, to both feed in the software and to store information.

Cathode Ray Tube - An electronic vacuum tube containing a screen on which information can be displayed. The abbreviation CRT is frequently used.

Central Processor - The unit of a computer system that includes the circuits which controls the interpretation and execution of instructions. Synonymous with CPU (Central Processing Units) and main frame.

Check digit - A digit associated with a word for the purpose of checking for the absence of certain classes of errors. See residue check.

Channel - Magnetic track running along the length of tape that can be magnetized in bit patterns to represent data.

CIS development - The section of computer installation responsible for the analysis, design, and development of new systems and programs.

Chip - A miniature electronic package containing imprinted circuits and components.

Clipart - These are pre-prepared graphic images that one can incorporate into a document with a word processor or a desktop publishing program.

Cluster System - A number of word processor or computer workstations which have been linked together in some form to share central resources, such as storage, printers, telex access, etc.

Coding - The process of translating a set of computer processing specifications into a formal language for execution by a computer. A set of coded instructions.

Command Driven System - Describes the method of operation adopted by a computer or word processor. Each function or facility is activated by a command keyed into the system. Compare this with a menu-driven system where the functions are activated by calling up a menu on the screen to identify each facility available. An example of a command is to key in 'PRINT' which will activate the printer.

Computer-aided instruction (CAI) - Interactive use of a computer to deliver educational contents to individuals and to adjust presentations according to learner responses.

Computer information system (CIS) - A coordinated collection of hardware, software, people, data, and support resources to perform an integrated series of functions that can include input, processing, output, and storage.

Concurrent processing - The capability of a computer system to share memory among several programs and to execute the instructions provides by each during the same time frame.

Control break - Point during program processing at which some special processing event takes place. A control break is usually signalled by a change in the value of a control field within a data record.

Conversational program - A program that permits a dialogue to take place between a user and computer.

COBOL (Common Business Oriented Language) - A procedure-oriented language developed to facilitate the preparation and inter-change of programs which form business data processing functions. Note: Designed in 1959 by a committee representing the U.S. Government and several computer manufacturers, COBOL has evolved through several versions (*e.g,*, COBOL-60, COBOL-61, COBOL 61-Extended, COBOL-65). Every COBOL source program has four divisions, whose names and functions are as follows: (1)

Identification Division, which identifies the source program and the output of a compilation, (2) Environment Division, which specifies those aspects of a data processing problem that are dependent upon the physical characteristics of a particular computer, (3) Data Division, which describes the data that the object program is to accept as input, manipulate, create, or produce as output, and (4) Procedure Division, which specifies the procedures to be performed by the object program, by means of English-like statements such as: "*Subtract tax from gross pay giving net pay*".

Compile - To prepare a machine language program (or a program expressed in symbolic coding) from a program written in another programming language (usually a procedure oriented language such as BASIC, COBOL or FORTRAN). The compilation process usually involves examining and making use of the overall structure of the program and/or generating more than one object program instruction for each source program statement. Contrast with assemble.

Compiler - A computer program that compiles. Compilers are an important part of the basic software for most computers permitting the use of procedure-oriented languages which can greatly reduce the human effort required to prepare computer programs.

Console - A portion of a computer that is used for communication between operators or maintenance engineers and the computer, usually by means of displays and manual control.

Control Program - A routine, usually contained within operating system, that aids in controlling the operations and managing the resources of a computer system.

CP/M Operating System - One of the most widely used microcomputer operating systems originally developed by Digital Research Inc., in USA. Computer users should be aware of the operating system of their machine to enable them to acquire the software capable of running on that system.

CP/M-86 Operating System - Another microcomputer operating system, a later and more sophisticated development of CP/M.

CR - Carriage Return - This is the most important key on a computer or word processor keyboard. It is used to activate most of the functions on the system. It is usually identified by a reverse L-symbol with an arrow on the end of the horizontal bar.

Cursor - A symbol that marks to current position of the mouse on the screen or the point of entry of data.

Data administration section - The group within the technical support area responsible for defining data requirements within an organization and setting up controls or managing the data.

Data Base - Data items that must be stored in order to meet the information processing and retrieval needs of an organization. The term implies an integrated file of data used by many processing applications in contrast to an individual data file for each separate application.

Data Base Administrator (DBA) - The person in charge of defining and managing the content of a data base.

Data Base Management System (DBMS) - Software to manage and control data resources.

Data Bus - The internal pathway in a computer on which data moves.

Data communications - The transmission of data between two or more separate physical sites through use of public and/or private communications channels or lines.

Data control section - The group within a computer installation responsible for meeting quality control standards for processing and for collecting inputs from and delivering outputs to computer users.

Data dictionary - A document listing and defining all items or processes represented in data flow diagrams or used within a system.

Data librarian - Person who maintains custody and control of tapes, disks, and procedures manuals by cataloging, checking out, and monitoring use of these data resources.

Data Management System - System software that supervises the handling of data required by programs during execution.

Debug - To trace and eliminate mistakes in a program or faults in equipment. The process is often assisted by a diagnostic routine.

Decision table - A table listing all the contingencies to be considered in description of a problem, together with the corresponding actions to be taken. Decision tables permit complex decision-making criteria to be expressed in a concise and logical format. They are sometimes used in place of flowcharts for problem definitions and documentation. Compilers have been written to convert decision tables into programs that can be executed by computers.

Desk checking - A manual checking process in which representative data items, used for detecting errors in program logic, are traced through the program before the latter is checked on the computer.

Dialog Box - A small window that opens up on the computer screen to the user request or put in information relating to a task (such as printing) or give the information to the user, such as when there is an error.

