Introduction to Information Technology

Study Material for MS 01

Directorate of Distance Education

Guru Jambheshwar University of Science & Technology, Hisar

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Part 7

Information Concepts and Processing

UNIT

1

DATA AND INFORMATION CONCEPTS

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Define data and information.
- Describe the need for information.
- Describe the characteristics of information and information system.
- Describe various categories of information.
- Describe the value of information.
- Describe various levels of information.

U N I T S T R U C T U R E

1.1 INTRODUCTION

In our day-to-day life we all require some or the other information for which we depend on different types of resources like television, radio, newspapers, environment, etc. These resources provide us with data which when grouped together in some relevant manner and processed in our mind, results in some meaningful thoughts, known as information. Information is used for decision-making.

We know that it is by virtue of automation and computerization that data processing and information circulation can happen at a very high speed. Information remains useful for a particular timespan or we can say that an information is useful only for that time period in which, we reach up to an appropriate decision. The data processing needs to be accomplished at a very high

speed to get useful information within its life-span, specially when time is the major constraint and the volume of data is very large. This is where computers play a very critical role by processing millions of data within a few seconds.

In this chapter we will see the difference between data and information, how computer performs the processing work and how we can utilize computers optimally in the field of information technology.

1.2 DEFINITIONS

Data

Data are the basic facts about entities within an organization which provide us with very little or no meaning until processed in some manner. Data are the raw facts about entities describing objects of relevance to an organization.

For example, for a shopkeeper goods purchased, purchase price, selling price, number or item sold, etc., are the data which until joined together and processed cannot give the information of profit or loss.

Information

Relevant data when joined together, processed and converted into a meaningful form is known as information. Data is processed so that it becomes relevant to a particular decision situation. It helps in reducing uncertainty associated with decision alternatives or choices and is presented in a form which is found useful by the decision maker. Timespan during which an information is useful is known as age of information. Note that information should be in a proper format and easily understood by the user.

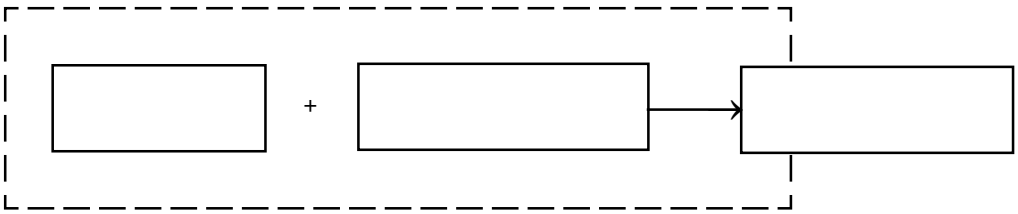
Example: Time-table, Merit list, Payslips, etc.

Information System

Information System is the system which provides us with the facility of data processing and interpretation of information to reach up to a set of alternative decisions.

Data Vs Information

Data is a set of symbols or experience stimuli that has no meaning or no value by itself until it is related to a specific decision situation. Data is the basis of information. In short, data, in its unprocessed form, gives no useful meaning (information). When we process this raw data into a usable form, it becomes information. Information, as distinct from data, is the result of processing of data according to some specific set of guidelines.



Data Processing

1.3 NEED FOR INFORMATION

In today's world knowledge is the basis of all development and organized activity. Information when interpreted precisely and accurately gets converted into knowledge.

Knowledge

Inferences are based on interpretation of relevant information. The scanning of the knowledge base suggests a final decision through inference process to achieve the desired goal.

Need of Information in Business Management

The main area of information management covers data processing, documentation, report generation, analysis and implementation of information in decision-making.

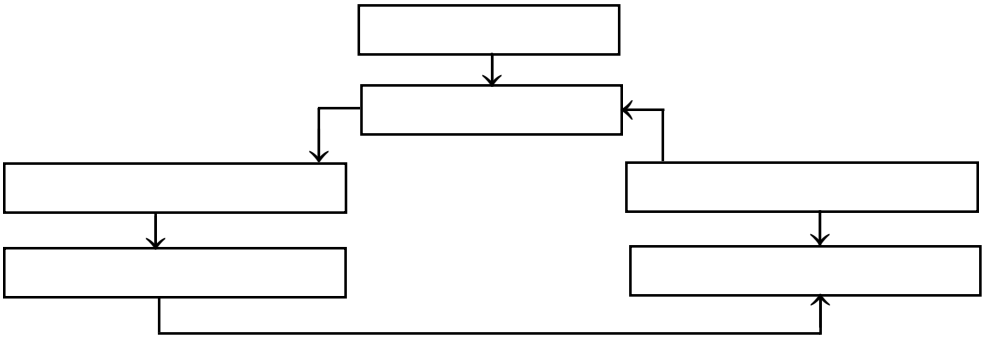
- Good information system increases the effectiveness of an organization.
- Information system is to the organization what the nervous system is to a human body.

Every business needs some information system to perform the following tasks:

- To take corrective measures in adverse condition.
- To improve the current organizational system so that performance can be improved.
- To secure the business from changes which can occur in the future.
- To define long-term and short-term objectives for an organization.

The requirement of information always changes according to the changes in the socio-economic and political systems; it leads towards changes in information system also.

So we can confidently say "an information system continuously keeps on changing rather than being in an absolute state."



Steps Involved in Decision-making Process

Need of Information in Decision-making

In any business organization, information needs change rapidly for many reasons such as:

- Growing dynamism of environment
- Growing size of organization
- Application of new technologies
- Growing competition.

Managers are involved in the decision-making process in many ways such as

- Management is largely concerned with making decisions and any action originating from such decisions.
- To make a good decision and to solve problems successfully, one needs reliable and accurate information.
- Information requirements will vary with level and functions of managers.

Basic information needs of a manager are:

- Information about the environment
- Understanding of the purpose of the organization

- Understanding of policies, programs, plans and goals of the organization
- Actual performance compared with plans/budgets/exception reports
- Possible corrective actions and their implications.

1.4 CHARACTERISTICS OF INFORMATION

- **Completeness:** Information must always be complete in all respects. Incomplete information is less useful. In the real world, it is not always possible to get complete information. So, if we get information which is complete in terms of the elements required and is sufficient in terms of the particular problem, our purpose may be solved.

  Example: To enter in a new product range, it is not required for an organization to analyze all the details of all the competitors in the market in same product range but only the information about major competitors, their product, quality and product support strategies with the details of demand and supply can fulfil the requirements.

- **Action-oriented:** Information must be given in a manner that it can be used directly for taking decisions or initiating action.

  This process suggests to the decision maker alternative course of actions and there outcomes to reach the best suitable course of action.

- **Conciseness:** Information system must produce information which is complete as well as concise. Decision-making process needs concise information that summarizes the relevant facts and it points out areas of exceptions to normal or planned activities.

- **Relevance:** Information must be relevant to the decision situation and should directly pin point the actual problem or the solution of the problem. It should help to reduce the uncertainty associated with the decision outcomes.

  Example: If a company is spending a very big amount of money on research and development and quality assurance, the quality can be the best in the market but the price of the item will also be high. If the price is more than the purchasing power of the target customers, the product will not sell and company will incur losses. The information about purchasing power is an action oriented information.

- **Availability:** Information must be stored systematically and in a classified and indexed manner for easy retrieval. It should provide the way of retrieving information in the media most convenient to the user. If information is not available, the situation can be misinterpreted which can lead to an adverse decision.

- **Timeliness:** Information has value in relation to the time in which it is made available to the decision maker. However, information must always be delivered in time, otherwise it loses its value. The time in which an information remains useful is known as the age of information. Age of information depends upon two type of data:

  - ***Conditional data*** which pertains to a particular point of time, e.g. total stock on 10 December 1999.
  - ***Operative data*** which changes over particular timespan, e.g. weekly raw material consumption.

    Information delays can be calculated by defining the time of data arrival, processing time required and the processing delays in data processing system.

- **Accuracy:** Accuracy is the ratio of correct information to the total amount of information produced over a period of time. Accuracy increases the cost of information. But it does not imply that the value of information will also increase. So for each type of decision, we have to decide what level of accuracy we want.

- **Exception Information:** Information reports should highlight the areas of exception to normal or planned activities, so that suitable corrective action could be initiated. Exception reports highlight conditions or situations, where actual performance (whether

overachievement or underachievement), differs from the planned or budgeted levels by more than a certain specified value, say ten percent, e.g. monthly exception sales reports showing all cases where sales have fallen below target by more than 10 per cent. Exception reports help in directing scarce managerial time and attention to most critical areas of business.

Student Activity 1

1. What is data?
2. What is information?
3. What is the difference between data and information?
4. Why do we need information?
5. What are the characteristics of information?

1.5 VALUE OF INFORMATION

Relevance to Receiver

Information has economic value as availability of relevant information helps in improving the performance of an organization. Organizations spend large sums of money to acquire information, either through their own processing systems, or through purchase from outside agencies. (Market researchers and Business consultants, Chartered Accountants, etc.)

Relevant information serves to reduce the element of uncertainty and therefore improves the probability of success in the decisions made by managers, at all levels in the organization.

Example: Before entering into a new product range, a company requires the market analysis and status reports of existing competitors, which can be done by the marketing team of the company, or other outside agencies.

Decision-making

From a given set of possible alternatives the decision maker will select one piece of information which is most likely to achieve his goal on the basis of the information at hand.

If new information causes a different decision to be made, the value of the new information is the difference between the outcome of the old decision and then of the new decision less the cost of obtaining the new information. Benefits of information must always be compared with the costs incurred in obtaining it. Value of information is related to its use. One kind of information may be useful to someone, but may be totally useless to another person. Decisions are basically of two types:

- **Unique or Non-programmable Decisions:** These decisions are basically those in which the decision should be taken when no fixed set of rules or actions are available for decision-making. These decisions are entirely based on the intelligence and experience of the decision maker.
- **Routine Based or Programmable Decisions:** These decisions are based on some static or bureaucratic rules and can be programmed for interpreting the information to define the possible course of actions with the possible outcomes for each of them.

Decision-making process depends upon two major factors:

- The complexity of the problem which depends upon the number of variables or factors associated with the problem. That is, in how many ways a problem can occur.
- Certainty associated with decision-making system to reach a decision associated with a particular problem.

1.6 LAW OF REQUISITE VARIETY

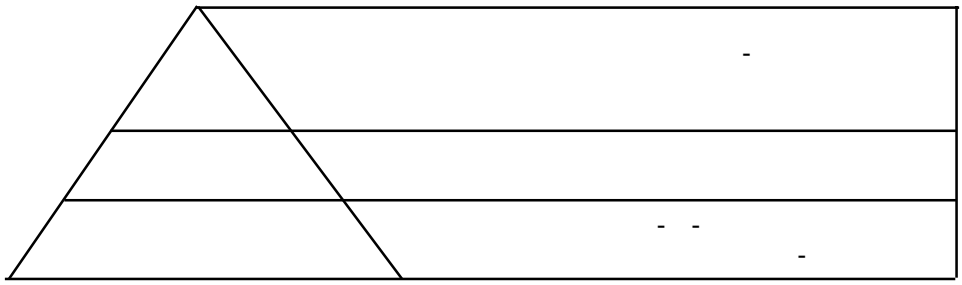
To control each possible state of the system elements, there must be a corresponding control state. That is, if there are ten ways in which a problem can occur in a system, there must be ten different control strategies available to solve the problem. This is called the law of requisite variety.

1.7 CHARACTERISTICS OF AN INFORMATION SYSTEM

- It should be the best suitable course of action from all alternative solutions suggested.
- Interactive decision-making helps the decision maker to achieve the best possible solution by making queries on the outcomes of each course of action.
- Decision-making process should have a very high level of intelligence (a good knowledge base) that should be updated every time a new type of decision is taken.
- Reasoning capabilities provide the facility of computing all the course of actions with their outcomes, to reach up to the best suitable course of action. The system should give its own suggestions.

1.8 CATEGORIES OF INFORMATION

Most of the computer-based information systems are not capable of properly utilizing the computer facilities and resources because they are just the copy of the old manual process. In modern civilization, business organizations are the major information processing centres. These are the places where various types of decisions are made by the managers on the basis of information generated by information systems. Depending upon their responsibilities and the level in the organization, managers will require information of different levels and categories. Management decisions arise from managerial planning which takes place at three levels



Management Hierarchy

Planning	Description
Strategic Planning	Charting future course for the organization. Determination of organizational mission, goals and objectives, definition of policies, procedures and guidelines.
Tactical Planning	Acquisition of resources. Acquisition tactics, plant location, new (Management Control) products, establishment and monitoring of budgets.
Operational Planning	Effective and efficient use of existing facilities and resources to Control carry out activities within budget constraints and stipulated time.

- **Strategic Planning or Long-term Planning:** At this level of planning, managers decide long-term strategies to achieve the company's objectives. These objectives cannot be achieved within a day or month. That is why, company objectives are based on the plan of improvement in company assets, cash resources, finance raising capabilities and company's reputation in the market. These plans are divided on a long-term basis, say a 5-year or 10-year plan, and set by the top level management (e.g. board of directors, etc.).

- **Tactical Planning:** These type of plans are normally developed for resource allocation and effective utilization of resources available. It includes manpower planning, development of new products, launching of new products, establishment of new plants, their locations budget monitoring, etc.

- **Short-term or Operational Planning:** These plans are developed to achieve short-term goals (say, year plans, half yearly plans, monthly plans, etc.), and are used to set objectives and standards of overall performance of an organization in terms of financial results. It includes sales, turnover, cost of sales target setting, etc.

  These elements can be broken down into controllable and computable factors such as:

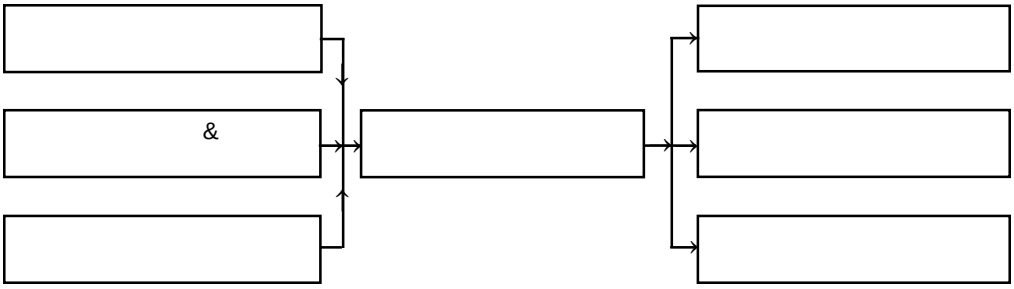
  - ♦ Investment on research and development
  - ♦ Product support strategies (advertising, attractive schemes, etc.)
  - ♦ Fixed assets management strategies
  - ♦ Accounts receivable
  - ♦ Cost of sales (overheads, labour, administrative expenses, shipping, etc.).

Student Activity 2

1. How is information required for decision making?
2. What do you mean by the law of requisite variety?
3. What are the characteristics of an information system?
4. List various categories of information.
5. Define
   (a) Strategic planning
   (b) Operational planning

1.9 INFORMATION FOR PLANNING

Information required for planning can be broken down into three types based on their usage and their requirement at different levels of management. Different levels of management use these information for the purpose of planning and decision-making.

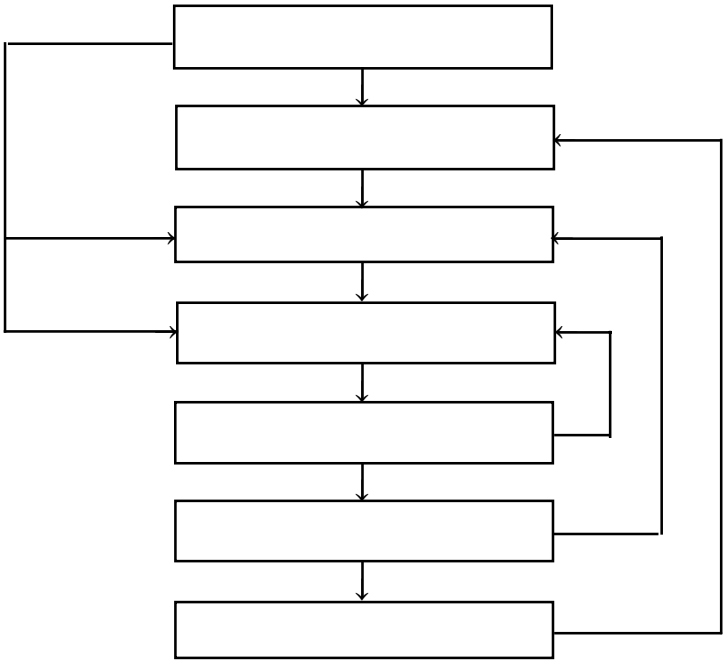


Management Planning Needs: Three Types of Information

Type of Information	Description
Environmental	The economic, political, social and technological environment in which the organization operates.
Market	The nature of competing organizations, their past performance, current activities and project plans/actions; changing customer needs and preferences.
Internal	Organization plans and activities.