Digitize - The process of converting lines, drawings and pictures to digital form by scanning the drawings and pictures with a device that converts sensed highlights into numbers or horizontal and vertical coordinates.

Direct access device - A hardware unit that can read and write records from or to a file without processing all preceding records.

Direct data entry - Entry of data directly into the computer through machine-readable source documents or through use of on-line terminals. Direct entry is a by-product of source business transactions, without requiring manual transcription from original paper documents.

Down time - Time at which the computer is not available for processing.

Drag - To move something around the computer with the help of the mouse. This involves holding down one of the mouse buttons while user moves it.

Dynamic processing - The technique of swapping jobs in and out of computer memory according to their priorities and the number of time slices allocated to each task.

Dump - (1) To copy the contents of a set of storage locations, usually from an internal storage device (such as disk storage) to an external storage medium (such as magnetic tape or floppy disk), and usually for diagnostic or rerun purposes. (2) The data that results from the process defined in (1).

EBCDIC (Extended Binary Coded Decimal Interchange Code) - An 8-bit code that represents an extension of a 6-bit "BCD" code that was widely used in computers of the first and second generations. EBCDIC can represent upto 256 distinct characters and is the principal code used in many of the current computers.

Echo checks - A check upon the accuracy of a data transfer operation in which the data received (typically, by an output device) is transmitted back to the source (Typically, a control unit) and compared with the original data. An echo check on an output operation usually can only verify that, for example, the proper print hammers or punch pins were actuated at the proper instants, it cannot ensure that the proper marks were actually recorded on the output medium.

Electronic journal - A log file summarizing in chronological sequence, the processing activities performed by a system. The file is maintained on magnetic storage media.

Exception report - Management report produced by a management information system to highlight business conditions that are outside the range defined as normal.

Executive routine - A routine designed to organize and regulate the flow of work in a computer system by initiating and controlling execution of programs. A principal component of most operating systems. Synonymous with supervisory routine.

Facsimile Transmission System - Often abbreviated to 'Fax', this system is employed to relay alphanumeric and graphic data to other Fax machines at distant sites along a telephone or other telecommunications link. A fax device produces a facsimile copy of the original in the same manner as an office copier, except that the original is received electronically.

Field - (1) In a record, a group of characters represents one item. (2) A subdivision of a computer word or instruction; a group of bit positions within an instruction that hold an address. (3) A subdivision of a record; that is, an item.

File - A collection of related records, usually (but not necessarily) arranged in sequence according to key contained on each record. Note: A record, in turn, is a collection of related items; an item is an arbitrary quantity of data that is treated as a unit. In payroll processing, an employee's pay rate forms an item; a group of items relating to one employee form a record, and the complete set of employee records forms a file.

File label - A label identifying the file. Note: An internal table is recorded as the first or last record of a file and is machine-readable. An external label is attached to the outside of the file holder and is not machine-readable.

File maintenance - The updating of a file to reflect the effects of period changes by adding, altering data; *e.g.*, the addition of new programs to program library on magnetic disk.

File processing - The periodic updating of master files to reflect the effect of current data, often transaction data contained in detail files; *e.g.*, a weekly payroll run updating the payroll master file.

Fixed length record - A record that always contains the same number of characters. The restriction to a fixed length may be deliberate, in order to simplify and speed processing or it may be dictated by the characteristics of the equipment used. Contrast with variable-length record.

Fixed word length - Pertaining to a machine word or operand that always has the same number of bits or characters. Contrast with variable word length. Most scientific computers are of the fixed word length type for maximum computational speeds, while many business oriented computers have variable word length to permit efficient handling of items and records of varying sizes. Some computers types have both fixed and variable words.

Flowchart - A diagram that shows, by means of symbols and interconnecting lines, (1) the structure and general sequence of operations of a program or (2) a system of processing (system flow chart).

Foreground Communication - Where the transmission or receipt of massage requires action by the operator of the terminal. This can mean setting up the machine to communicate, making contact with the third party sending or receiving the message and activating the terminal to perform that function.

FORTRAN (Formula Translation) - A procedure oriented language designed to facilitate the preparation of computer programs that performs mathematical computations. It was designed by IBM in the 1950's to use symbols and expression similar to those of algebra, FORTRAN was not originally intended to be a common language. However, it has evolved through

several basic versions (*e.g.* FORTRAN II, FORTRAN IV) plus numerous dialects, has become largely machine-independent and has been approved as a USA standard programming language in two versions (FORTRAN and basic FORTRAN). FORTRAN is widely used procedure-oriented language in the United States and is being effectively employed in certain business as well as scientific applications. The essential elements of the FORTRAN is the assignment statement; *e.g.* Z = X + Y causes the current value of the variables X and Y to be added together and their sum to replace the previous value of the variable Z.

Font - A character set in a particular style and size of type, including all alphanumeric characters, punctuation marks and special symbols.

Fourth Generation Languages - These are infact sophisticated software packages that permit users to query data bases and extract the information needed to solve problems and prepare reports. With these languages, very complex operations are accomplished by just pressing a few keystrokes. Some examples of fourth generation languages are dBASE, FRED and PC/FOCUS.

Joystick - A vertical lever, usually in a ball socket, which can be titled in any direction and is used to move a cursor around the screen or display unit of a computer.

Generator A computer program designed to construct other programs for performing particular types of operations; *e.g.,* report program generator. Based upon parameters supplied to it, the generator typically selects from among various alternatives the most suitable method for performing the specified task, and adjusts the details of the selected method to produce a program attached to the characteristics of the data to be handled by the generated program.