1.10 USE OF INFORMATION SOURCES

All information sources are handled differently at different levels of management. The upper level of management uses the data provided by the lower level management and some other managerial data and procedures. After the plans are made, they are passed to lower level management to utilize them at their level. This process runs in a cycle for development of new plans by summarizing the current plans with the detailed information received by different managerial levels from their lower levels, and then, passing the plans and decisions developed, to their lower level management for further utilization in their decision-making process.



Use of Information Sources

1.11 LEVELS OF INFORMATION

The level and amount of information required depends on the complexities of the organization and nature of tasks involved therein.

International Information

Foreign governments and international agencies publish reports on the economy and other related matters of significance. These reports can be utilized, to expand the area of organization in the market by selecting the suitable market according to facilities available, and economic and political strategies of countries.

Example: United Nations Statistical Year Book, Reports by International Monetary Fund (IMF) and World Bank, Information on Current Foreign Exchange Rates, European Economic Community Reports, International Stock Exchange Rates, etc.

National Information

Central and state governments and their different departments publish reports reflecting the country's progress in various fields.

Example: Census of India, RBI Bulletins, Statistical Abstracts of the States, Central Statistical Organization Reports, Annual Industry Surveys.

Corporate Information

All companies regularly publish reports which provide information regarding the company's present performance and future plans for attracting new investors as well as providing information to the shareholders about the companies Net Asset Value (NAV) and the dividend, etc., e.g.

Departmental Information

Bodies like municipalities and district boards publish reports and data regarding birth and death, health and sanitation etc.

Departments in corporations prepare departmental budgets and progress reports periodically, for the use of corporate office, to develop new plans in order to improve the efficiency of each part of the organization.

Individual Information

This may be required by individual owner-manager in a small organization, or individual manager in a section, group, or a business centre in a large organization. It is used for taking decisions relevant to individual manager's responsibilities in the organization and may include plans, progress reports, problems, resource requirements, etc., e.g. daily sales report, stock status report, daily production report.

Student Activity 3

1. Describe various types of information required for planning.
2. What is national and International information?
3. What is corporate and departmental information?
4. What is individual information?

1.12 SUMMARY

- Data are the raw facts about entities which do not mean much until joined, together and processed and converted in a useful form known as information. We require some information which, when interpreted correctly, becomes knowledge. Knowledge facilitates the decision-making and helps in achieving goals.
- In business management, Information System plays a vital role by providing us with the facility to make decisions which help us in following ways:
  - ♦ Corrective decisions against any adverse condition or problem.
  - ♦ To secure the business from the future changes, using forecasting techniques.
  - ♦ To improve the current organizational performance.
  - ♦ For defining long-term and short-term goals.
- Useful information needs to have the following basic characteristics

  1. Completeness 2. Action oriented
  3. Conciseness 4. Relevance
  5. Availability 6. Timeliness
  7. Accuracy 8. Exception Information
- Each information has some value associated with it until it is within the range of information, increase in the cost of information; doesn't ensure that the value of information will also increase.
- There are two basic type of decisions; routine-based programmable decisions and non-programmable or unique decisions. They depend upon two major factors; complexity of a problem and certainty associated with decisions.
- Decision-making process depends upon the different management levels for which

requirement of information is also different. There are three levels of management. Top management handles the long-term strategic plans whereas middle level management handles the tactical planning to implement the strategic plans. Lower management handles the day to day decisions. Each level of management receives the information from its lower level and also generates some managerial data for itself. The information according to its source, can be divided into five levels. They are international, national, corporate, departmental and individual information.

1.13 KEYWORDS

Data: The raw facts about entities describing objects of relevance to an organization.

Information: Relevant data when joined together, processed and converted into a meaningful form is known as information.

Information system: System which provides the facility of data processing and interpretation of information to reach up to a set of alternative decisions.

Knowledge: Information when interpreted precisely and accurately gets converted into knowledge.

Conditional data: Data which pertains to a particular point of time.

Operative data: Data which changes over particular time span.

1.14 REVIEW QUESTIONS

Fill in the Blanks

1. Information is _____ data.
2. Good information system increases _____ of an organization.
3. Information system in the organization is similar to the _____ in human body.
4. Middle level managers use _____ information.
5. _____ highlight conditions or situations where actual performance differs from the planned or _____ levels.
6. Information has economic value since _____ is available.

Multiple Choice

1. Information is
   a. Collection of data
   b. Summarization and processed data
   c. Textual form of data
   d. Same as data
2. Managers perform strategic planning, using
   a. Internal information
   b. Internal and external information
   c. Market information
   d. Global information
3. Top level management is responsible for the development of
   a. Strategic planning
   b. Operational decisions
   c. Tactical planning

d. Day to day decision-making

4. Example of departmental information is

a.. Annual report

b. Daily sales report

c. Annual industry survey

d. Monthly report of marketing

5. Law of requisite variety is dependent upon

a. The value of information and cost of information

b. Programmable and non programmable decisions

c. Number of ways an error can occur and the number of preventive measures

d. None of the above.

Descriptive Questions

1. What do you understand by Information System? Why is its important in business?
2. Describe the law of requisite variety.
3. What do you understand by age of information? Describe in brief.
4. Write down the details of short-term planning.
5. How does an organization utilizes information resources on different management levels? Explain with the help of a diagram.
6. Describe the types of information required for planning.
7. What are the various characteristics of information?
8. Write the details of decision-making process.

Answers to Review Questions

Fill in the Blanks

1. Processed
2. Effectiveness
3. Blood
4. Tactical
5. Exception information, budgeted
6. Relevant Information

Multiple Choice

1. (b)
2. (d)
3. (a)
4. (b)
5. (c)

1.15 FURTHER READINGS

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

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

UNIT 2

ELEMENTS OF ELECTRONIC DATA PROCESSING

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Describe various data concepts.
- Describe data and file organization.
- Describe the features of electronic data processing.
- Understand the commercial applications of text processing.
- Understand the concept of EFT and E-com.

U N I T S T R U C T U R E

2.1 INTRODUCTION

This is the era of automation/mechanization and electronic applications in the field of manufacturing and management. In order to maintain accuracy and to save on manual labour, electronic and mechanical equipment have been introduced in every field of life. Today computers are the most popular electronic equipment used for this purpose and we can say that today we are living in the age of computers.

Computers have made great in-roads in our day-to-day life and thinking. They are used for all sorts of applications ranging from complex calculations in the field of frontline research, engineering, simulation, to teaching, printing books and recreational games. The ease with which computers can process, store and retrieve data makes them inevitable in office and business environments. So a common man today finds it difficult to survive without computer awareness and literacy.

2.2 DATA CONCEPTS

Data consists of symbols which represent, describe or record some aspects of reality. Symbols used in recording data must reflect the needs and views of users of data. There are three levels of data arrangements through which we can describe the different views in which data can be prepared as discussed below.

Example: A name identifies a person.

View Concept of Data

The end-user oriented way of describing and understanding data is termed as view concept. This refers to the way the end in which user views arrangement of data in terms of the input and output formats available for him. The input/output formats are arranged by programmers. Programmers and end-users mutually decide the final arrangements over the screen as well as of the printed documents.

Logical Concept of Data

The programmer-oriented way of describing and understanding data is termed as logical view. This refers to the way in which the programmer views arrangement of data in terms of data structures in programs. The large volume and variety of data is organized into a hierarchy of data fields, records, files and databases for the user's convenience. Some advanced concepts like relation and objects are used for more efficient data management and effective programming.

Entity, Attribute and Relationship

- ***Entity:*** An entity is an object that has certain attributes or properties which may be assigned values and which is having physical existence.
- ***Attribute:*** Attributes are values associated with an entity, which have some relevance and can show the relationship with the entity set.

  Example:

  Entity : Employee

  Attributes : Name, age, basic pay

  Entities, with similar attributes, form an entity set. These entity sets form separate files which have some common attributes to form relations in different entity sets known as key fields.

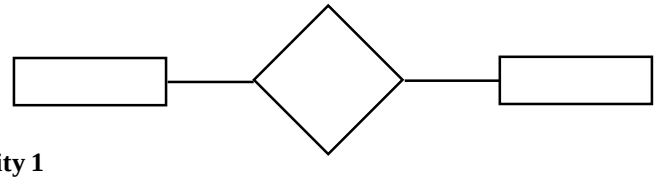
  Example:

  Entity set : Department

  Entity : Employee working in the department.

- ***Relationship:*** The way various entities are associated to each other in a relevant manner which provide some meaning to us is known as relationship as in the following example.

  There is a relation between a customer entity and items entity that a customer purchases.



Student Activity 1

1. Define data.
2. Describe the logical concept of data.
3. What is an entity?
4. What is an attribute?
5. What is an relationship?

Physical Concept of Data

Physical concept of data refers to the way in which data is recorded on the computer storage medium (like disk and tape). The programmer must have knowledge of physical data storage in order to understand and respond to constraints in logical representation that may be imposed by physical storage. It provides help to the programmers in making more efficient programs by facilitating better understanding and use of computer resources.

Data Storage and Retrieval

Retaining data permanently on some physical medium for future reference is known as data storage. In computer system, data is stored in the magnetic or optical form on suitable devices known as secondary storage devices. Some of the secondary storage devices are given below:

- Magnetic/Cartridge tapes
- Hard disks
- Floppy disks
- CD-ROM

Comparison of Various Data Processing and Storage Methods

There are many different ways available to process and store data for fast and easy retrieval in the current era. The data processing system can be categorized as:

- Non-Electronic Data Processing (Non-EDP)
- Electronic Data Processing (EDP)

Non-Electronic Data Processing includes two types of systems. However, these are not considered very effective due to their slow speed and poor efficiency.

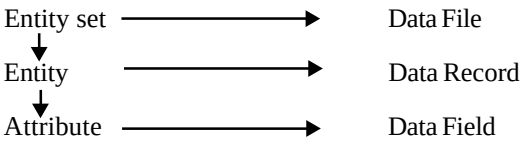
Manual Systems: Earlier all the business systems used to have manual information system for data processing using basic tools as pens, index cards, registers, accounting books, cabinets, files, etc. Most such business systems were not capable of providing very basic and current summary information in time about stock position, status reports. Manual systems had very limited aids to help the user like calculators for arithmetic calculations or a cash receipt machine.

Semi Automatic Punch Card Systems: The early computation systems used punch card machines and punch card readers to read and store data using punch cards or paper tapes. It was very difficult to handle these bulky cards. Also a card or paper tape is not reusable.

Electronic Data Processing Systems (EDP): Consist of various input and output devices connected to an electronic computer. All the operations are performed automatically without much human intervention.

2.3 ORGANIZATION OF DATA AS FILES

Data is arranged into the hierarchy of fields, records and files. Field is a single elementary unit of information representing an attribute of an entity. A set of field values (attribute) of a given entity, when combined together, forms a record. File is the collection of records of entities in a given entity set.



Example: Assume the following file structure.

Name	Date-of-Birth	Occupation
Amit	16-08-1965	Businessman
Rakesh	08-04-1956	Engineer
Dinesh	12-11-1968	Doctor
Raman	11-10-1973	Teacher

Here the entity set is the set of persons in the file. Each person is a separate entity. Name, Date-of-Birth and Occupation are fields and the value attached to each field for a particular entity is attribute for that entity. A person in record one is an entity and Amit, 16-08-1965, businessman are his attributes. When these attributes are connected together and the entity is recognizable by these values this becomes a record (each row for a person is a record).

2.4 FILE ORGANIZATION

The way in which records are arranged in the file is known as file organization. In a file, records are organized for data access purposes. File organizations are of three types:

- Serial/Sequential
- Direct/Random
- Indexed Sequential Files

Serial/Sequential Organization

Records are stored in serial or sequential manner as the user has entered them in a file. Records can be processed serially, one after the other, and backward processing is not possible. This system is suitable for payroll type of processing and we can use magnetic tape and disks both, for storing such files.

Direct/Random Organization

In a random file, records are organized in such a way that they can be accessed directly. Records are stored by arranging them in order of a unique key field or index. These key fields provide the facility of direct accessing of a record using an arithmetic function called hashing.

Indexed Sequential Organization

Records can be accessed directly as well as sequentially in indexed sequential files. The sequential access of data can be done by reading one record at a time, until we reach-up to the desired record.

The record may be stored randomly but the index table is created on order of the key value. In an index table, each key value is associated with a pointer to that particular record position which can be accessed directly using the index table randomly. This technique is known as Indexed Sequential Access Method (ISAM).

2.5 DATA TYPES

Data types can be divided into two categories

Numeric Data Types

Numeric data types are used to represent the numeric values by using symbols 0 to 9 and may take decimal point and leading + or – sign. These data types are used for calculation purposes.

Example: Salary of a person, marks of a student, age of a person, etc. Numeric data types can further be of two types:

- Integer to store integer values in variables of fields. e.g. number of employees (can't be in decimals).
- Real/floating point data type to represent decimal numbers (e.g. marks of student may be 65.5%).

Character/Alphanumeric Data Type

Character or alphanumeric data types represent character values and can take all printable characters from the keyboard. It includes 0-9, A-Z and special characters mentioned on the keyboard. They are used for formatting and representation purposes of non-numeric values and are not used for calculation purposes. Example, name, address of a person, department of an employee, etc.

Student Activity 2

1. How can you retain data permanently?
2. Give various categories of data processing system.
3. Define EDP.
4. What is a file?
5. List various types of file organizations.
6. List various data types.

2.6 TRANSITION TO EDP

The new technologies in the field of Electronic Data Processing have reduced the cost of high performance computers. Today's PCs are comparable to yesterdays mainframe in terms of power and reliability.

Data processing has gained added importance with the advent of computers. Today, the term "data processing" generally stands for data processing using computers. However, there are other means of data-processing as well which are in use all over the world. Data can be processed in one of the following three ways.

- ***Human being acting as data processor:*** Even after the evolution of computer technologies, human beings prove to be the best data processors because of their higher level of intelligence. We use ears, eyes, nose, etc., as input devices and the output is produced in oral or written form. The human brain, acting as CPU, is capable of changing operations sequence with the situation automatically.

  On the other hand, computers can retrieve and process the data at much higher speed without mistakes but they have limitations in that they are able to perform only according to instructions.

- ***Electromechanical data processing:*** Before the evolution of computers, aids to computation included electrical and mechanical devices such as cash sales register machines, punch card processing machines etc. The advantages and disadvantages of these machines against computers are:
    - ♦ Computers can compute a large amount of data within a very short time and hence are much faster than manual processing.
    - ♦ In computerized systems, the chances of errors are very less, as compared to any other system.
    - ♦ It is very difficult to handle the bulky cards and these cards are not reusable also. We can store the material of around fifteen thousand cards in a single floppy. A hard disk can store material of thousands of floppies within itself. That means a device like hard disk which is not more than a small box can store data which if stored on punch cards can fill a big godown.
- ***Electronic data processing:*** Electronics entered the field of data processing with the use of calculators. The principle behind the manual method, electronic data processing is very much similar. Same data processing activities take place but with a very high speed and accuracy.

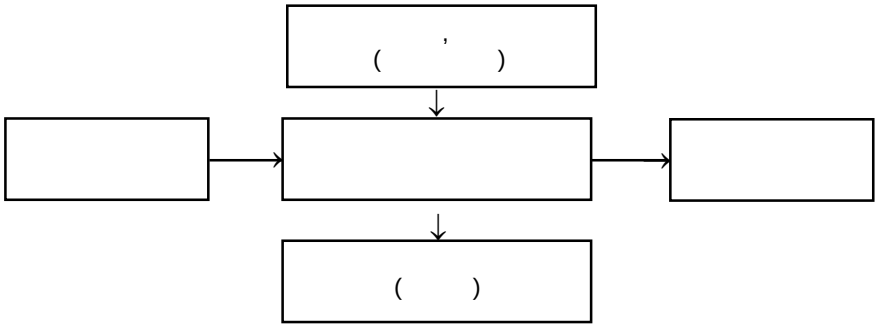
Use of computers does not mean that the conventional human labour for data processing has completely vanished. The collection of data inputs, deciding the procedures in the form of writing algorithms and programs will always be there as the need of information changes. These devices are just the helping hand which, provide improved computational accuracy and decrease the time of processing and chances of error.

2.7 FEATURES OF ELECTRONIC DATA PROCESSING SYSTEMS

- More commonly known by its acronym, EDP.
- EDP involves the use of computers for data processing.
- Computer is an electronic device which operates at a speed comparable to the speed of electricity.
- Electronic processing increases the speed of data handling and is very cost effective.
- Carries out its operations without much human intervention.
- Computers can be used in applications having one or more of the following characteristics:
    - ♦ Large volumes of data to be processed,
    - ♦ Complex computation, manipulation or processing logic,
    - ♦ Need to retrieve particular data quickly from a large data set,
    - ♦ Need to process data quickly,
    - ♦ Need for high processing accuracy,
    - ♦ Tasks which are highly repetitive in nature.

2.8 DATA PROCESSING

Data processing is a series of operations that result in the conversion of data into useful information. The term data processing system includes the resources required as a source of data. The resources are personnel, material, facilities, equipment, political and socio-economic agencies and different consultancy and research agencies.



Basic Components of a Data Processing System

Data Input

In this phase, the initial data or input data is prepared in some convenient form for processing. Input format depends upon the requirements of the input device and the requirements of the end user in terms of sequence of input fields. All input data must be recorded or captured in some computer readable form and should be retrieved as per the requirements.

Processing

In this phase, the input data is processed and usually combined with other stored data to produce information in a more useful form. This phase includes the development of programs and procedures by programmers leading to analysis and computation of data. It includes a number of steps:

a.	Classifying	:	Organizing similar items into groups
b.	Calculating	:	Arithmetic manipulation of data
c.	Comparing and sequencing	:	Arrangement of data in some logical sequence
d.	Summarizing	:	Reducing masses of data to a more concise form

Output

In this phase, results of the processing phase are compiled into meaningful reports which are useful for managers in decision-making. This phase includes the contribution of managers and programmers for deciding the format of outputs. Following operations can be performed on the output data.

Storing and Retrieving

The process of retaining data for future reference is known as storing and recovering stored data and/or information is known as retrieving. We require some permanent storage devices for this.

Communicating and Reproducing

Transferring data from one location to another for further processing or use is known as communication. It requires some sort of physical medium to connect computers at different locations also known as networking.

2.9 TYPES OF PROCESSING

Processing may be categorized as:

- Business Data Processing
- Scientific Computation
- Process Control Computation

Business Data Processing

It requires the processing of large volumes of business-related data and generates large volumes of output in the form of reports. It requires high speed computers with powerful input/output devices to facilitate graphic and multimedia applications and also for the conversion (editing) and sorting of data into various reports and document formats.

Scientific Computation

Scientific applications require relatively low volume of input or output but involve complex and extensive computations and advanced graphics feature. So for scientific applications, computers with very high processing capability are required to handle complex models and calculations.

Process Control Computation

Computer accepts input data from the process which is being controlled through sensors (i.e. chemical heat or radioactive sensors) for which internal processing is done to adjust the process control parameters. Special hardware is designed for this purpose which can result in totally automated production systems without human intervention.

Example: Petroleum refineries, steel mills, atomic power plants, pharmaceutical plants, etc.

Relevance of Information Output

In the previous chapter, we studied about the age of information so we know that management needs useful and timely information for making different types of business decisions. This means that as early as possible output should be available to the manager after processing the data. We had seen how an information system can have an impact on the quality of a manager's performance by means of:

- Creating an early awareness of emerging problems and opportunities.
- Permitting managers to explore more complex relationships among various factors affecting the decision.
- Enabling managers to devote more time to planning.
- Assisting in decision implementation through rapid feedback.
- Providing the facility of interaction with the system to know the outcomes of various courses of actions.

Student Activity 3

1. How can data be processed?
2. What are the features of electronic data processing?
3. What are the basic components of data processing system?
4. What do you mean by storing and retrieving the data?
5. What do you mean by communicating the data?
6. Give various categories of processing. Explain them in one sentence.

2.10 OVERVIEW OF COMMERCIAL APPLICATIONS

- ***Billing:*** A bill is a document which shows the payable amount for customers against the purchased item. These days computers are becoming very popular for billing purposes because of the fast and accurate calculation even if the list of purchase items is very big. Because of this fact various sales organizations, like shops and hotels, are using computers to generate bills.
- ***Accounting:*** One of the major uses of computers in any business is in the accounting department. Purpose of accounting is to get the details of all expenses and gains maintained in various fields which the organization is dealing in.

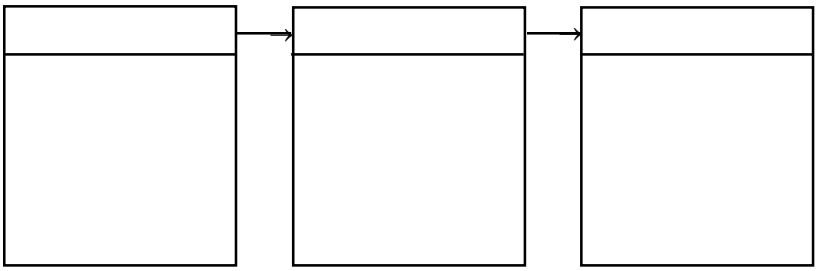
2.11 TRANSACTION PROCESSING

Every organization has some basic activities which are based on the primary plan and mission of the organization. All the activities involved in it are transformed into information to provide some help in the business missions achievement and is known as transaction processing. In a transaction processing system, our main aim is to process all the resources in terms of data, not the actual transaction. A transaction is exchange or conversion of one resource into another. Business organizations function by carrying out large number of diverse transactions which can be processed for various goal achievement activities of the organization. The objective of Transaction Processing Systems (TPS) is to process data that reflects or describes these transactions, e.g. sale of products, purchase of raw materials, employment of labour, etc. Following are the steps involved in transaction processing system:

- Transaction Data Input
- Input Data Validation
- Processing of Transaction Data
- Production and Distribution of Outputs

Functions of TPS

TPS (Transaction Processing System) is the system in which we collect data from various sources, input them in the form of records and manage them for further use. That is why there is not much conceptual difference between Manual Data Processing System and Computer Based Transaction Processing System.



Steps in TPS

Transaction Data Input

Operational steps performed to make transaction data available for processing are:

- ***Data Collection:*** TPS input may be in the form of Direct Input or Indirect Input. In Direct Input, data collection, data preparation and data entry are combined into one single function. Whereas, in indirect input, first data is collected for a period of time and prepared as well and then it is entered into the system in a sequence.
- ***Data Preparation:*** This involves conversion of data into a form for which the format is consistent with the data entry procedures. It may involve transcribing data from transaction documents to data entry documents.
- ***Data Entry:*** Data Entry is the process which makes data available for processing by means of entering data the manually or by receiving it in the form of outputs from the processes. Data entry differs according to the timing of the input: Immediate or Deferred. Immediate data entry is required within the execution of data processing. That means, in the processing of data and input of data, both the processes are running parallel. Whereas in deferred data entry, once the data entry process finishes, the processing module starts its execution.
- **Data Validation**
  - ♦ It is most important to ensure that data fed into a computing system is correct and logically consistent.

- ♦ Validation means ensuring that the data stands the best of logic and reasonability.
- ♦ A numeric data is checked to ensure that it is within the acceptable range.
- ♦ Alphabetic fields like names should not contain numeric entries.
- ♦ Appropriate data validation checks are suitable for particular application which should be designed to ensure that only correct and valid data is processed.

Processing of Validated Data

The valid records are processed further. Two major activities occur during transaction processing:

- Updation of machine readable stored data (master file) which is related to, or affected by the transaction.
- Preparation of outputs such as transaction listing and reports.

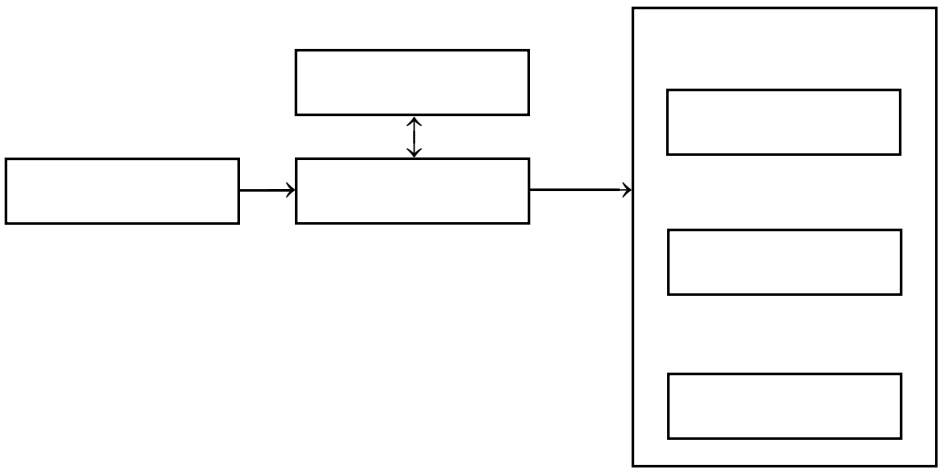
Production of Outputs

There are two types of output:

- *Soft Copy* is information that appears on the monitor and is lost when other information is displayed on the monitor. It is volatile in nature.
- *Hard Copy* is output recorded on a physical media such as paper or microfilm. It is non-volatile in nature.

Three steps necessary in the output phase of data processing are as follows:

- Retrieving or taking out the output data from storage.
- Converting or translating data into a useful form.
- Communicating or providing information to the proper users, at the proper time and place, in an intelligent form.



Types of Information Outputs

Characteristic of TPS Processing

- Storage is the capability to store large volumes of data in storage devices for further retrieval of data.
- Retrieval. Fast retrieval of data is an essential characteristic of any computerized TPS. Organizing data in different file organization according to the requirement of accessing capabilities facilitates fast retrieval.

- Classification of data means grouping according to some common characteristics like department, city of residence, etc. Classifying data according to the key fields provides us with linking capabability to other data files and quick retrieval of records using queries.
- Sorting means arranging of data into a specified sequence (numerical or alphabetical).
- Updation of data means addition of new data, deletion of obsolete data, and changing incorrect or outdated values.

Modes of Transaction Processing

There are basically two modes for processing transaction data.

Batch Processing

User prepares data to be processed at a later time by the computer. The input data consists of a batch of transactions prepared over a period of time such as a day or week, e.g. preparation of payroll, periodic preparation of customer bills, etc.

Online Processing

Direct interaction between the user and computer helps in processing each transaction immediately as it occurs. Transaction details are kept in a transaction file and master file is updated at a later time with the transaction file. Hence master file is not always up-to-date. Besides transaction processing and file updation, simple enquiries are also handled.

Example: Hospital billing system, stores issue and receipt, bank transaction, etc.

Student Activity 4

1. What is a bill?
2. What is the objective of a data processing system?
3. List various steps involved in transaction processing system.
4. What are the functions of transaction processing system.
5. Describe output phase of transaction processing system.
6. What are the characteristics of transaction processing?
7. Describe various modes of transaction processing.

2.12 REAL TIME PROCESSING

At the technical level, real time mode of processing is related to the response time of the system. Response time is the time interval between end of input message by the user and the beginning of the reply message from the system.

A computer system is classified as real time system if its response time is short enough to affect the decision-making of the phenomenon which triggered the system, i.e. created the transaction. The results of the processing are available quickly enough to influence the process which created the data input process.

Examples:

- ***Railway Reservation System:*** A passenger approaches the reservation window with a request for reservation by a particular train on a particular date. The passenger's decision will depend on the response from the system, whether or not seats are available as requested, waiting list status, seat availability on alternative trains, etc.
- Hotel Reservation System
- Stores Management System
- Real Time Banking System

However, the major area of application of real time systems is process control in continuous process plants (chemical, textile, steel etc.). It refers to the technique of updating relevant files with transaction data immediately after the event to which it relates. It is distinct from batch processing which processes selected data in batches at pre-defined periods of time.

Real time systems are basically online systems which specialize in inquiry processing. The response of the system to the inquiry itself is used to control the activity. It requires immediate transaction input from all input originating terminals. The terminals are directly connected via high speed communication links to one or more processors. There may be several terminals/stations operating at the same time. The data received from the terminals is updated immediately and all queries are answered in the split of a second with up-to-the-minute updated records.

Real time operating systems are used in environments where a large number of requests, mostly external to the computer system, must be accepted and processed in a limited time. Such applications includes:

- Inventory control – availability of stocks
- Airlines – flight seat availability
- Telephone switching equipment

Airline/Train Reservation System

A customer may want to know the availability of a seat on a particular flight/train for a particular day and class. For this, the system would be required to access data in real time mode and service the request. If a seat is available, the customer may want to book a ticket. In such a situation the file containing seat status information has to be updated and a ticket is presented.

2.13 WORD/TEXT PROCESSING

Information which is in the form of words is more meaningful than numeric data, which requires the interpretation capability of the user. In today's world many softwares are available for word processing which provide us with the ability to create useful documents and store them in storage devices for further use.

Manipulation of non-numeric data, like text, is known as word/text processing. Words are collected together in sentences to form a document. It is a term which describes the use of computer system to create, view, edit, manipulate, transmit, store, retrieve and print data in the form of text. There are many word processing packages available today. Some of the more commonly used are: Microsoft Word, Wordstar, Word Perfect, etc.

Features of Word Processor

Word processor provides us with the facility to write, edit, format, save and print a document with ease. Following are basic features of a typical word processing package.

Writing

With a word processing program, we can enter our work without being concerned about how the document will look. The software program recognizes when to begin a new line and automatically moves words to the next line. This capability is called "word wrap". Word processor creates "paragraphs" as unit of text that begins and ends with an enter key stroke. It automatically determines when to begin a new page, and also allows to include footnotes, footers, headers and adjust the page size.

Editing

While editing we can use either "Insert mode" or "Typeover mode". In "Insert mode" the software moves the rest of the text to the right when we type new text and in "Typeover mode", the new text replaces the existing one. Editing includes deletion of text (using delete and backspace keys), moving characters, words, etc. Text can be moved by using cut and paste facilities. Find and replace features is a handy editing tool to find a particular word in the document and provides the facility of replacing it with a specific string.

Formatting

Formatting is the process of adjusting the appearance of the document. We can format an entire document, paragraph(s), word(s) or a single character. It also includes moving and justifying margins, setting and moving tabs, adjusting line spacing and changing fonts. It also provides us with the capability of special effects like centering text, adding boldface and underlining words.

Saving

This allows us to save the document in secondary storage media by giving a name for further retrieval of the document.

Printing

It allows you to print the document whenever required. Some additional features are spell check, style and grammar checker and mail merge.

2.14 APPLICATIONS OF TEXT PROCESSING

Various types of documents can be created and edited easily using word processor software. A special application is Mail Merge, where similar letters or document can be sent to a number of people by writing only once and then by merging the addresses stored in a separate file.

2.15 DTP

DTP stands for Desk Top Publishing. This is the latest development in the world of word processing. Use of the software which allows the user to incorporate images and pictures into the document is a very important tool, as it provides more meaning to the text. These software are used to design the layout of various advertisements, which are to be given in newspapers and magazines and also used to design the layout of various printed products like books, journals, newspapers, etc.

2.16 COMPUTER GRAPHICS

"Images speak louder than words" – the computer gives us the facility of creating our own pictures and images by using different packages and even scanning real life images by using devices like scanners. Scanners scan a picture and can store it into the storage devices. Graphic software converts the numeric data used by computers into pictorial representation that is a more effective mode of communication.

Types of Graphic Packages

- ***Designing Package:*** These software tools have dramatically improved the productivity of design and drafting efforts for graphics development and are used to create, edit, store and make permanent prints of pictorial representations for engineering, drawings, architectural structures, etc.

  Example: Computer Aided Designing (CAD) Package – AUTO CAD.

- ***Paint Package:*** These software is used by artists for creating drawings and images by implementing their imagination and artistic abilities aided with the facilities provided by these software.

  Example: MS-Paint Brush, Coral Draw etc.

- **Analysis Package:** Software used by analysts to summarize large volume of data in pictorial form to represent the statistical images are known as analysis packages. These pictorial forms may be a bar charts pie charts, or line diagrams.

  Example: MS-Excel, Harvard Graphics, etc.