Hard Copy -Data stored on a more permanent medium, such as printing paper. Data stored on a floppy or hard disk can be overwritten.

Header label - A machine-readable record at the beginning of the file containing data identifying the file and data used in control.

Hollerith code - A widely used code for representing alphanumeric data on punched cards, named after Herman Hollerith, the originator of punched card tabulating. Each card column holds one character, and each decimal digit, letter, and special character is represented by one, two or three holes punched into designated row positions of the column.

IDP (Integrated Data Processing) - Data processing by a system that coordinates a number of previously unconnected processes in order to improve overall efficiency by reducing or eliminating redundant data entry or processing operations. An example of IDP is a system in which data describing orders, production, and purchases is entered into a single processing scheme that combines the functions of scheduling, invoicing, inventory control, etc.

Input/Output - A general term for the techniques, and media used to communicate with data processing equipments and for the data involved in these communications. Depending upon

the context, the term may mean either "input and output" or "input or output". Synonymous with I/O.

Instruction - A set of characters that specifies an operation to be performed and, usually, the value of locations of one or more of its operands. In this context, the term instruction is preferable to the terms command and order, which are sometimes used synonymously.

Interblocked Gap - The distance on a magnetic tape between the end of one block and the beginning of the next. Within this distance, the tape can be stopped and brought up to the normal speed again. Since the tape speed is not constant when stopping, no reading or writing is permitted in the gap. Synonymous with inter-record gap and record gap, though the use of these two terms is not recommended because of the important distinction between blocks and records.

Item - An arbitrary quantity of data that is treated as a unit. A record, in turn, is a collection of related items, while a file is a collection of related records. Thus, in payroll processing an employee's pay rate forms an item, all of the items relating to one employee form a record, and the complete set of employee records forms a file.

Intergrated Circuit (IC) - A device incorporating circuitry and semiconductor components within a single unit, usually a miniature chip. Circuit elements and components are created as part of the same manufacturing procedures.

Interpreter - Language translator that converts source code to machine code and executes it immediately, statement by statement.

Job scheduler - Person within a computer installation who monitors computer work loads and makes sure that all resources and materials necessary for running jobs are available to people who need them.

Key - One or more characters associated with a particular item or record and used to identify that item or record, especially in sorting or collating operations. The key may or may not be attached to the record or item it identifies. Contrast label and tag.

Label - A name attached to or written alongside the entity it identifies *e.g.* a key that is attached to the item or record it identifies, or a name written alongside a statement on a coding sheet.

Machine language - A language that is used directly by a computer. Thus, a "Machine language program" is a set of instructions which a computer can directly recognize and execute and which will cause it to perform a particular process. In Machine-oriented language there is a general (though not necessarily strict) one-to one correspondence between the statements of source program and the instructions of the object program (which will normally be a machine language program ready for executing on a particular computer). The input to an

assembler is usually expressed in a machine-oriented language. Contrast with procedure-oriented language.

Marco Instruction - An instruction written in a machine-oriented language that has no equivalent operation in the computer and is replaced in the object program by a predetermined set of machine instructions. Macro instruction facilities can ease the task of coding in a machine-oriented language by precluding the need for detailed coding of input and output operations, blocking format control, checking for errors, etc.

Management information system - A system designed to supply the managers of a business with the information they need to keep informed of the current status of the business and to understand its implications; and to make and implement the appropriate operating decisions.

Maintenance (file) - Process of changing a master file through the addition of new records, the deletion of old records and changing the contents of existing records.

Mark sensing - A technique for detecting pencil marks entered by hand in prescribed places on some preprinted documents. The marked data may be converted into light patterns and transmitted directly to a computer.

Mass storage - Same as secondary storage or auxiliary storage.

Master file - A file containing relatively permanent information which is used as source of reference and is generally updated periodically. Contrast with detail file.

Merge - To form a single sequenced file by combining two or more similarly sequenced files. Merging may be performed manually, by a collator, or by a computer system for which a "merge routine" is available. Repeated merging, splitting and remerging of strings of records can be used to arrange the records in sequence; this process, called a "merging sort," is frequently used as the basis for sorting operations on computer systems.

Message Switching System - A facility which uses computer techniques to transmit and receive, and store and retrieve textual information. It is a means of communicating in a fast, cost-effective and reliable way, using modern technology. These systems allow immediate access to any person or office using the facilities and all massages are transmitted and received instantly whether addressee is in the next office or the other side of the world.

MICR (Magnetic Ink Character Recognition) - The automatic reading by machine of graphic characters printed with magnetic ink.

Module - In programming, a solution document representing a processing function that will be carried out by a computer.

Module N check - Same as residue check.

MS-DOS Operating System or Microsoft Disk Operating System - The operating system used by most of the major personal computer systems, especially the IBM Personal Computer 'look-likes'. IBM personal computers used a variation known as PC-DOS.

Multiprocessing - The simultaneous execution of two or more sequences of instructions in a single computer system. Frequently refers to simultaneous execution accomplished by the use of a system with more than one central processor.

Multi-programming - A technique for handling two or more independent programs simultaneously by overlapping or interleaving their execution. The overlapping or interleaving of the execution of the various programs is usually controlled by an operating system which attempts to optimize the performance of the computer system in accordance with the priority requirements of the various jobs.

Natural language processing - Use of command language that closely resembles English syntax and style to direct processing of a computer. Use of non structured commands.

Network - An integrated, communicating collection of computers and peripheral devices connected through communication facilities.

Object program - A program expressed in an object language (*e.g.,* a machine language program that can be directly executed by a particular computer).

OCR (Optical Character Recognition) - The automatic reading by machine of graphic characters through the use of light-sensitive devices.

Offline (or Off-line) - Pertaining to equipments or devices that are not in direct communication with the central processor of a computer system. Offline devices cannot be controlled by a computer except through human intervention. Contrast with online.

Online (or On-line) - Pertaining to equipments or devices that are in direct communication with the central processor of a computer system. Online devices are usually under the direct control of the computer with which they are in communication. Contrast with offline.

Operating System - An organized collection of routines and procedures for operating a computer. These routines and procedures will normally perform some or all of the following functions - (1) Scheduling, loading, initiating and supervising the execution of programs; (2) allocating storage, input/output units and other facilities of the computer system; (3) initiating and controlling input/output operations; (4) handling errors and restarts; (5) coordinating communication between the human operator and the computer system; (6) maintaining a log of system operations, and (7) controlling operation in a multi-programming, multi-processing or time-sharing mode. Among the facilities frequently included within an operating system are an executive routine, a scheduler, an IOCS, utility routines, and monitor routines.

Overflow - In an arithmetic operation, the generation of a quantity beyond the capacity of the register or storage location which is to receive the result.

Overlay -To transfer segment of program from auxiliary storage into internal storage for execution, so that two or more segments occupy the same storage locations at different times. This technique makes it possible to execute programs which are too large to fit into the computer internal storage at one time, it is also important in multi-programming and time-sharing operations.

Pack - To store several short units of data in a single storage cell in such a way that the individual units can latter be recovered, *e.g.,* to store two 4—bit BCD digits in one 8 bit storage location.

Parallel Interface - Generally used to link a printer into a computer or word processor. This interface allows the printer to accept transmission of data which is sent in parallel bit sequences. See also Serial Interface.

Parity Bit - A bit (binary digit) appended to an array of bits to make the sum of all the 1-bits in the array either always even ("even parity") or always odd ("odd parity"). For example,

	Even parity			*Odd parity*	
	01	1	0	1	1
	01	0	0	1	0
	01	0	0	1	0
Data bits	01	1	0	1	1
	01	1	0	1	1
	11	0	1	1	0
Parity bits	10	1	0	1	0

Parity Checks - A check that tests whether the number of 1-bits in an array is either even ("even parity check") or odd ("odd parity check")

Peripheral equipment - The input/output units and secondary storage units of a computer system. Note : The central processor and its associated storage and control units are the only units of a computer system which are not considered peripheral equipment.

Programming language/1 - (PL/1) A general-purpose, high level language that is designed to combine business and scientific processing features and that can be easily learned by novice programmers, yet contains advanced features for experienced programmers.

Privacy - In connection with the use of computer-maintained files, the right of individuals to expect that any information kept about them will only be put to authorized use and to know about and challenge the appropriateness and accuracy of the information.

Programmable read-only memory (PROM) - Computer memory chips that can be programmed permanently, by burning the circuits in patterns, to carry out predefined process.

Problem-oriented language - A language whose design is oriented toward the specification of a particular class of problems, such as numerical control of machine tools. Sometimes used as a general term to describe both procedure and problem-oriented languages.

Procedure-oriented language - A language designed to permit convenient specification, in terms of procedural or algorithmic steps, of data processing or computational processes. Examples include ALGOL, COBOL and FORTRAN. Contrast with problem-oriented language and machine-oriented language.

Program - (1) A plan for solving a problem. (2) To devise a plan for solving a problem. (3) A computer routine, *i.e.,* a set of instructions arranged in proper sequence to cause a computer to perform a particular process. (4) To write a computer routine.

Program flowchart - A flowchart diagraming the processing steps and logic of a computer program. Contrast with system flowchart.

Programmer - A person who devices programs. The term "programmer" is most suitably applied to a person who is mainly involved in formulating programs, particularly at the level of flowchart preparation. A person mainly involved in the definition of problems is called an analyst, while a person mainly involved in converting programs into coding suitable for entry into a computer system is called a coder. In many organizations all three of these functions are performed by "programmers".

Programming language - An unambiguous language used to express programs for a computer.

PROM - Programmable Read Only Memory - The program stored in a ROM (Read only Memory) can be read but not changed. A PROM, however, can be programmed in the field by suitably qualified personnel.

Protocol Translator - A peripheral device which converts the communications protocol of one system into the protocols of another system so that the two systems are compatible enabling data to be transferred between them.

Random access - Pertaining to a storage device whose access time is not significantly affected by the location of the data to be accessed, thus, any item of data which is stored online can be accessed within a relatively short time (usually in part of a second). Same as direct access. Contrast with serial access.

Realtime (or Real-time) - (1) Pertaining to the actual time during which a physical process takes place. (2) pertaining to fast-response online computer processing, which obtains data from an activity or process, performs computations, and returns a response rapidly enough to control, direct or influence the outcome of the activity or process. For example, realtime operation is essential in computers associated with process control systems, message switching systems and reservation systems.

Record - A collection of related items of data. Note - In payroll processing, for example, an employee's pay rate forms an item, all of the items relating to one employee form a record, and the complete set of employee record forms a file. see also fixed-length record and variable-length record.

Record gap - Same as interblock gap.

Recording density - The number of useful storage cell per unit of length or area; *e.g.,* the number of digits (or characters) per inch on a magnetic tape/floppy diskette, or the number of bits per inch on a single track of a tape. The most common recording densities in current use are 10 rows per inch for punched tape and 200, 556, 800 or 1600 bits per inch (bpi) for magnetic tape.

Redundancy check - A check based on the transfer of more bits or characters than the minimum number required to express the massage itself, the added bits or characters having been inserted systematically for checking purposes. The most common type of redundancy check is parity check.