Application of Computer Graphics

Computer graphics packages are used by:

- Architects
- Civil Engineers
- Machine Designers
- Electronic Circuit Designers
- Fashion Designers
- Computer Animation Producers

2.17 OFFICE AUTOMATION

An automated office is a multifunction, integrated, computer-based facility that allows many office activities to be performed in an electronic mode to provide easier access to infomation. Office automation facilitates fast processing of data and information transfer. The components of the automated office and their major functions are:

Functions	Facilities
Word Processing	Facilitates the preparation of typed documents
Electronic Mail	Allows typed messages to be sent electronically
Voice Mail	Allows spoken message to be sent electronically
Fascimile	Allows the document to be sent electronically
Tele Conferencing	Brings conference participants together electronically
Personal Computing	Places computational decision support at user's fingertips
Computer Terminals	Provides access to electronically stored data and other components of the automated office
Micro Graphics	Stores documents on microfilm for easy retrieval

2.18 EFT AND E-COM

EFT (Electronic Fund Transfer)

It stands for Electronic Fund Transfer systems which enables employees to have their payroll cheques automatically deposited to their account, or have regular monthly payments deducted automatically. It can maintain complete records of all transactions which may affect customer's accounts. Using EFT, funds or money can be transferred electronically (through telephone lines) between parties involved in a business transaction. It uses plastic "money cards" commonly known as credit cards to pay for goods and services.

E-COM (Electronic Commerce)

E-Com is the application of communication and information sharing technologies among trading partners in the pursuit of business objectives. In the real world of business, four distinct types of E-Com are emerging.

- **Information Access:** It provides search and retrieve capability for public domain and proprietary data archives which provide the facility to receive only the data of general use to all users and special information to those who are having the permission to see those information. For example, information services (e.g. Dialog, Nexus, Lexus and ABI Informs) that maintain a database and charge for access.

- ***Interpersonal Communications:*** These services provide methods for parties with mutual interests to exchange information, discuss ideas and improve their cooperation in various fields related with research, education engineering, science, business, etc. For example, customer and supplier design groups jointly working out product specifications, updated files being sent by a publisher to printer and a purchasing agent using electronic mail to negotiate an expediting schedule with a supplier.

- ***Shopping Services:*** Shopping services allow people to seek and purchase goods or services through the Internet. These days, on Internet, we can find several groups providing services like booking of tickets, purchasing items, which can be home delivered, etc. (e.g. Home Shopping)

- ***Virtual Enterprises:*** Virtual enterprises are business arrangements in which trading partners separated geographically but having expertise are able to engage in complex joint business activities as if they were a single enterprise, e.g. true supply chain integration, where planning and forecast data are transmitted quickly and accurately throughout a mutilator supply chain.

Student Activity 5

1. Describe real time processing.
2. Which type of system is required for airline/train reservation?
3. Define word processing.
4. What are the features of word processor?
5. Write a short note on the following:
   (a) DTP
   (b) Computer Graphics
   (c) EFT
   (d) E-com
6. What are the applications of computer graphics?

2.19 SUMMARY

- To cope up with the fast-growing need of information we require computers to process data at a very high speed and accuracy on different levels. Different people have different views about data – end users see it in the form of input screen and output format known as view concept. In the logical concept, the programmer views it in the form of data types, structure and program sequencing, etc., and in physical concept we can get information about how data will be stored in the computer internally.

- Entities have certain attributes which, when combined together, show the physical existence of entity. Entities with similar attributes form an entity set and when these entity sets are used in the computer to store information they are known as data files. In data files, entities are known as records and attributes are defined as fields. Relationship between various entity sets can be defined by a single set of common attributes known as key field. Files can be organized in three ways: serial/sequential files, direct/random files and indexed sequential files.

- Modern data processing is divided in two parts: Non-Electronic Data Processing (Non-EDP), and Electronic Data Processing (EDP). Non-electronic data processing can be divided into manual and semi automatic data processing, (using calculators, punch card machines, etc.).

- Data processing in computers provides the facility to compute data and logical reasoning and planning. The basic components of data processing are the programs which instruct

the computer on how to work, take data input, a processing unit to process the data, record files for further data retrieval and output reports.

- Data processing is used in almost every field of our life including business, science, process control, etc., although computers are mostly used for commercial purposes, as billing systems, inventory control, accounting, etc.
- In every field of data processing, we require some documentation in the form of text and images. Many word/text processors provide the facility to create text documents in the format we like; some provide extra facilities to include images and pictures also in our document with text, and are known as DTP software.
- To develop images, pictures, image merging drawing, etc., we use software known as graphic packages. They can be used for designing architectural drawings, mechanical, electronic, or other types of designs. Some are used by artists for creating drawings, etc., known as paint packages, other may be used for the purpose of analysis known as analytical packages used for creating graphs charts, work sheets, etc.
- In many areas, computer graphics is growing at a very fast speed, for example, in architectural design, engineering, machine designing, electronic circuit design, fashion designing, computer animation procedures, etc.
- Some important EDP usage is in office automation, electronic fund transfer, E-com (E-commerce), international communications, home shopping (cyber marketing) virtual enterprises etc.

2.20 KEYWORDS

Entity: An object that has certain attributes or properties which may be assigned values and which is having physical existence.

Attribute: Values associated with an entity.

Relationship: The way various entities are associated to each other to provide some meaning.

Data storage: Retaining data permanently on some physical medium for future reference.

Field: Single elementary unit of information representing an attribute of an entity.

Record: A set of field values of a given entity.

File: The collection of records of entities in a given entity set.

File organization: The way in which records are arranged in the file.

Data processing: A series of operations that result in the conversion of data into useful information.

Storing data: The process of retaining data for future reference.

Retrieving data: Recovering stored data and/or information.

Communication data: Transferring data from one location to another for further processing or use.

Bill: A document which shows the payable amount for customers against the purchased item.

Transaction: Exchange or conversion of one resource into another.

Response time: The time internal between end of input message by the user and the beginning of the reply message from the system.

Word processing: Manipulation of non-numeric data.

EFT: Electronic fund transfer system which enables employees to have their payroll cheques automatically deposited to their account, or have regular monthly payments deducted automatically.

E-com (Electronic Commerce): The application of communication and information sharing technologies among trading partners in the pursuit of business objectives.

2.21 REVIEW QUESTIONS

Fill in the Blanks

1. Data entry is the process which makes _____ prepared for processing.
2. Soft copy appears in the form of output on the _____.
3. Output phase of data processing involve _____, and _____ data into useful form and _____ .
4. Real time processing is related to the _____ of the system.
5. Paint packages are used for the purpose of _____.
6. EFT stands for _____.
7. Formatting is the process of adjusting _____ of the document.

Multiple Choice

1. Logical concept of data describes
   a. The way in which data is physically stored.
   b. The input and output screens and reports.
   c. The data structure and file organization.
   d. None of the above.
2. Entity Set is
   a. The set of entities with similar attributes.
   b. The set of fields.
   c. The set of attributes of similar nature.
   d. The set of similar entities.
3. Punch card system is the example of
   a. Manual System.
   b. Electro Mechanical Data Processing.
   c. Semi Automatic System.
   d. Electronic Fund Transfer.
4. Data types are
   a. Representation of variable types.
   b. Data fields.
   c. Organization of entities.
   d. None of these.
5. Function of TPS
   a. Interpretation of information.
   b. Information System Design.
   c. Input, process, output.

d. Data Transfer.

Descriptive Questions

1. What are the features of a typical word processor? Describe them.
2. Describe the various data concepts and their needs.
3. How many different types of file organization can we have?
4. Describe the use of data types?
5. What are the various steps involved in TPS?
6. Write down the features of EFT and E-com.
7. What are the full forms of
   a. TPS
   b. DTP
   c. EFT
   d. E-COM
8. Write short notes on:
   a. Virtual enterprises
   b. Physical concept of data
   c. Office automation
   d. Computer graphics

Answers to Review Questions

Fill in the Blanks

1. Input data
2. Monitor
3. Retrieving, converting, intelligent form
4. Response time
5. Creating drawings and images
6. Electronic fund transfer
7. Layout

Multiple Choice

1. (c)
2. (a)
3. (b)
4. (a)
5. (c)

2.22 FURTHER READINGS

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

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

Elements of Computer Hardware

UNIT

3

EVOLUTION OF COMPUTERS

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Define a computer.
- Describe various generations of computers.
- Classify computers.
- Classify digital computers.

U N I T S T R U C T U R E

3.1 INTRODUCTION

The word 'Computer' is taken from the word 'computation'. Computers are devices which can compute at a very high speed. But most of the work in todays era, on computers, is non-numerical in nature, so we can say that computers are the machines which operate on data or information.

In this chapter we will study the evolution of computers with reference to memory, storage, performance level, etc.

3.2 DEFINITION OF COMPUTER

A computer can be defined as a fast and accurate electronic system for data management designed to 'automatically accept and store input data, and process them under the direction of a program (a set of instructions) stored in the computer itself', for producing the desired outputs. So we can say that "a computer is an electronic device which can receive inputs (data) as raw material and process it according to the program instruction to produce the output in a useful form".

Characteristics of Computer

- ***Speed:*** A computer is a very fast and accurate device. It can process thousands of instructions within a few seconds for which a human being can take several days or months.
- ***Accuracy:*** Degree of accuracy of the computer is very high. Errors can occur in computerized system also but most of them occur due to human mistakes rather than technical problems in the computer.

- ***Versatility:*** We can perform many different tasks on the computer. One moment it might be busy in calculating the statistical data of a business organization for annual performance evaluation and at next moment it is capable of working on inventory control.
- ***Permanent Memory:*** We can store very large amount of information in the secondary storage devices. This information stays with the computer for further use where as humans tend to forget things.
- ***No Intelligence:*** A computer can perform the information processing and reasoning only on the basis of the intelligence provided by human beings (in terms of programs developed) but it cannot make decisions on its own.
- ***Diligence:*** Computer is free from problems like exhaustion, lack of concentration, confusion, etc., unlike human beings.

3.3 GENERATIONS OF COMPUTERS

Computing large amounts of data quickly and accurately was the basic requirement which launched research on the development of computing machines. Computers have been developed in five distinct phases known as generations of computers according to their speed of data processing, electronic technology, special task capabilities, etc. Each generation is characterized here by the type of electronic technology employed:

1st Generation	Thermionic valve (Vacuum Tube)	1942-55
2nd Generation	Transistors	1956-65
3rd Generation	Integrated circuits (IC)	1966-75
4th Generation	Large and very large-scale integrated circuit or micro chip (LSI and VLSI)	1975 onwards
5th Generation	Very very large scale integrated (VVLSI); Genetic, neural and atomic chips	Under development

First Generation Computers (1942-55)

First generation computers used vacuum tubes/thermionic valve technology for their circuitry used for internal operations and magnetic drums for secondary memory. These machines had limited amount of primary memory and suffered from the problem of heating. Input and output operations were performed using punched cards which worked with a very slow speed and also had the disadvantage of being bulky. The punched cards were not reusable also.

Programmers used to write the programs in low level symbolic language expecting programmers to have an understanding of the internal structure of compilers. These programs were also not portable on other machines because of the machine dependent structure of programs. These computers were very huge and required very large space. Some computers of the first generation were:

ENIAC : Electronic Numerical Integrator and Calculator

EDVAC : Electronic Discrete Variable Automatic Computer

EDSAC : Electronic Delay Storage Automatic Computer

Second Generation Computers (1956-65)

Transistors are smaller and more reliable electronic device than vacuum tubes. They were invented in 1947-48. But the computers using transistors were not produced widely until a decade later. In first and second generation of computers, the main similarity was that both of them were made up of thousands of small components mounted together with wires to form a circuit which was installed by hands. Due to this, in the manual assembly of individual components, the cost of labour involved was very high.

The second generation computers used the transistor technology for their circuitry in internal operations. Magnetic core technology was used for primary memory and tapes and disks were used for secondary storage. The primary advantage of computers of this generation was reduction in size and heat generation, and increased capabilities in processing speed and reliability. The use of high level languages was started. Some of the second generation computers were

Model	Size		Application
IBM	1620	Small	Scientific
IBM	1401	Small to medium	Business
ICL	1901	Medium	Business
IBM	7094	Large	Scientific and business

Third Generation Computers (1966-75)

Technological advancements in the field of electronics resulted in a lot of advancement in the field of computerization. Invention of microelectronics technology made it possible to join several units of a large computer in very small silicon chips known as chip technology. These components are known as integrated circuits. The third generation of computers was based on this technology.

Third generation computers use Integrated Circuits (IC technology) on silicon chips for their circuitry and had increased primary memory capacity in comparison to the computers of second generation. Need for complex control software was also fulfilled in them. The primary advantage of these computers was a reduction in size and cost with increase in speed and reliability as compared second generation computers. These computers were the first computers which used Printed Circuit Boards (PCBs) for their circuit. Some of the computers which belonged to the generation were:

IBM - 360 Series

ICL - 2900 Series

Honeywell-361

Fourth Generation Computers (1975 Onwards)

In third generation computers an integrated circuits contained only about ten or twenty components which was named as Small-Scale Integration (SSI). After some more advancement in the field of microelectronics, it became possible to install around 100 and more components over a single chip known as Medium-Scale Integration (MSI). After some more development, it was possible to install thousands of components over a single chip known as Very Large-Scale Integration (VLSI) technology. This technology is growing very fast. There will be a time when all the computer circuitry will be over a single chip of the size of thumb nail.

These computers use Large Scale and Very Large Scale Integration (LSI/VLSI technology) for the computer's internal operations. They have very large primary and secondary memories and greater versatility in software with very high speed of processing. Moreover parallel processing capabilities are also used in these computers. They were also having limited artificial intelligence capability which enabled them to perform human like tasks, i.e. in robotics. These computers are very small in size due to the very compact circuitry. Most of the present day computers belong to this generation.

Fifth Generation Computers (yet to be developed)

These days scientists of many countries are working on this generation. The aim of this concept is to create human like intelligence in computers and ability of reasoning logically with real knowledge of the world. According to this concept, computers will be able to do multiple tasks simultaneously and will not act only as a data processing machine.

These computers are still under development. The technology used for them would be very very large-scale integration based microprocessors using parallel processing architecture and would

be using highly sophisticated operating system. They would work at a very high speed – may be 1000 times faster than today's super computer and provide natural language interface. The capabilities of these computers would exhibit artificial intelligence and inference processing capabilities. Some of the newer technologies, besides VVLSI, likely to be utilized in the development of fifth generation computers are as follows:

- Molecular computers using a molecule as basic switch (on-off) device.
- Genetic computers using neurons as switching as well as communication agent.

Student Activity 1

1. Define computer
2. What are the characteristics of computer?
3. What are first generation computes? Give examples.
4. What are second generation computer? Give examples.
5. Describe third generation computers
6. Describe fourth generation computers.
7. Write a short note on fifth generation computers.

3.4 CLASSIFICATION OF COMPUTERS

Computers can be classified on the basis of their circuitry and task performance capabilities. According to this classification computers have been classified into three categories:

- Analog computers
- Digital computers
- Hybrid computers.

Analog Computer

Continuous system simulation is being used for studying complex systems long before discrete system studies were applied because of the non-availability of digital computers at that time. There existed devices which can perform mathematical operations such as addition integration.

An Analog Computer operates and computes by using physical analogs, such as electrical resistance, pressure as the variable of a given problem and provides solutions in a graphic representation. Analysis of the problem is mirrored by the varying behaviour of the physical system. These computers are work specific computers (i.e. they are made to perform some particular task only). It deals with continuous data and does not communicate directly with numbers. They deal with the variables measured against a continuous scale. These computers are mostly developed for the purpose of testing and studying other existing systems or for new system development. These are designed for measuring variable characteristics at definite points of time. The main characteristics of analog computers are:

- Operate by measuring rather than counting;
- Used for simulation and modelling of systems;
- Use signals as input and outputs in terms of actions or environmental/conditional changes (speed, temperature, chemical changes, moisture, etc.); and
- Mostly used in engineering and scientific applications.

The most widely used analog computers are electronic analog computer based on the use of high gain DC amplifiers, called operational amplifiers. Voltages are equated as mathematical variables. All inputs and outputs are calculated in terms of the voltage differences on various parts known as complifiers of the circuitry. An amplifier can be used to add several voltage inputs each of

which can represent a variable of the model.

Example: Thermometer, Speedometer, Hydrometer, etc.

Digital Computer

A computer in which data is represented in discrete units, using coded digits, to represent all the variables of the problem and which can provide mathematically calculated solutions is known as Digital Computers. These computers can perform several different tasks and are interactive in nature. If the input in these computers is given incorrectly, we have the ability to terminate the process and start it again with correct inputs which is not possible in analog computers and hybrid computers because of their non-interactive nature and specific task performance. In these computers, if the input value is not correct, we have to wait until they finish the processing and than reprocess with correct inputs. The digital computer:

- operates essentially by counting instead of measuring;
- converts the data into digits;
- accepts information in the form of discrete electronic pulses, transmitted in code combinations and stores these pulses in the memory as strings of 0's and 1's;
- performs all operations on these digits at extremely fast speeds;
- is used for business and scientific applications;
- is interactive in nature; and
- is the most popular and widely used computer.

Hybrid Computer

These computers can be described as a combination of analog computers used in continuous system and also non-linear discrete features of a digital computer such as storing values, logical operations and switching. They are basically the combination of specially designed devices with an analog computer to extend its capability. Hybrid computers are mostly used with process control equipment in continuous production plants like oil refineries, etc., and used at places where signals as well as data are to be entered into computers.

Areas of application are: nuclear power plants, mines, intensive care unit of hospitals, etc.

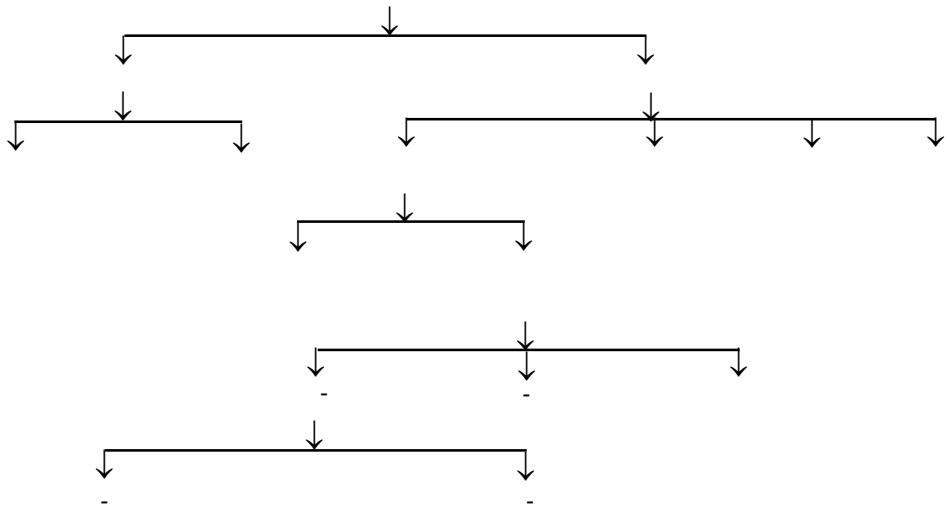
Student Activity 2

1. What are analog computers?
2. What are digital computers?
3. What are hybrid computers?
4. What are the characteristics of analog computers?
5. List some of the areas of application of hybrid computers.

3.5 CLASSIFICATION OF DIGITAL COMPUTERS

Digital computers may be classified in two ways, according to:

- Usage and
- Size



Usage-wise Classification

- ***Special Purpose Computer:*** These computers can be designed for a specific class of applications. Their instruction set is permanently stored in computer chips. It lacks versatility but performs the assigned task quickly and efficiently.
- ***General Purpose Computer:*** These computers can be used for a large variety of applications and have versatility in use.

Size-wise Classification

Size-wise digital computers may be classified into the following five categories, in increasing order of size:

- Micro Computer (PC)
- Workstation
- Mini Computer
- Mainframe Computer
- Super Computer

Micro Computer

A micro computer mainly consists of a single chip, e.g. 8088, 8086, etc., and has low storage capacity. The average data transfer rate of a micro computer is 5 lakh bytes per second. It can hold from 8 to 32 bit word length. Micro computer may be built around any microprocessor chip ranging from 8086, 80286, 80386, 80486 to Pentium processors. These computers can be subdivided into two types:

i. Home Computers

ii. Personal Computers

Home Computer

These computers are meant for hobbies rather than professional tasks. They consist of a keyboard integrated with CPU in one box and interfaced with ordinary television and multimedia system used for entertainment and training in various computer centres and home.

Example: BBC'S ACORN, APPLE II, IBM'S PC JUNIOR, etc.

Personal Computer

Personal computers are designed for personal use of individual professionals and meant for small

business units and office automation systems. These computers are mostly used for a variety of applications like:

- Computer literacy
- Business and professional applications
- Electronic spreadsheets
- Telecommunications
- Database management
- Accounting
- Word processing, etc.

These computers are divided in three broad categories on the basis of their physical structure:

- ***Desk Top PCs:*** They are comparatively big in size and are not portable.
- ***Lap Top PCs:*** They are slightly smaller than desk top and can be used while travelling.
- ***Note Book PCs:*** These computers are very small (approximately the size of a normal notebook) and use in-built battery for power supply to them.

Workstations

Workstations are desktop machines which have more powerful processors – speeds of about 10 times that of PCs. Most workstations have a large column video display unit and around 32 to 128 MB main memory with 4 to 15 GB disk and normally use RISC processors. The standard operating system of workstations is Unix and it has derivatives like AIX(IBM), Solaris (SUN) and HP-UX (HP). They provide good graphics facilities. Most workstations have built in hardware to connect to a LAN.

Some examples of workstations are:

- Silicon Graphics Workstation of SUN Systems.
- NEXUS-3500 CAE (Computers Aided Engineering) Workstations.

Mini Computers

Mini computers are usually multiple processing units in a single CPU out of which each processing unit can do a separate kind of work.

It is an improved version of micro computer. It uses word length of usually 16, 24, 32 or 64 bits. The data transfer rate is about 4 million bytes per second for mini computer. They can support 15 to 25 terminals simultaneously. Some important mini computers are:

- ESPL SM-32
- Magnum
- Mighty Frame
- VAX
- CDC 6600

Mainframe Computers

These are huge machines with high capacity of processing using parallel processing capabilities. The data transfer rate is 8 million bytes/second. It uses the word length of usually 24, 32, 48, 64 or 128 bits. A mainframe computer can support up to 500 terminals simultaneously. It can be used in Centralized Train Reservation System, Airline Reservation System, etc. Some important main frames are:

- IBM 3090
- IBM AS/400
- VAX 8842
- RS/4000 and RS/6000
- UNIVAC - 1100/10

Super Computers

Super computers are used for solving multivariable mathematical problems which require repetitive floating point arithmetic operations on a large array of numbers, known as vector super computer, due to vector processing capabilities. These computers are mostly used in the field of aerodynamics, seismology, atomic and nuclear physics, etc., and are capable of handling hundreds of millions of floating point operations per second (MFLOPS, i.e. Mega Floating Point Operation). There cost is in the range of Rs 3 to 5 crore. Super computers work on the concept of parallel processing, vector processing and pipelining techniques. Some famous super computers are:

- Cray Series of Super Computers: CRAY-I, CRAY-II, CRAY-XMP CRAY-YMP, etc.
- Fujitsu VP-200
- Hitachi S-8-10-20
- NEC SX-2
- ETA GF-10
- PARAM Series of Super Computers: PARAM 5000, PARAM 8600, PARAM 10000 (manufactured by C-DAC India).

Student Activity 3

1. What are special purpose computers?
2. What are general purpose computers?
3. How will you classify digital computers on the basis of size.
4. What are micro computers?
5. What are Home computers? Give examples.
6. What are personal computers? Describe its various categories.
7. What are workstations? Give examples.
8. What are mini computers? Give examples.
9. What are mainframe computers? Give examples.
10. What are super computers? Give examples.

3.6 SUMMARY

- Computer is a an electronic device which can take input in the form of raw material (data) to process it and convert in a useful form (information). Computer has some basic characteristics like very high speed of computation, accuracy, versatility, storage, diligence and lack of intelligence and feelings.
- On the basis of the technology used in computer architecture, computers can be classified in five distinct generations. First generation computers used vacuum tubes, second generation computers used transistor, in third generation the integrated circuits were used whereas the fourth generation uses the LSI and VLSI technologies. Fifth generation computers are under development and would be using VVLSI technology, genetic, natural and atomic chips for there internal circuitry.

- Computers can be further classified on the basis of their circuit design and according to the task they can perform. Using this classification we can classify computers in three categories. First is Analog computers – they are made up of analog circuitry and are used for the purpose of study or development of a new system or other existing systems using modelling techniques. Digital computers are used for business and scientific applications mostly and use the binary digit manipulations. They can compute values at a very high speed. The hybrid computers use features of both digital and analog computers and are mostly used for process control in continuous production plants.
- Digital computers can be further classified by means of usage and size. Usage-wise digital computers are of two types, first is general purpose and second is special purpose. Whereas size-wise computers can be divided in four categories – super computers, mainframe, mini, workstation and micro computers respectively in decreasing order of size. Micro computers are of two types – home computers and personal computers. Personal computers are also of three types – desktop, laptop and notebooks.

3.7 KEYWORDS

Computer: An electronic device which receives data, processes it according to the program instruction to produce output in a useful form.

Analog computers: Computers that operate and compute using physical analogs, such as electrical resistance, pressure as the variable of a given problem and provides solutions in a graphic representation.

Digital computer: A computer in which data is represented in discrete units, using coded digits, to represent all the variables of the problem and which can provide mathematically calculated solutions.

Hybrid computer: A combination of analog computers used in continuous system and also non-linear discrete features of a digital computer.

Special purpose computers: Computers designed for a specific class of applications.

General purpose computers: Computers that can be used for a large variety of applications.

Microcomputer: The smallest and least expensive category of general-purpose computers.

Minicomputer: Relatively small, in-expensive, and compact computer that performs the same functions as a mainframe but to a limited extent.

Mainframe: Relatively large computer, used by corporations for centralized data processing and maintenance of large data bases.

Laptop computer: Transportable, lightweight microcomputer.

Desktop personal computer: The typical microcomputer system used as a standard tool in business and the home.

Notebook computer: Transportable, light weight microcomputer that fits easily into a briefcase.

Workstation: Powerful desktop-sized computer that provides high-speed calculations and high-resolution graphics required by engineering applications.

Super computers: Computer with the most processing power, used in scientific and military work and increasingly in business, for simulation, modeling and other types of computation-intensitive analysis.

3.8 REVIEW QUESTIONS

Fill in the Blanks

1. Normally workstations use _____ processors.
2. CRAY-XMP is a _____ computer.

3. Mini computers are the improved version of _____.
4. Word length of a main frame is usually _____ or _____ bits.
5. VAX is a _____ computer.
6. Micro computers can be subdivided in _____ and _____ computers.
7. _____ languages were used for programming in first generation computers.
8. ICL 1901 computer is the example of _____ generation computers.

Multiple Choice

1. Computer is
   a. a calculating machine
   b. used for DTP work only
   c. electrical machine
   d. electronic machine
2. Third generation computer uses
   a. Vacuum tubes technology
   b. VVLSI technology
   c. Integrated Circuit technology
   d. VLSI technology
3. EDSAC computer is the example of
   a. First generation computers
   b. Second generation computers
   c. Fourth generation computers
   d. None of these
4. Micro computers were introduced in
   a. Second generation computers
   b. Third generation computers
   c. Fourth generation of computers
   d. None of these
5. Hybrid computers are made for
   a. Specific Task performance
   b. Use signals for inputs and outputs
   c. Process control in continuous production
   d. Business and scientific applications

Descriptive Questions

1. What do you understand by the word computer?
2. Write down the basic characteristics of a computer.
3. For which purpose are hybrid computers used?

4. Classify digital computer on the basis of size?
5. Write shortnotes on:
    i. Special purpose computers
    ii. Hybrid computers and digital computers
    iii. First generation computers and third generation computers
    iv. Fourth generation computers and fifth generation computers.

Answers to Review Questions

Fill in the Blanks

1. RISC
2. Super
3. Microcomputer
4. 24, 32
5. Mini
6. Home computers, personal
7. Low level
8. Second

Multiple Choice

1. (d)
2. (c)
3. (a)
4. (c)
5. (c)

3.9 FURTHER READINGS

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

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

UNIT

4

HARDWARE CONCEPTS

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Define hardware.
- Describe various components of hardware.
- Describe instruction cycle.
- Describe memory and its types.
- Describe CISC and RISC.

U N I T S T R U C T U R E

4.1 INTRODUCTION

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

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

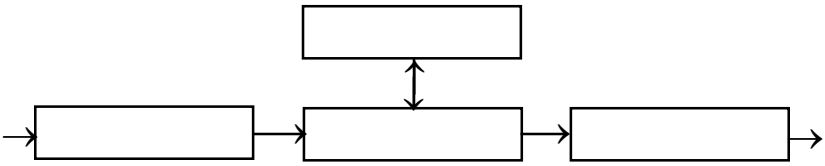
4.2 DEFINITION OF HARDWARE

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

4.3 HARDWARE COMPONENTS

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

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



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

Input Unit

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

Output Unit

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

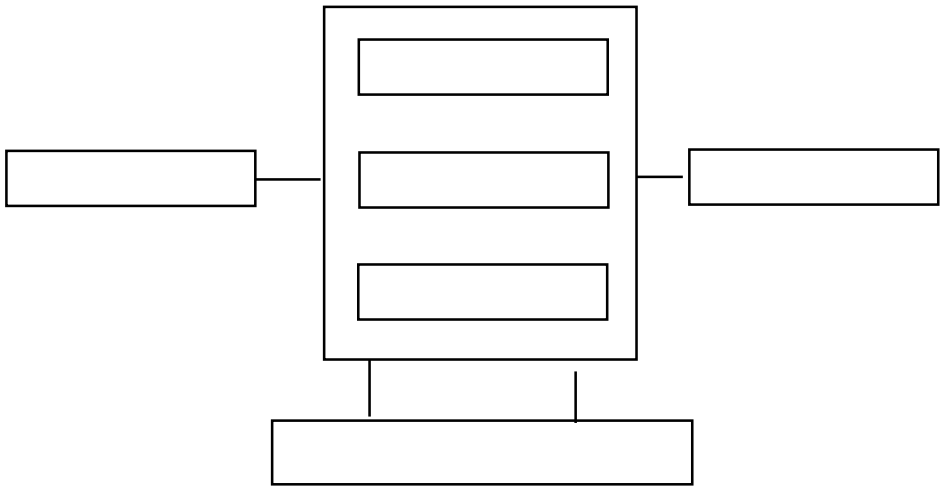
Central Processing Unit

The Cental Processing Unit (CPU) is the brain of the computer system. All the actions performed by the computer system are initiated, performed and controlled by the CPU. The CPU works with binary signals only. Every instruction that is executed first gets stored in the memory unit, then it gets processed by the CPU. Basically CPU has three parts:

i. Arithmetic Logic Unit

ii. Control Unit

iii. Memory



Block Diagram of a Computer

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

Data Bus

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

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

Address Bus

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

Control Bus

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

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

Components of CPU

The main components of CPU are discussed below.

Control Unit

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

Arithmetic and Logic Unit (ALU)

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

Memory

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

Student Activity 1

1. What is hardware?
2. What are the components of computer hardware?
3. Describe the following:
   (a) Input Unit
   (b) Output Unit
   (c) Central Processing Unit
   (d) Databus
   (e) Address Bus
   (f) Control Bus
4. What are the various components of CPU?
5. What is the function of Control Unit?
6. What is the function of Arithmetic Logic Unit?
7 Define Primary memory.

4.4 REGISTERS

The CPU consists of a set of registers which are used for various operations during the execution of instructions. CPU needs registers for storing instructions as well as for storage and manipulation of temporary results. Following registers are present in a computer.

- ***Memory Data Register (DR):*** Memory Data Register is used to read the value of an operand from a memory location. It can hold up to 16 bits of data.
- ***Memory Address Register (AR):*** Memory Address Register holds the address of memory where operand is stored. By using this address the data from the memory location is retrieved. The size of address register is 12 bits.
- ***Accumulator:*** Accumulator can contain 16 bit value. It is a general purpose processing register and used to perform arithmetic and logical operations.
- ***Instruction Register (IR):*** It generally contains 16 bits for storing the instructions. Instructions read from memory are placed here for execution.
- ***Program Counter (PC):*** It is a 12 bit register and holds the address of the instruction to be executed next. When the next instruction is read for execution, the program counter jumps to the next instruction.

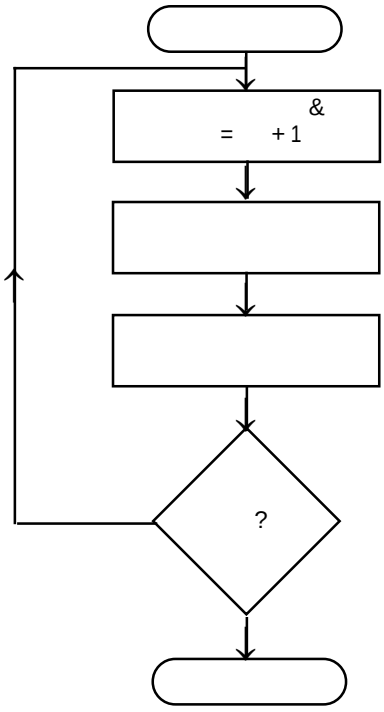
- ***Temporary Register (TR):*** Temporary Register can contain 8 bits and can hold the temporary or intermediate data as well as memory locations during processing. These registers are also known as general purpose registers. There are six general purpose registers available known as BX CX, DX, EX, HX, LX. They can be used in pairs of BC, DE and HL, to store 16 bit data.
- ***Stack Pointer (SP):*** A useful feature in CPU is a program stack, a last in first out (LIFO) list. A stack is created in the main memory and stores information in such a manner that the item stored last is the first item retrieved. It requires only an address register which can count the current location of stack. The register that holds the address for the stack is called Stack Pointer (SP) which always points to the top item in the stack.
- ***Index Registers:*** The SI and DI registers are available for indexed addressing. The 16 bit Base Index Register (BP) facilitates the referencing parameters which are data and address passed via stack.
- ***Flag Registers:*** They are used to indicate the current status of the machine and the results of processing. Many instructions require comparison and conditions to be evaluated based on previous results. These flag registers provide memory information to such instructions. The common flag registers are Overflow (OF), Direction (DF), Interrupt (IF), Sign (SF), Zero (ZF).