Residue check - A check of numeric data or arithmetic operation in which each number A, is divided by the modulo, N, and the remainder, B, accompanies A as a check digits. For example, in modulo 4 checks, B will be either 0, 1, 2 or 3; if the remainder formed when A is divided by 4 does not equal B, an error is indicated. Synonymous with modulo N check.

Resolution - It indicates the degree of details—that can be perceived. The higher the resolution, the finer the detail.

RS-232-C Port - This is standard communications port on most microcomputers and word processors which is used as the link to a printer or the communications link to electronic mail, telex and other transmission systems. Also known as the V24 port.

Routine - A set of instructions arranged in correct sequence to cause a computer to perform a particular process. In this context, the term "routine" is somewhat more precise than the more general (and more commonly used) term "program".

Run - A performance of a specific process by a computer on a given set of data *i.e.,* the execution of one routine or of several routines which are linked to form one operating unit, during which little or no human intervention is required.

Run manual - A manual documenting the processing system, program logic, controls, program changes, and operating instructions associated with a computer run.

Scroll - To move a graphics image or the text on the monitor up, down, right, or left, in a smooth, usually continuous and reversible action.

Secondary storage - Storage that supplements a computer's primary internal storage. Synonymous with auxiliary storage.

Security program - Systems program that controls access to data in files and permits only authorized use of terminals and other equipments. Control is usually through various levels of pass words assigned on the basis of need to know.

Semiconductor - Material with electrical conducting qualities that fall between those of conductors and resistors. Also refers to electronic components and devices using semiconductor materials treated to impart special electrical properties.

Sequential processing - Same as batch processing.

Serial access - Pertaining to a storage device in which there is a sequential relationship between the access times to successive locations, as in the case of magnetic tape. Contrast with direct access or random access.

Serial Interface - Used to connect a printer to the input device, either a computer or word processor. Allows the printer to accept transmission of data which is sent serially, or one character at a time. See also Parallel Interface.

Software - A collection of programs and routines associated with a computer (including assemblers, compilers, utility routines, and operating systems) which facilitates the programming and operation of the computer. Contrast with hardware.

Source language - A language that is an input to a translation process. Contrast with object language.

Source Program - A program written in a source language (*e.g.,* written in COBOL, C, FORTRAN, or symbolic coding for input to a compiler or assembler).

Statement - In computer programming, a meaningful expression or generalized instruction.

Software package - A collection of programs, usually for specific applications, designed to solve common problems in selected industries or professions; offered as a means of reducing system development efforts and costs.

Spooling - Computer processing technique under which input and output files originating on and destined for slow-speed devices are written to high-speed storage devices prior to and following processing. Thus, processing can take place at high speeds while input and output can be handled separately at relatively slow speeds.

Status line - An area - a strip -at the bottom of the screen that tells the user about the operations of a program he/she is working in. For instance, a status line could tell that the file is now being saved, or that it is being printed.

Storage allocation - The assignment of specific programs, program segments, and or block of data to specific portions of a computer's storage.

Subroutine - A routine that can be part of another routine. A closed subroutine is stored in one place and connected to the program by means of linkages at one or more points in the program. An open subroutine is inserted directly into a program at each point where it is to be used. A great deal of coding effort can be saved through judicious use of subroutines to handle tasks which are encountered repetitively, such as the control of input operations, the evaluation of mathematical functions, and the handling of checking and error recovery procedures.

Supervisory routine - Same as executive routine.

Symbolic address - An address expressed in symbols convenient to the programmer, which must be translated into an absolute address (usually by an assembler) before it can be interpreted by a computer. For example, the storage location that holds an employee's gross pay might be assigned the symbolic address PAY.

Symbolic Coding - Coding that uses machine instruction with symbolic address. Contrast with absolute coding and relative coding. The input to most assemblers is expressed in symbolic coding. Mnemonic operation codes are usually employed along with the symbolic address to further simplify the coding process. For example, a two-address instruction that subtracts an employee's taxes from his gross pay might be written SUB TAX GPAY.

System - A set or arrangement of entities that forms, or is considered as an organized whole. This term is a very general one that is applied to both hardware and software entities; therefore it must be carefully qualified to be meaningful *e.g.,* computer system, management information system, number system, operating system.

System analysis - The examination of an activity, procedure, method, technique or business to determine what needs to be done and how it can best be accomplished.

System development life cycle (SDLC) - Activities required to develop, implement and install a new or revised system. Standard activity phases include investigation, analysis and general design, detailed design and implementation, installation, and review.

System flowchart - A flowchart diagramming the flow of work documents, and operations in a data processing application. Contrast with program flowchart.

Time sharing - (1) the use of given devices by a number of other devices, programs, or human users, one at a time and in rapid succession. (2) A technique or system for furnishing computing services to multiple users simultaneously, providing rapid responses to each of the

users. Time sharing computer systems employ-multi programming and/or multiprocessing techniques and are often capable of serving users at remote locations *via* data communication network.

Toggle - A switch or control code that turns an event on or off by repeated action or use; to turn something on or off by repeating the same action.

Track - That part of a data storage medium that is influenced by (or influences) one head; *e.g.,* the ring-shaped portion of the surface of a disk, or one of several divisions (most commonly seven or nine) running parallel to the edges of a magnetic tape.

Trailer record - A record that follows another record or group of records and contains pertinent data related to that record or group of records.

Transaction Code - One or more characters that form part of a record and signify the type of transaction represented by the record (*e.g.,* in inventory control, the types of transactions would include deliveries to stock, disbursement from stock, orders, etc.)

Transaction file - Same as detail file.