4.5 INSTRUCTION CYCLE

Instruction register is used to hold the instructions to be executed. Every such instruction is first brought into the computer's main memory, only then it can be executed. The instruction execution cycle is divided into three main parts – Fetch, Decode and Execute.

Fetch

To bring the instructions from main memory into the instruction register, the CPU first places the value of PC into memory address register. The PC always points to the next instruction to be executed. The memory read is initiated and the instruction from that location gets copied in IR. PC is also incremented by one simultaneously so that it points to the next instruction to be executed. This completes the fetch cycle for an instruction.



Instructions Cycle

Decode and Fetch Operands

Decoding means interpretation of the instruction. Each and every instruction initiates a sequence of steps to be executed by the CPU. Decoding means deciding which course of action is to be taken for execution of the instruction and what sequence of control signals must be generated for it. Before execution, operands, i.e. necessary data is fetched from the memory.

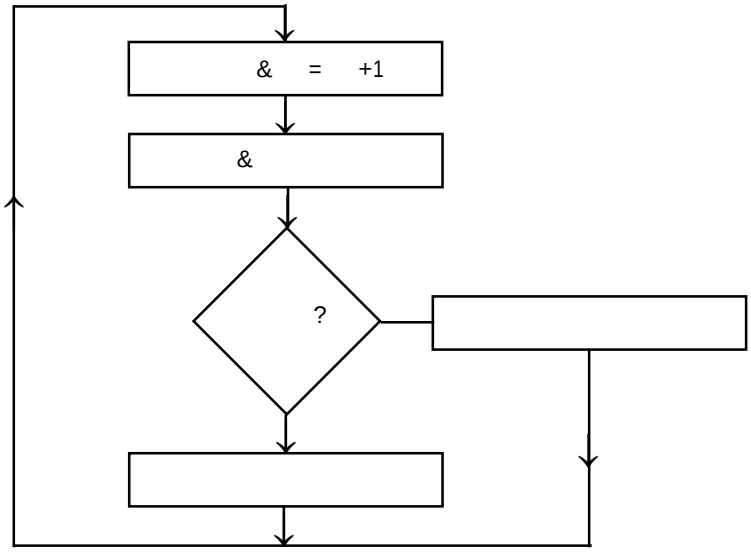
Execute

Every instruction has a set of control signals and series of steps associated with it. The instruction is executed after the fetching of operands is complete. The control unit is responsible for sequencing the steps necessary to complete the execution of instructions.

Once the execution of one instruction is complete, next instruction is fetched and instruction cycle is repeated again. This execution process continues undisturbed until the program counter reaches the end of this program or if there is an interrupt, branch or jump instructions, in which case the control jumps to another location specified in the instruction.

4.6 BRANCH INSTRUCTION

The branch instruction changes the program counter to the address of the next branched instruction which is to be executed. The branch address is specified with the branch instructions. The next instruction performed will be the instruction at this location indicated by the branch address.

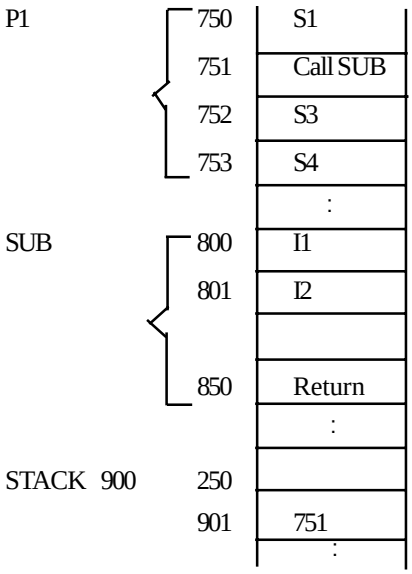


Branch Executions

Call Instruction

In the execution of a call statement, the control is returned back to the calling program. This is the only difference in the call and branch statements. Therefore it contains a return instruction at the end of the sub routine. But how does a return statement know the return address? The return address cannot be fixed because different programs from different locations in the memory may be calling the subroutine and the control has to return back to the next instruction from where the call was initiated. To cater to this problem, whenever a call statement is executed, the value of the then PC is stored on to the stack and PC is over written with the new instruction address. Thus the older value of PC is still there on the stack. When the return statement is encountered, the value on the top of stack is moved back to the PC. In this way the control gets transferred back to the calling program.

Let us consider an example, Suppose 'P1' is the main program to be executed which calls a subprogram named 'SUB' stored at location 800. In the main memory, stack is located at address 900. Now see the table which shows how the control jumps to SUB and at the changes in the values of SP, IR and PC.

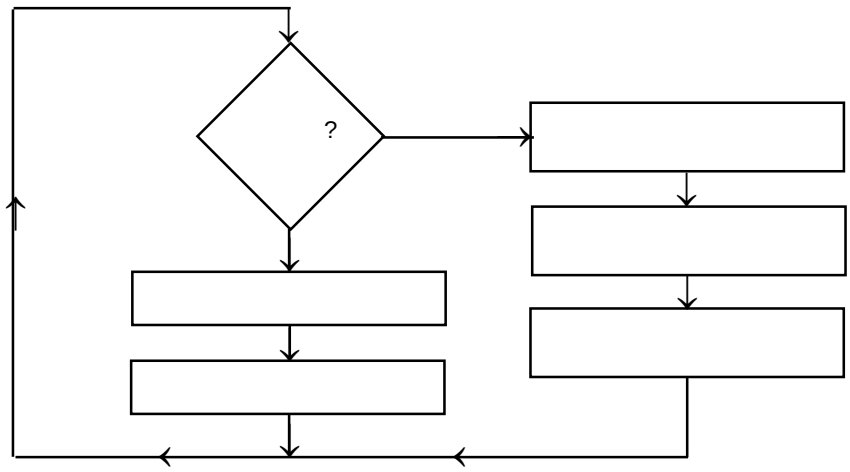


PC	IR	SP	TOS	
750	S1	900	250	Before Call
751	Call SUB	900	250	Call instruction fetched
800	11	900	250	Call instruction executed
801	12	901	751	Execution of program SUB
.	.	.	.	
.	.	.	.	
752	S3	-	-	Instruction of calling program fetched
.	.	.	.	
.	.	.	.	

Different Values of Registers when Subroutine is Called

Interrupt

What is an Interrupt? It is disturbance or obstruction in the normal sense. In the computer system an interrupt is any state or signal causing disturbance in the normal execution of CPU. The interrupt signal may be generated on the completion of specific tasks, some error conditions, or due to I-O devices. The interrupts have to be handled carefully by the CPU so different types of interrupts have interrupt routines associated with it. These interrupts are encountered by the CPU. To handle the interrupt, CPU halts the main program and calls the interrupt routine. This is explained with the help of this figure.



Interrupt Execution

1. What are registers?
2. What is the function of:

   (a) DR (b) AR (c) IR (d) PC (e) TR (f) SP
3. What are flag registers?
4. What are index registers?
5. What is an interrupt?

4.7 MEMORY

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

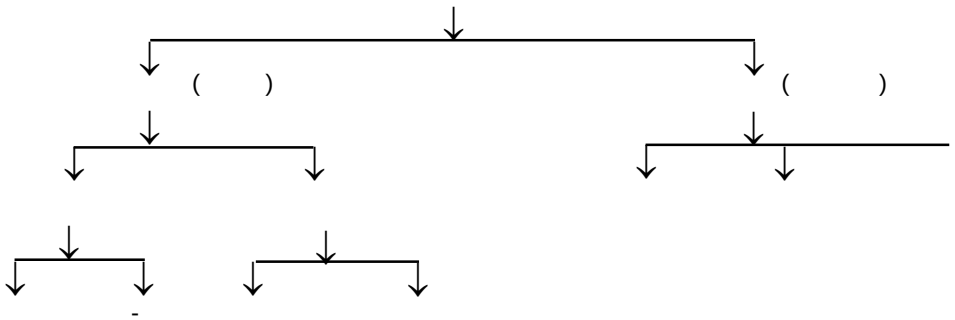
- Semiconductor memory
- Magnetic memory

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

Primary Memory and Secondary Memory

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

The secondary memory is employed for bulk storage of programs, data and other information. The secondary storage is of a permanent nature, i.e. it stores the information permanently. Magnetic memories like hard disks and floppy disks are commonly used as secondary memories. The classification of memory can now be done on the basis of primary and secondary memories.



Capacity of Memory

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

1 character = 1byte = 8 bits

1 Kilo bytes (KB) = 1024 bytes or 2^{10} bytes

1 Mega byte (MB) = 1024 KB

= 1024 × 1024 bytes or 2^{20} bytes

1 Giga byte (GB) = 1024 MB

= 1024 × 1024 × 1024 bytes or 2^{30} bytes

Thus if we say that the capacity of a primary memory is 16 MB it means it contains 16×2^{20} bytes or 2^{24} bytes. Also a 1.44 MB floppy can store 1.44×2^{20} bytes of information.

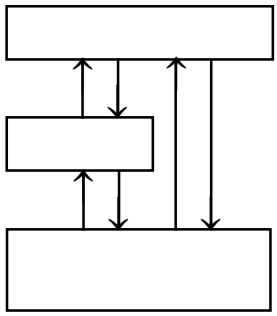
Student Activity 3

1. What is the difference between semiconductor memory and magnetic memory?
2. What is Primary memory?
3. Differentiate between RAM and ROM.
4. Why is secondary memory required?
5. Describe various units of memory.

Cache Memory

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

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



Most of the 32-bit microprocessors, new-a-days, have cache memory on the chip. Besides this modern computers also provide external cache on the mother board. The technique to access the cache memory is different from that of accessing the main memory. When CPU accesses the main memory, it outputs the data contained at that specified address. The cache memory first compares the incoming address to the address stored with data in cache – if it matches it is said that a 'hit' has occurred and corresponding data is read from cache memory. In case the address does not match then it is said that a 'miss' has occurred and the data is read from the main memory by the CPU which also gets stored in cache memory simultaneously, so that when the same address is accessed next time, a hit may occur.

RAM (Random Access Memory)

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

A chip actually contains lot of memory cells within it. Each cell contains group of bits that are accessed together. The size of memory data register is equal to the number of bits stored in each of the cells. The data bus contains a number of lines equal to the size of MDR. Each memory cell

is identified by a unique address. This address is placed in the memory address register to access the memory cell. The size of the address bus is equal to the number of bits in memory address register. Two control signals are used to distinguish between memory read and memory write. It is volatile in nature. Although both RAM and ROM possess random access, the R/W memory is called RAM. There are two important types of RAM – Static RAM and Dynamic RAM.

Static Ram (SRAM)

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

Dynamic RAM (DRAM)

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

ROM (Read Only Memory)

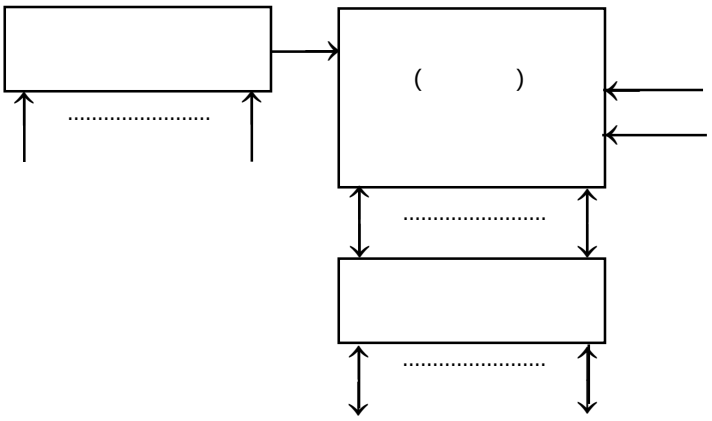
ROM stands for Read Only Memory, i.e. nothing can be written on it. ROM is a non-volatile memory, i.e. the information stored on it is not lost when power goes off. It is used for storing the bulk of the programs that are permanent residents in the computer. The contents of ROM are decided by the hardware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

Need for ROM

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

Memory Unit

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



Memory Unit

MAR

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

MDR

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

Example:

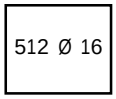
i. A memory which is capable of storing 64K (K = 1024) bytes contains 16 bits in MAR and 8 bits in MDR.

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

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

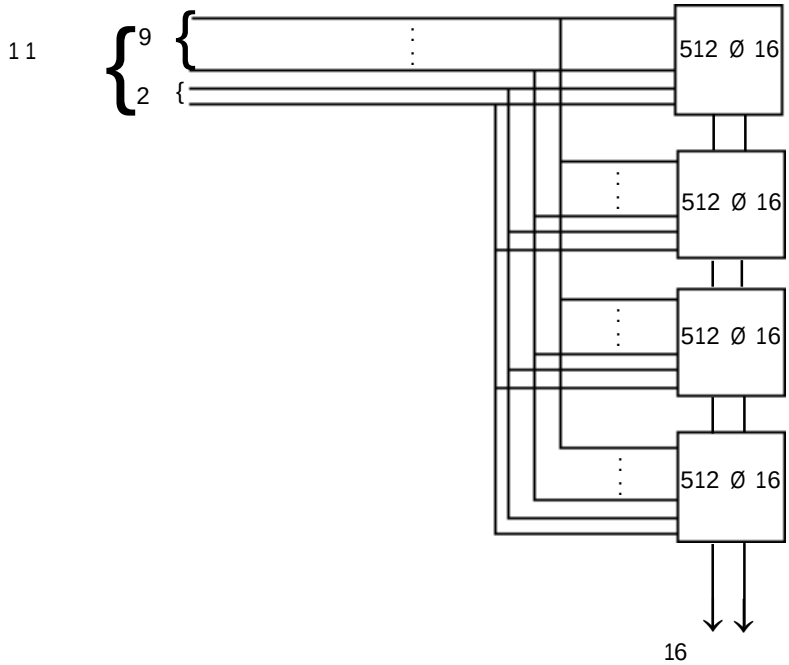
$2K = 2 \times 1024 = 2048 = 2^{11}$ ® 11 address lines, 16 data lines.

A RAM chip of capacity 512 × 16 means 512 memory cells each containing 16 bits of data. This requires 9 address lines and 16 data lines because 9 address lines can address 2^9, i.e. 512 different addresses and 16 data lines are used to carry of data.



RAM Chip

Similarly 4 RAM chips of capacity 512 × 16 means it would require total of 11 address lines and 16 data lines.



4.8 OTHER TYPES OF MEMORY

PROM

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

EPROM

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

EEPROM or E^2 PROM

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

Non-volatile Flash Memory

Flash memories are also electrically erasable and reprogrammable non-volatile memories. It can be used in place of EPROM. It is suitable for firmware (i.e. code) storage. The whole device is erased in one operation. For the updating of firmware codes flash memories are quick and economical than EPROMs. Its reliability is higher than E^2PROMs.

4.9 CISC AND RISC

RISC and CISC are designs of a microprocessor. RISC stands for Reduced Instruction Set Computing and CISC stands for Complex Instruction Set Computing. The aim of RISC design is to increase the computing speed by reducing the execution time of instructions. It has been observed that only 20 per cent of computer instructions are used frequently for most of the time. In the RISC architecture, these 20 per cent of the instructions are implemented in the hardware circuitry of the chip itself, i.e. by hardware technique. The remaining 80 per cent instructions are implemented by computer software. Usually a RISC design based machine is 5 to 10 times faster than a CISC machine.

CISC machines use microprogramming. With the help of the microprograms, highly complex instruction sets are generated. Complex instructions lead to a number of complications in both hardware and software design. In scientific computation involving floating point operations, CISC machines are likely to give better performance. Generally CISC machines are more complex and less efficient. Features of RISC design based microprocessor are:

- There are few instruction types and few addressing modes.
- Instruction set is simple so that the processor runs faster.
- Most of the instructions are executed in a simple cycle.
- Instructions generally involve register to register operations.
- Large number of registers and large cache memories are employed.
- Instead of microprogramming hardwired controls are used.