Translator - A device or computer program that performs translation from one language or code to another - *e.g.,* an assembler or compiler.

UNIX Operating System - Computer operating system developed by the Bell Telephone Laboratories in the USA. Currently considered to be the system of the future with many manufacturers adopting UNIX for their new ranges of equipments. Office automation software is, on the whole, not very well represented in the UNIX area. There are some world processing packages, such as Q-One from Quadratronic, an offering from Interplex within an integrated package, Crystalwriter from Syntactics and UNIX-option Multimate which will be available shortly.

Unpack - To separate short units of data that have previously been packed *i.e.,* to reverse a packing operation.

Update - To incorporate into a master file the changes required to reflect recent transactions or other events.

Utility routine - A standard routine used to assist in the operation of a computer by performing some frequently required processes such as sorting, merging, report program generation, data transcription, file maintenance, etc. Utility routines are important components of the software supplied by the manufacturers of most computers.

Variable length record - A record that may contain a variable number of characters. Contrast with fixed-length record. In many cases where the equipment would permit the use of variable length records, the records are nonetheless held to a fixed length to facilitate both programming and processing.

Variable word length - Pertaining to a machine word or operand that may consist of a variable number of bits of characters. Contrast with fixed word length. Many business-oriented computers are of the variable word length type for efficient processing of items and records of varying size.

Very large scale integration (VLSI) - Design and production techniques to place thousands of electronic components within small integrated circuit chips to reduce their sizes and costs.

Word processing - Use of computers or specialized text-oriented equipments (including electronic typewriters) for the storage, editing, correction, and revision of textual files and for the printing of finished letters, reports and other documents from these files.

Word - A group of bits or characters treated as a unit capable of being stored in one storage location. Within a word, each location that may be occupied by a bit or characters is called a "position".

Word Length - The number of bits or characters in a word.

Word mark - A symbol (*e.g.,* a special character or a single bit) used in some variable word length computers to indicate the beginning or end of a word or item.

Working storage - A storage section set aside by the programmer for use in the development of processing results for storing constants, for temporarily storing results needed later in the program sequence, etc.

Workstation - A basic physical unit of a word processing or computer system which may comprise such hardware as a display unit, keyboard, storage system, and others, that enables an operator to perform computer functions, word processing and other tasks.

GLOSSARY 2

INTERNET RELATED TERMS

ARPA NET - (Advanced Research Projects Agency Network) - The precursor to the Internet. Developed in the late 60's and early 70's by the US Department of Defence as an experiment in wide-area networking that would survive a nuclear war.

Bandwidth - How much data one can send through a connection. Usually measured in bits-per-second. A full page of English text is about 16,000 bits. A fast modem can move about 15,000 bits in one second. Full-motion, full-screen video would require roughly 10,000,000 bits per second, depending on compression.

Baud - In common usage, the baud rate of a modem is how many bits it can send or receive per second. Technically, baud is the number of times per second that the carrier signal shifts value. For example, a 1200 bit-per-second modem actually runs at 300 baud, but it moves 4 bits per baud (4 × 300 = 1200 bits per second)

BBS - (Bulletin Board System) - A computerised meeting and announcement system that allows people to carry on discussion, upload an download files, and make announcements without the people being connected to the computer at the same time. There are many thousands (millions ?) of BBS's around the world, most are very small, running on a single IBM clone PC with 1 or 2 phone lines. Some are very large.

Bps - (Bits-per-Second) - A measurement of how data is moved from one place to another. A 28.8 modem can move 28,800 bits per second.

Browser - A Client program (software) that is used to look at various kinds of Internet resources. Mosaic, Netscape Nevigator and Internet Explorer are some of the commonly used browsers.

Client - A software program that is used to contact and obtain data from a Server software program on another computer, often across a great distance. Each Client program is designed to work with one or more specific kinds of Server programs and each Server requires a specific kind of Client. A Wed Browser is a specific kind of Client.

Cyberspace - Term originated by author William Gibson in his novel Neuromancer. The word Cyberspace is currently used to describe the whole range of information resources available through computer networks.

Domain Name - The unique name that identifies an Internet site. Domain Names always have 2 or more parts, separated by dots. The part on the left is the most specific, and the part on the right is the most general. A given machine may have more than one Domain Name but a given Domain Name points to only one machine. For example, the domain names :

matisse.net

mail.matisse.net

workshop.matisse.net

can all refer to the same machine, but each domain name can refer to no more than one machine.

E-mail - (Electronic Mail) — Messages, usually text, sent from one person to another via computer. E-mail can also be sent automatically to a large number of addresses (Mailing List).

Ethernet - A very common method of networking computers in a LAN. Ethernet will handle about 10,000,000 bits-per-second and can be used with almost any kind of computer.

FTP - (File Transfer Protocol) - A very common method of moving files between two Internet sites. FTP is a special way to login to another Internet site for the purposes of retrieving and/or sending files. There are many Internet sites that have established publicly accessible repositories of material that can be obtained using FTP.

Gigabyte - 1000 or 1024 Megabytes, depending on who is measuring.

Host - Any computer on a network that is a repository for services available to other computers on the network. It is quite common to have one host machine providing several services, such as WWW and USENET.

HTML - (Hyper Text Markup Language) - The coding language used to create Hypertext documents for use on the World Wide Web.HTML looks a lot like old fashioned typesetting code, where you surround a block of text with codes that indicate how it should appear. Additionally, in HTML one can specify that a block of text, or a word, is linked to another file on the Internet. HTML files are meant to be viewed using a World Wide Web client Program, such as Netscape Nevigator, Internet Explorer or Mosaic.