Student Activity 4

1. Define Cache memory. Describe its utility.
2. What is RAM? Describe its various types.
3. What is ROM? Why is it required?
4. What is a memory unit?
5. Differentiate between EPROM and EEPROM.
6. What is flash memory?
7. Compare and contrast RISC and CISC computer systems.

4.10 SUMMARY

The CPU has three main parts – ALU, control unit and memory. The CPU works in coordination with other devices under the supervision of control unit. The logical and conditional operations make the CPU different from a simple calculator. All the instructions with the CPU are in binary form, i.e. in the form of electric pulses. The capability of computer system to memorize comes from semiconductor devices like RAM, ROM chips which form the computers main memory and magnetic memory devices like tapes, disks, etc., which constitute the computer's secondary or auxiliary memory. The operation of computer system is only a series of input, processing and output instructions along with some storage capability. No hardware part functions on its own but they all are controlled by the operating system which is categorized as a system software. Thus for the functioning of the computer system hardware is not sufficient by itself, rather software must also co-exist to run and control the hardware.

4.11 KEYWORDS

Hardware: The physical equipment used for the input, processing, output, and storage activities of a computer system.

Central processing unit(CPU): The part of the computer that performs the actual computation or "number crunching"; also called microprocessor.

Bus: Internal set of wires.

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

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

Control unit: Portion of the CPU that controls the flow of information.

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

Primary memory: The main memory of a computer, in which small amounts of data that will be used immediately are stored.

Registers: Parts of CPU that store very small amounts of data and instructions for short period of time.

Interrupt: Any state or signal causing disturbance in the normal execution of CPU.

Random access memory (RAM): The part of primary storage that holds a software program and small amount of data when they are brought from secondary storage.

Read only memory (ROM): A type of primary storage where certain critical instructions are safeguarded because the storage is non-volatile and the instructions can be read only by the computer and not changed by the user.

Secondary memory: Memory that can store very large amount of data for extended periods of time on a variety of media.

Flash memory: A form of read only memory on a silicon computer chip that is compact, portable, has limited capacity, and requires little energy.

Cache memory: A type of primary memory, closer to the CPU that is RAM, where the computer can temporarily store blocks of data used more often.

Memory unit: A collections of storage cells together with associated circuits needed to transfer information in and out of storage.

PROM: Programmable ROM, whose contents are decided by the user.

EPROM: Erasable PROM, whose contents can be erased by exposing it to high intersity short wave ultraviolet light for about 20 minutes.

EEPROM: Electrically erasable PROM, whose contents can be erased and reprogrammed on the board easily on a byte basis.

4.12 REVIEW QUESTIONS

Fill in the Blanks

1. All the physical components of a computer system are called _____ .
2. The _____ unit acts as an interface between CPU and output devices.
3. The _____ is the brain of the computer system.
4. The three types of buses are address bus, data bus and _____.
5. CPU needs _____ for storing instructions as well as intermediate results.
6. To access the main memory, the address is placed in _____ register.
7. _____ points to next instruction to be executed.
8. Secondary memory is also called _____ memory.
9. The memory in between the processor and the main memory is called _____ memory.

Multiple Choice

1. The address bus is
   a. bidirectional
   b unidirectional
   c. both the above
   d. none of the above
2. The cache memory enhances
   a. speed of input devices
   b. access speed for CPU and main memory
   c. speed of output devices
   d. none of the above
3. RAM is a
   a. permanent memory
   b. temporary memory
   c. both (a) and (b)
   d. none of the above
4. Interrupt is
   a. signal wanting attention of CPU
   b. initiated by I/O devices
   c. associated with interrupt routines
   d. all of the above.

5. DRAM
    a. has reduced power consumption
    b. does not require periodic refreshing
    c. is costlier than SRAM
    d. none of the above

State (T)rue or (F)alse

1. The magnetic memory is cheaper than static memory.
2. RAM stores memory which is not subjects to change.
3. The contents of PROM are decided by the user.
4. RISC are the computer systems with a large number of instructions.
5. Program counter holds the address of the instruction to be executed next.

Descriptive Questions

1. What will be the size of MAR and MDR for a 4K × 8 RAM chip? How many such chips will be required to construct a memory of 256K × 16 capacity? Calculates the new size of MAR and MDR for this memory.
2. What does a '32 bit processor' mean?
3. What is a 'bus'? How many different kinds of buses are there?
4. How does a CPU execute its instructions?
5. Explain the role of cache memory.
6. In computers what does 'K' stands for? How many memory locations are there in a 4K × 8 memory and 64K × 16 memory?
7. Distinguish between
    a. CPU and ALU
    b. Internal and external memory
    c. Static RAM and Dynamic RAM
    d. CALL and BRANCH instructions
    e. CACHE memory and main memory
8. What is an interrupt? How is it handled by the CPU?
9. What is a register? Explain the role of different types of registers in processing.
10. What is the significance of ROM?
11. Describe computer architecture in general.
12. A computer system has 20 bit address lines and 16 bit data lines. What is the maximum size of memory?
13. Which of the buses are unidirectional and why?
14. How is a 'CALL' instruction executed?
15. What is CISC? How does RISC differ from it?

Answers to Review Questions

Fill in the Blanks

1. Hardware
2. Memory
3. CPU
4. Control bus
5. Memory
6. Address
7. Program counter
8. External
9. Cache

Multiple Choice

1. b
2. b
3. b
4. d
5. a

True or False

1. True
2. False
3. True
4. False
5. True

4.13 FURTHER READINGS

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

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

UNIT 5

PERIPHERAL DEVICES

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Define peripheral devices.
- Describe various input and output devices.
- Describe various types of printers.
- Understand hard copy and soft copy output devices.

U N I T S T R U C T U R E

5.1 INTRODUCTION

The peripheral devices of a computer, referred to as I/O devices, provide an efficient mode of communication between the central system and the outside environment. Programs and data must be entered into the computer for processing and results obtained are recorded or displayed. A computer serves no purpose without the ability to receive information from an outside source and transmit back the results in a meaningful form. The most familiar means of entering information into a computer is through the keyboard, mouse, punched card readers, tapes and disks, etc. Similarly a number of output devices are available on which the computer system can give its processing results like printer, computer screen (VDU), plotter, disks, etc. In this chapter we will study in detail different types of input and output devices and their usage.

5.2 PERIPHERAL DEVICES

Input output devices attached to the computer are also called Peripherals. Among the most common peripherals are keyboards, display unit and printers. Peripherals that provide auxiliary storage for the system are magnetic disks and tapes. Peripherals are electromechanical and electromagnetic devices. These devices are called peripherals because they are attached in the surroundings (periphery) of the computer systems. Peripheral devices are classified mainly into two types; input devices and output devices.

Input devices accept different forms of inputs from the user and forward it to the computer system in its understandable form, i.e. by converting the inputs to the binary form. Examples are keyboard, mouse, etc.

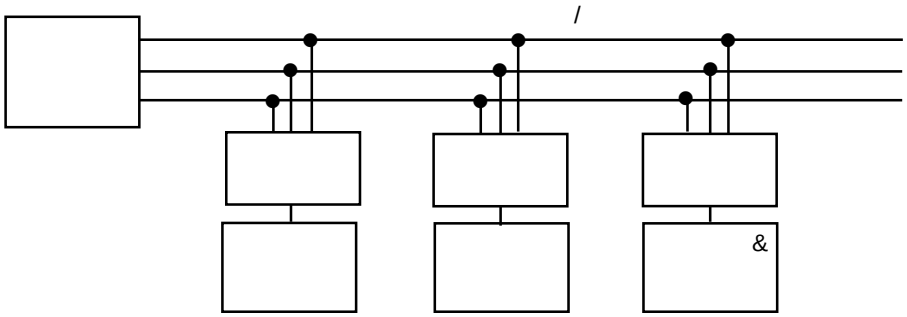
Output devices take the binary form of output from the computer system and produce it in the desired form. Examples are printer, plotter, VDU, etc.

Some devices which serve the purpose of input as well as output are sometimes referred as I/O devices such as magnetic disks, magnetic tapes, etc.

Input-Output Interface

For communicating with various types of devices available nowadays, the computer system requires an input-output interface. An I/O interface provides a method for transferring information between internal storage and external I/O devices. Peripherals connected to each other need special communication links for interfacing with the CPU. The purpose of the interface units is to resolve the differences between computer system and each of the peripheral devices. It supervises and synchronizes all I/O transfers. The main reason why this interface is needed, is because:

1. The manner of operation of peripherals is quite different from CPU and memory, which are electronic devices.
2. The data transfer rate of peripheral device is slower than that of CPU.
3. Data codes and formats in peripherals differ from the word format in CPU and memory.
4. Operation of peripherals is different from each other and each must be controlled to avoid disturbances in the operation of other peripheral devices.



5.3 INPUT DEVICES

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

Need for Input

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

- Timeliness Timely input of data is important because it is the first step in data processing. Delay in either the collection or preparation of data results in bottlenecks that delay the completion of all subsequent processing operations.
- Accuracy Input is usually the best place to detect and correct errors, if poor data is entered (i.e.untimely, inaccurate or incomplete data), the outputs are bound to be less useful.
- Potential Usefulness In computerized data processing application, much of the data that is entered into a computer system is used later to update files stored on tapes and disks in a

batch mode. Accurate input is, therefore, essential to protect these files from accidental or intentional damage.

Source Documents

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

Advantages of Source Documents

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

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

Student Activity 1

1. What are peripheral devices?
2. Why is input-output interface required?
3. What are input devices?
4. What are the characteristics of good quality input data?
5. What is a source document?
6. What are the advantages of source documents?

Key Entry Input Device

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

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

Off-Line Data Input Devices

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

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

On-Line Data Input / Terminal Input Devices

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

Dumb Terminals

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

Smart Terminals

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

Intelligent Terminals

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

Advantages of Terminal Input

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

Disadvantages of Terminal Input

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

Machine Readable Media Inputs

Machine readable input documents can be read and data extracted using appropriate input devices. Business organizations attempt to collect data in machine readable format. This minimizes the costs and time delays in data transcription and also increases data transcription accuracy. Automated data collection devices include:

- Point of Sale (POS) Terminal
- Bar Code Readers
- Magnetic Ink Character Recognition (MICR)
- Plastic Cards with Magnetic Strips
- Optical Character Reader (OCR)
- Audio Input
- Optical Mark Reader (OMR)

Popular Input Devices

Some popular input devices are as follows:

- Keyboard
- Mouse
- Light Pen
- Audio Input Units
- Magnetic Disks
- Scanner
- Tele Terminals
- Joystick
- Digitizer (Graphic Tablet)
- Magnetic Tapes and Cassettes
- Floppy and Winchester Disks
- Optical Mark Reader (OMR)

- Optical Character Reader (OCR)
- Magnetic Ink Character Reader (MICR)
- Universal Bar Code Reader

Keyboard

The most widely used input device today is the keyboard. It is similar to a typewriter in that all the keys are arranged like those on a typewriter but there are some extra keys also. Every key and key combination passes a unique signal to the computer. It is generally used for typing text-based information. During typing, the keys get displayed on the VDU so that the user can see what he is typing. Control (Ctrl) and Alter (Alt) key have special functions associated in combination with other keys. The traditional format of a computer keyboard is called QWERTY keyboard because of the sequence of six letters in the left hand corner of the upper row.

There are some advanced input devices, also known as pointing devices, which are used with VDT (Visual Display Terminal) and PC systems. Some of the commonly used pointing devices are mouse, lightpen and joystick.

Keyboard

Mouse

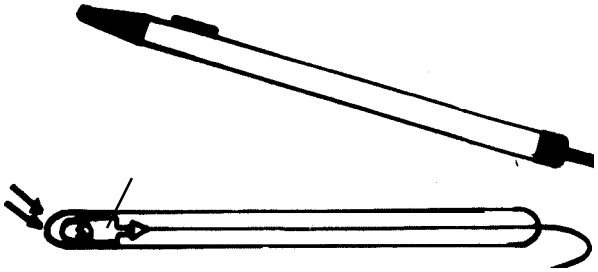
A mouse is a pointing device which rolls on a small rubber ball and has two or three buttons on the top. The movement of the ball is sensed by two sensors and resolved into horizontal and vertical components. The movement of cursor on the screen is controlled by the movement of the mouse. Selection of menu option is done by clicking of the mouse button while the cursor or pointer points to the option to be selected.

Three Button Mouse

Inside of a Mouse

Light Pen

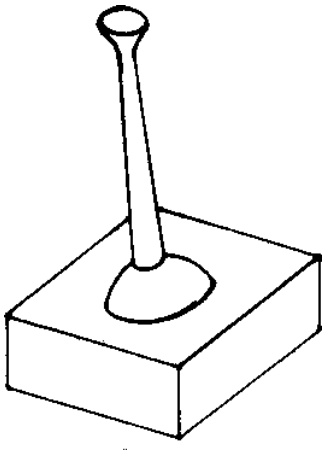
Light pen is used to select a menu option displayed on the screen. It functions on the concept of photo cell. It is used in application areas like designing and engineering.



Light Pen (Internal Structure)

Joystick

It is commonly used for playing games on computers. It provides fast, controlled movement on the screen and allows movement of objects around the screen easily. The movement is sensed by a vertical stick which is attached to a solid base. Different shapes of joysticks are available nowadays.



Joystick

Digitizer (Graphics Tablet)

Digitizer is an input device used to input graphic information like drawings and maps. It locates the coordinates on its surface by the tip of a stylus positioned by the user and feeds these coordinates to the computer. Electrical pulses are used for locating the coordinates.

Magnetic Ink Character Reader (MICR)

MICR is generally used by banks to process the large volumes of cheques. The information coded on the cheque is printed with a special ink that contains magnetized particles of iron oxide. The characters are read or recognized by the reader based on patterns of magnetization of particles in the ink. Magnetic ink characters are also human readable. It eliminates the document encoding process. Applications besides banking include utility bills, customer payment coupons, etc.

Optical Mark Reader (OMR)

It works on the concept of mark sensing and reflectance of light. Using these methods, data can be directly transferred to the computer. It is used for evaluating multiple choice answer sheets and works at a speed of 200 documents per minute.

Optical Character Reader (OCR)

OCR permits direct reading of any printed character. It can also read bar codes to enter data directly into a computer. Using OCR, each character is scanned photoelectrically and converted into a pattern of electronic signals which are then compared with the stored patterns to identify the character.

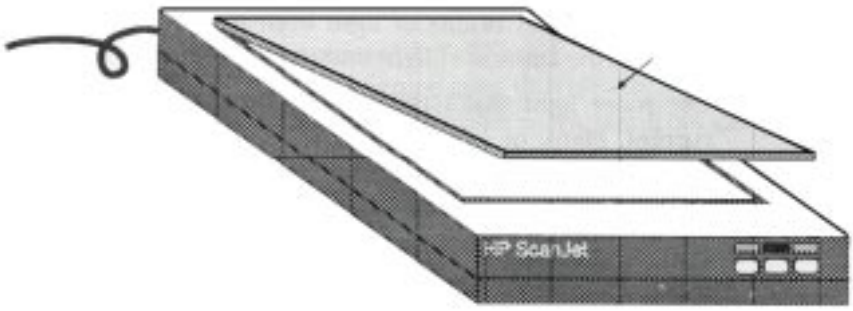
OCRs recognize characters printed in a special format. Use of OCR saves a lot of time which would otherwise be spent in data transcription. It increases data accuracy and timeliness of information produced.

Examples are American National Standards OCR, European OCR.

Scanner

These scanners look and work somewhat like a photo copier. One needs to simply lay an image or page of text face down on the flatbed scanner and then issue a command to scan the page.

The page stays stationary and a mechanism inside the flat bed scanner moves over the image to scan it. The scanned image is then transferred to the system and saved in the graphics format generally as a paint package file or coreldraw file.



Scanner

Bar Code Reader

Small bars of varying thickness and spacing are printed on packages, badges, tags, etc. These bars are read by bar code reader or optical reader and converted into electrical pulses. The pattern of bars is unique and standardized which gets converted into specific information.

Voice Input/ Recognition Devices

These devices convert human speech into electric signals that a computer can recognize. These electric signal patterns are then compared to a dictionary of patterns stored previously to identify a particular character. Most of the voice recognition systems are speaker-dependent. For example, Talkwriter.

Student Activity 2

1. What are off-line input devices?
2. What are dumb terminals?
3. What is the difference between smart terminals and intelligent terminals?
4. What are the advantages and disadvantages of terminal Input?
5. List some popular input devices.
6. Write a short note on the following:

(a)	keyboard	(b)	Mouse	(c)	lightpen
(d)	Joystick	(e)	Digitizer	(f)	MICR
(g)	OCR	(h)	OMR	(i)	BCR
(j)	Scanner	(k)	Voice input/recognition devices.		