Internet - (Upper case I) The vast collection of inter-connected networks that all use the TCP/IP protocols and that evolved from the ARPANET of the late 60's and early 70's. The Internet now connects more than 70,000 independent networks into a vast global internet.

internet - (Lower case i) Any time when 2 or more networks are connected together, one has an internet - as in international or inter-state.

Interanet - A private network inside a company or organisation that uses the same kind of software that one would find on the public Internet, but that is only for internal use.

As the Internet has become more popular, many of the tools used on the Internet are being used in private networks. For example, many companies have web servers that are available only to employees.

Note that an Interanet may not actually be an internet — it may simply be a network.

ISP - (Internet Service Provider) - An institution that provides access to the Internet in some form, usually for money. For example, in India, VSNL (Videsh Sanchar Nigam Limited) is the Internet Service Provider.

Java - Java is a network-oriented programming language invented by Sun Microsystems that is specifically designed for writing programs that can be safely downloaded to one's computer through the Internet and immediately run without fear of viruses or other harm to one's computer or files. Using small Java programs (called "Applets"), Web pages can include functions such as animations, calculations, and other fancy tricks.

One can expect to see a huge variety of features added to the Web using Java, since a Java program can be written to do almost anything a regular computer program can do, and then include that Java program in a Web page.

Leased-line - Refers to a phone line that is rented for exclusive 24-hour, 7 days-a-week use from one location to another location. The highest speed data connections require a leased line.

Login - Noun or a verb. Noun : The account name used to gain access to a computer system. Not a secret (contrast with Password).

Verb : The act of entering into a computer system.

Maillist - (or Mailing List) A (usually automated) system that allows people to send e-mail to one address, whereupon their message is copied and sent to all of the other subscribers to the maillist. In this way, people who have many different kinds of e-mail access can participate in discussions together.

Mosaic - The first WWW browser that was available for the Macintosh, Windows, and UNIX, all with the same interface. Mosaic really started the popularity of the Web. The source-code to Mosaic has been licensed by several companies and there are several other pieces of software as good or better than Mosaic, most notably, Netscape.

Netscape - A WWW Browser and the name of a company. The Netscape browser was originally based on the Mosaic program developed at the National Center for Supercompting Applications (NCSA).

Netscape has grown in features rapidly and is widely recognised as the best and most popular web browser. Netscape Corporation also produces web server software.

Netscape provided major improvements in speed and interface over other browsers.

Node - Any single computer connected to a network.

Packet Switching - The method used to move data around on the Internet. In packet switching, all the data coming out of a machine is broken up into chunks, each chunk has the address of where it came from and where it is going. This enables chunks of data from many different sources to co-mingle on the same lines, and be sorted and directed to different routes by special machines along the way. This way many people can use the same lines at the same time.

PPP - (Point to Point Protocol) — Most well known as a protocol that allows a computer to use a regular telephone line and a modem to make TCP/IP connections and thus be really and truly on the Internet.

Router - A special purpose computer (or software package) that handles the connection between 2 or more networks. Routers spend all their time looking at the destination addresses of the packets passing through them and deciding which route to send them on.

Server - A computer, or a software package, that provides a specific kind of service to client software running on other computers. The term can refer to a particular piece of software, such as a WWW server, or to the machine on which the software is running *e.g.,* Our mail server is down today, that's why e-mail isn't getting out. A single server machine could have several different server software packages running on it, thus providing many different servers to clients on the network.

SQL - (Structured Query Language) — A specialized programming language for sending queries to databases.

TCP/IP - (Transmission Control Protocol/Internet Protocol) — This is the suite of protocols that defines the Internet. Originally designed for the UNIX operating system, TCP/IP software is now available for every major kind of computer operating system. To be truly on the Internet, your computer must have TCP/IP software.

URL - (Uniform Resource Locator) — The standard way to give the address of any resource on the Internet that is part of the World Wide Web (WWW). A URL looks like this :

http://www.icai.org/seminars.html

or telnet://well.sf.ca.in

or news:new.newusers.questions etc.

The most common way to use a URL is to enter into a WWW browser program, such as Netscape, or Lynx.

APPENDIX 1

COMPUTER ABBREVIATIONS

ACC	Accumulator
ACK	Acknowledge character
A/D	Analog to Digital
ADCCP	Advanced Data Communication Control Procedure
ADP	Automatic Data Processing
ALGOL	ALGOrithmic Language
ALU	Arithmetic/Logic Unit
AM	Amplitude Modulation or Accounting Machine or Access Mechanism
ANSI	American National Standards Institute
APDOS	Apple DOS Operating System
AP	Attached Processor
APL	A Programming Language
ASCII	American Standard Code for Information Interchange
ASR	Automatic Send and Receive
ATM	Automatic Teller Machine
AU	Arithmetic Unit
BASIC	Beginner's All-purpose Symbolic Instruction Code
BCD	Binary Coded Decimal
BCS	British Computer Society
BDOS	Basic Disk Operating System
BIT	Binary digit
BIOS	Basic Input/Output System

BMC	Bubble Memory Control
bps	bits per second
BPI	Bytes per Inch
BROM	Bipolar Read Only Memory
BSAM	Basic Sequential Access Method
BSC	Binary Synchronous Communications
CAD	Computer–Aided (Assisted) Design
CAD/CAM	Computer-Aided Design/Computer-Aided Manufacturing
CAFS	Contents Addressable File Store
CAI	Computer–Aided (Assisted) Instruction
CAL	Computer–Aided (Assisted) Learning
CAM	Computer–Aided (Assisted) Manufacturing or
	Content Addressed Memory
CASE	Computer–Aided Software Engineering
CAT	1. Computer–Aided (Assisted) Training
	2. Computer–Aided (Axial) Topography
CCD	Charge Coupled Device
CGA	Colour Graphics Adapter
CDAC	Centre for Development of Advanced Computing
CDROM	Computer Disk–Read Only Memory
CICS	Computer Information Control System
CILP	Computer Language Information Processing
CIM	Computer Input Microfilm
CMI	Computer Managed Instruction
CMOS	Complementary Metal Oxide Semiconductor
CML	Computer Managed Learning
CNC	Computer Numerical Control
COBOL	Common Business Oriented Language
CODASYL	Conference on Data System Languages

COM	Computer Output (Originated) Microfilm
COMAL	Common Algorithmic language
CORAL	Class Oriented Ring Associated Language
Cps	Characters per second
CP/M	Control Program for Microprocessor
CPU	Central Processing Unit
CROM	Control Read Only Memory
CRT	Cathode Ray Tube
CSI	Computer Society of India
DS/HD	Double Sided, high density
DS/DD	Double Sided, double density
DAD	Direct Access Devices
DASD	Direct Access Storage Device
DBMS	Data Base Management System
DBTG	Data Base Task Group (of CODASYL)
DCE	Data Communications Equipment
DDL	Data Description (or Definition) Language
DDP	Distributed Data Processing
DOS	Disk (based) Operating System
DP	Data Processing
DPI	Dots per inch
DTP	Desktop Publishing
DPM	Data Processing Manager
DPS	Data Processing System
DRO	Destructive Read Out
DSS	Decision Support System
EBCDIC	Extended Binary Coded Decimal Interchange Code
ECMA	European Computer Manufacturers' Association
ECOM	Electronic computer oriented mail

EDI	Electronic Data Interchange
EDS	Exchangeable Disk Store
EEPROM	Electrically Erasable Programmed Read Only Memory
EDP	Electronic Data Processing (equivalent to DP)
EFTS	Electronic Funds Transfer System
ENIAC	Electronic Numerical Integrator and Calculator
EPROM	Erasable Programmable Read Only Memory
FGCS	Fifth Generation Computer System
FEP	Front-End Processor
FORTRAN	Formula Translation
G	Giga-one thousand million (usually called 1 billion)
GB	Giga Bytes
GIGO	Garbage In/Garbage Out
GUI	Graphical User Interface
HIPO	Hierarchical Input/process/Output
HLL	High Level Language
Hz	Hertz
IBG	Inter Block Gap
IC	Integrated Circuit
IDP	Integrated Data Processing
IFIP	International Federation for Information Processing
IMPLE	Initial Micro Program Load
I/O	Input/Output
IOCS	Input/Output Control System
IPS	Instructions per second
ISAM	Index(ed) Sequential Access method
ISDN	Integrated Services Digital Network
ISO	International Standards Organisation
ISR	Information Storage Retrieval

JCL	Job Control Language
K	Kilo-1000 in decimal; 1024 (2^{10}) in binary system
KBS	Kilo-Bytes per second
LAN	Local Area Network
LAP	Link Access protocol
LCD	Liquid crystal Display
LED	Light Emitting Diode
LISP	LIST Processing
LSI	Large Scale Integration
MB	Mega bytes–1 million in decimal; 1,048, 576 (2^{20}) in binary system
MAR	Memory Address Register
MCI	Magnetic Character Inscriber
MDR	Memory Data Register
MICR	Magnetic Ink Character Recognition
MIPS	Millions of instructions per second
MIS	Management Information System (or Services)
MOS Chips	Metal Oxide Semiconductor chips
MPU	Micro-Processor Unit
MSI	Medium Scale Integration
MVS	Multiple Virtual Storage
NCC	National Computing Centre
NMOS	N-Channel Metal Oxide Semiconductor
NS	Nano Second
OCR	Optical Character Recognition (Reading)
OMR	Optical Mark Recognition (Reading)
OOF	Office of the Future
OOP	Object Oriented Programming

OS	Operating Systems
OPS	Operating per second
OSI	Open systems Interconnection
PABX	Private Automatic Branch exchange
PBX	Private Branch Exchange
PCB	Printed Circuit Board
PC	Personal Computer
POS	Point-of–Sale
PIN	Personal Identification Number
PL/1	Programming Language/1
PMOS	P-Channel Metal Oxide Semiconductor
PROLOG	Programming in LOGic
PROM	Programmable Read Only Memory
PSE	Packet Switched System
PSTN	Public Switched Telephone network
QBE	Query By Example
RAM	Random Access Memory
RCS	Realtime Communication System
RJE	Remote Job Entry
ROM	Read Only Memory
RPG	Report Program Generator
RTL	Real Time language
RDBMS	Relational Data Base Management Systems
SOP	Standard Operating Procedure
SIMULA	Simulation Language-an extension of ALGOL for Simulation LANGUAGE PROBLEMS
SNOBL	String Oriented Symbolic Languages
SNA	Systems Network Architecture
SQL	Structured Query Language

SSI	Small Scale Integration
TDM	Time Division Multiplexing
TPI	Tracks Per inch
TRS	Tandy Radio Shack
T/S	Time Sharing
TSS	Time Sharing System
TTY	Tele Typewriter
UG	User Group
UNIVAC	Universal automatic computer
VDU	Visual Display Unit
VAN	Value Added Network
VLDB	Very Large Data Base
VMOS	V-Channel Metal Oxide Semiconductor
VGA	Video Graphics Adapter
VLSI	Very Large Scale Integration
WAN	Wide Area Network
WORM	Write Once, Read Memory
WP	Word Processing