5.4 OUTPUT DEVICES

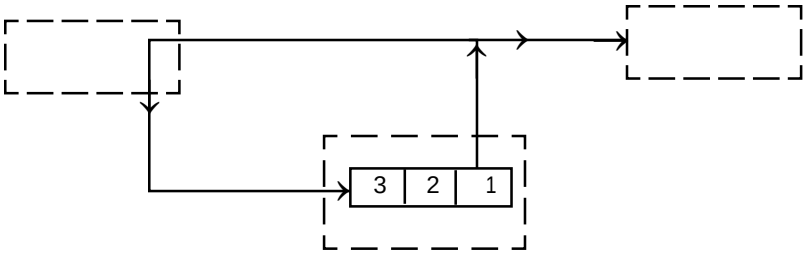
Output may be typed, printed or graphical, or may be of video or audio type. Output devices can be classified as soft copy devices and hard copy devices. All the output devices communicate with the CPU through an output unit.

Output Unit

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

Spooling

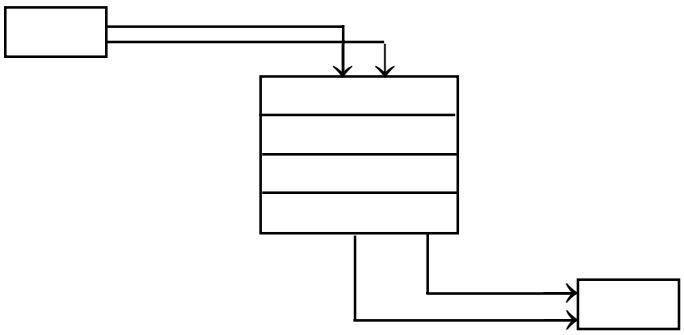
Spool stands for Simultaneous Peripheral Operation On Line. It is a technique used by computers to allow users to continue using CPU for other stations while printing is in progress. Under this approach the output is redirected to an intermediate disk-file instead of to a printer, because disk-writing speed is much faster than the printing speed. This frees the CPU to do another job. Later on, the output is retrieved from the disk and printed on the printer. This process continues till all the printing is completed.



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

Buffering

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



Types of Output Devices

Hard Copy Devices

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

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

Soft Copy Devices

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

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

Student Activity 3

1. What are output devices?
2. Define spooling?
3. Define buffering?
4. What are hard copy devices? Give examples.
5. What are soft copy devices? Give examples.

5.5 HARD COPY OUTPUT DEVICES

Printers

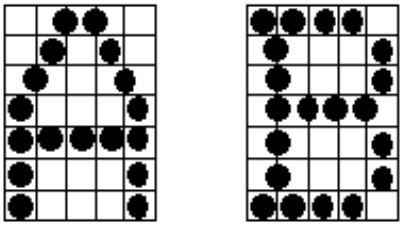
Hard copy devices, i.e. printers, can be divided into two distinct categories on the basis of producing impression over the paper:

- Impact Printers
- Non-impact Printers

Impact Printers

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

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



Impact Printers can further be categorized into two categories

Character Printer

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

Line Printer

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

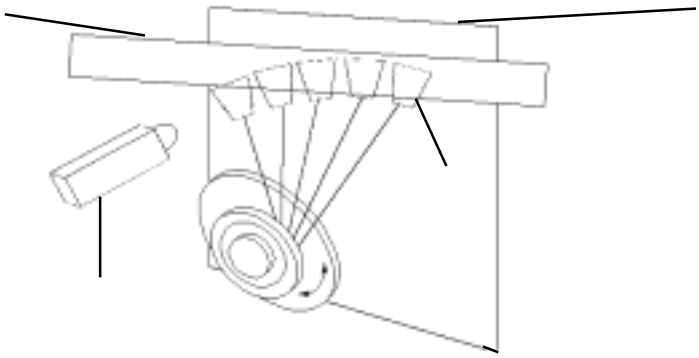
Dot Matrix Printer

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

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

Daisy Wheel Printer

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



Daisy Wheel Printer

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

Non-impact Printers

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

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

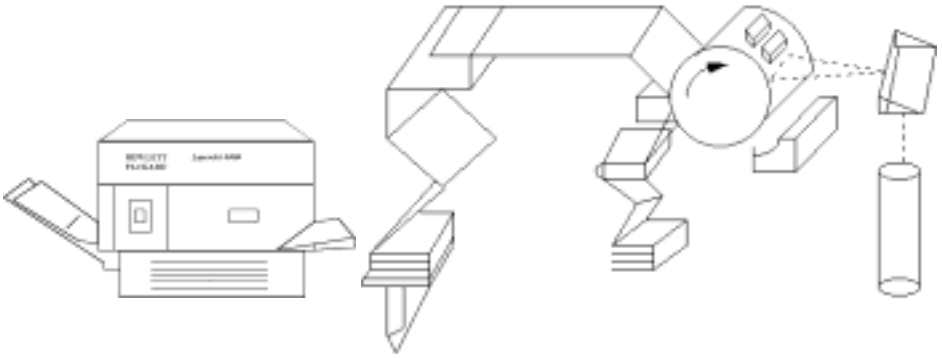
Thermal Printer

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

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

Laser Printer

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



Ink Jet Printers

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

Electrostatic Printers

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

Comparative View of Printers

Printer Type	Advantages	Disadvantages
Dot Matrix	Inexpensive, fast, prints graphics	Poor quality printing
Daisy Wheel	High quality printing	Slow, noisy, expensive
Thermal	Light weight, battery powered	Slow, poor-quality printing, requires special paper.
Plotter	Prints colour and graphics	Expensive
Laser	Excellent print quality, prints graphics	Expensive

Examples

1. The ABC Pharmaceutical company uses a daisy wheel printer with the following characteristics to print their monthly pay bill.

   - Speed: 40 cps
   - Bi-directional printing
   - Line spacing time, i.e. time taken to skip one line = 25 ms.

   The company uses 72 lines per page stationary and each page contains only 60 lines of printed matter.

   The entire pay-bill runs to 50 pages. Estimate the amount of time for printing the statement.

   Solution

   Assuming 80 columns/line

   Time taken by printer to print one complete line = 2 seconds

   Time taken by printer to skip 12 lines = $\frac{12 \times 25}{1000}$ = 0.3 seconds

   Time taken by printer to print one page consisting of 60 printed lines = 60 × 2 = 120 seconds

   Total time taken by printer to print one page = 120 + 0.3 = 120.3 seconds

   Therefore to print statement of 50 pages, the printer will take = 50 × 120.3 = 6015 seconds

2. A remote line printer is capable of printing 600 lines per minute (132 columns/lines). Line capacity options are 2400, 4800 or 9600 bits/sec. Data is transmitted according to ASCII 7 bit coding system. What capacity would you recommend for a channel to utilize the full capacity of the printer?

   Solution

   In 1 minute it can print 600 lines

   Therefore in 1 second it can print 600 / 60 = 10 lines

   In 1 second number of characters it can print = 10 × 132 = 1320 characters.

   In 1 second number of bits printer uses = 1320 × 7 bits = 9240 bits

   Therefor 9600 bps must be used for optimum utilization of the printer.

3. A line printer has a speed of 600 LPM. Assume the time taken to load the stationary is 1 minute. The operator uses 72 lines per page stationary and only 60 lines per page are to be printed and then a form feed is issued. Assume that form feed time per page is 10 second. Find the time taken (in seconds) to print 50,000 lines document.

   Solution

   Number of pages to be printed = 50000/60 = 833.33 × Pages

   Time to print 600 lines = 60 seconds

   Therefore to print 60 lines = 6 seconds

   Time spent on one page = Printing Time + Form Feed Time = 6 + 10 = 16 seconds

   After this step two approaches are possible.

   i. Neglecting form feed time after last page.

   ii. Considering form feed time after last page.

Approach I

Time taken by printer in printing 833 pages = 833 × 16 = 13328 sec.

Time taken by printer in printing last 33 page (i.e. 20 lines) = 2 sec.

Total time to print whole document = 13328 + 2 = 13330 sec.

Total time taken by printer in printing 50, 000 lines document = Printing Time + Loading Time

= 13330 + 60 = 13390 seconds

Approach II

Time taken by printer in printing 833.33 pages = 833.33 × 16 = 13333.28 seconds

Time take by printer in printing whole document = Printing + Loading Time

= 13333.28 + 60 seconds = 13393.28 seconds

= 13394 seconds

Plotters

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

Student Activity 4

1. What are printers?
2. What are impact printers?
3. Describe various types of impact printers?
4. What are non-impact printers?
5. Describe various types of non-impact printers?
6. What are plotters?

5.6 SOFT COPY OUTPUT DEVICES

Visual Display Unit (VDU)

It is the most commonly used output device. VDU works on the concept of Cathode Ray Tube (CRT) and no media, cards or paper output are involved. VDU can be used for character or graphic display. The input errors can be corrected instantly - without wasting any time. It can be used as on-line terminal as well as off-line terminal. Finally, VDUs are quiet, clean and fairly reliable in operation.

There are many types of VDU based on different characteristics: Text and Graphics, Monochrome and Coloured.

- ***Text and Graphics:*** Certain VDUs are capable of displaying a character set such as that provided by the ASCII code. The output of a computer is best presented in graphical form. For that a graphical monitor is required which has a high degree of resolution and the screen is divided into rows and columns of dots called pixels.
- ***Monochrome and Colour Monitor:*** Monitors capable of displaying only a single colour image are called monochrome monitors. It has only one electron gun. Colour monitor is

capable of displaying up to 17 million colors using combinations of basic colours. It has different colours. Generally two types of coloured monitors are used:

- RGB. (RED, GREEN, BLUE)
- CMYK (CYAN, MAGENTA, YELLOW and 'K' for BLACK)

RGB colour monitor has three electron guns and the screen is coated with three types of phosphors: Red, Green and Blue.

Audio Response Unit (ARU)

ARU permits computers to talk to people. It works in the following manner.

All the sounds needed to process the possible inquiries are provided on a storage medium. Each sound is given a code. When enquiries are received, the processor follows a set of rules to create a reply message in a coded form. This coded message is then transmitted to an audio-response device. The sounds are assembled in proper sequence. The audio message is transmitted back to the station requesting the information.

A common example of an ARU is the way messages and train schedules are narrated on railway stations having automatic enquiry system.

Other Output Devices

Photographic Output

It is in the form of a high resolution image on the photographic film. It is capable of storing large quantities of data in readable character form in a relatively small space. Photographic output may take two forms: micro film, micro fiche.

- Micro Film Micro film is an ordinary film in one of the standard widths, most commonly 6mm. Its density is very high. It is used to store data for future viewing.
- Micro fiche Micro fiche is a sheet of film 105 mm by 148 mm, containing a rectangular pattern of pages. These pattern of pages are 80 at a reduction of 25 times or 224 at a reduction of 72 times. Special viewers are available to magnify a page at a time up to readable size. Normal printouts can be photographed onto micro film or micro fiche.

Student Activity 5

1. What is VDU?
2. Describe various types of VDU.
3. What do you mean by Audio response system?
4. What is the difference between micro film and micro fiche?

5.7 SUMMARY

- Input/Output devices and secondary storage of a computer attached to its surroundings are called 'peripherals'. Data and instructions are entered into a computer through input devices. The results and response of the computer system are communicated back to the user through output devices. Some of the devices serve both as input and output devices. Inputs to the computer can be given through various media - it may be on-line or off-line, directly computer readable form like MICR, OMR, etc., or simply through keyboards. The input may be visual or audio. Many advanced input devices are available to accept these different forms of input.
- All the responses and outputs of different forms are presented through different output devices. The most common output devices are VDU and printer. On a VDU, soft copy is generated while printer gives a hard copy output. Besides a variety of printers, lot of other output devices like audio response unit, video outputs are available nowadays. For communicating with these devices, the computer system uses input output ports and I/O

interface units. All the storage devices also come under I/O devices. The usage of these devices is not limited only to give inputs or store output but they have an important role to play during processing too. These devices like magnetic tapes, magnetic disks, CD ROMs are classified separately as storage devices and dealt with in the next chapter.

5.8 KEYWORDS

Source document: Document which records transaction data and are the starting point for capturing input data.

Dumb terminals: Devices that immediately transmit each keyed data character to the processor.

Smart terminals: Devices that are equipped with a micro processor chip and internal storage capability to store and consolidate input data prior to sending it to the processor.

Intelligent terminals: User- programmable devices which are equipped with built-in microprocessor chip.

They can collect, edit and even check the validity of data.

Keyboard: Most common input device, designed like a typewriter but with added function keys.

Mouse: Hand-held device used to point a cursor at a desired place on a computer screen; a click instructs the computer to take some action.

Light pen: An input device used to select a menu option displayed on the screen. It uses the concept of photo cell.

Joystick: Input device that positions cursor on a screen, used primarily for dynamic graphics at work stations and for video games.

Digitizer: Input device used to input graphic information like drawings and maps.

Magnetic ink character reader: Optical scanner that reads magnetic ink printed on bank cheques.

Optical character reader: Input device that recognizes text and converts it into a digital form that can be manipulated by word processing applications.

Optical mark reader: Optical scanner that reads pencil marks made on a predetermined grid.

Scanner: A device like photocopier, which creates an electronic form of a printed image.

Bar code: A pattern of printed bars on various types of products.

Bar code reader: Input device the reads the barcode label on merchandise.

Voice recognition system: Computer device that uses microphones and special software to input speech into computers.

Printer: Output device that transforms digital computer content into a printed, paper-based form.

Impact printer: In these printers, there is mechanical contact between the print head and paper.

Non-impact printer: In these printers, there is no mechanical contact between the print head and paper.

Plotter: Output device that uses computer-directed pens to create complex, high-quality images.

Monitor: The video screen used with most computers, which displays both input and output.

Microfilm: An ordinary film used to store data for future viewing.

5.9 REVIEW QUESTIONS

Fill in the Blanks

1. Computer can talk to users through _____ .
2. _____ printer requires special paper.
3. Laser printer is a _____ printer.
4. _____ printer prints by spraying ink droplets on paper.
5. Computer system interacts with I/O devices through _____ .
6. _____ is a technique used to match the speed of CPU to that of I/O devices.
7. An autocad system using complex designs and drawing will use _____ to print the drawings.
8. _____ stores the output temporarily on a disk and prints it one by one in a FIFO order.
9. _____ is used to evaluate answer sheets automatically through computer.
10. Visual Display Unit is also known as _____.

Multiple Choice

1. The main purpose of off-line input device is
   a. to reduce the number of operator errors in recording data
   b. to save computer time
   c. to save floor space in the computer space
   d. none of the above
2. The mouse is
   a. pointing device
   b. data entry device
   c. output device
   d. none of the above
3. An impact printer
   a. is faster than non impact printer
   b. makes higher quality copy than a non-impact printer
   c. can make carbon copies
   d. all of the above
4. How many characters can a VDU display on one line?
   a. 24 b. 80
   c. 132 d. 240
5. Magnetic Ink Character Reader is
   a. used on bank cheques
   b. easily read by a person

c. formed by magnetic particles

d. All of the above

Descriptive Questions

1. What is the purpose of I/O interface?
2. How does an audio response unit works?
3. What is spooling? How does it help in printing?
4. Explain the difference between
   i. Softcopy and hardcopy devices
   ii. Dotmatrix printer and Daisy Wheel printer
   iii. Off-line input device and on-line input device
   iv. Impact and non-impact printer
   v. OMR and MICR
5. Explain how the laser printer works.
6. What is a mouse? How does it differ from a light pen?
7. Why do we need buffers? Explain.
8. Distinguish between character printer and line printer.
9. How does standard VDU differ from special graphics VDU? Name three applications where graphics VDU can be used.
10. How does a dot matrix printer work? Can it generate carbon copies?
11. Estimate the time required for printing a file containing 120 records each having 80 characters on a 240 CPS DMP (neglect the line feed time).

Answers to Review Questions

Fill in the Blanks

1. Output devices 2. Thermal 3. High quality 4. Inkjet 5. I/O Interface 6. Spooling 7. Plotter 8. Buffer 9. Optical mark reader 10. Monitor

Multiple Choice

1. (b) 2. (a) 3. (c) 4. (c) 5. (d)

5.10 FURTHER READINGS

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

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

UNIT

6

SECONDARY STORAGE DEVICES

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Describe the need of secondary storage devices.
- Describe the characteristics of secondary storage devices.
- Describe various types of storage devices.
- Describe magnetic tape and magnetic disk system.
- Describe the concept of CD-Rom.

U N I T S T R U C T U R E

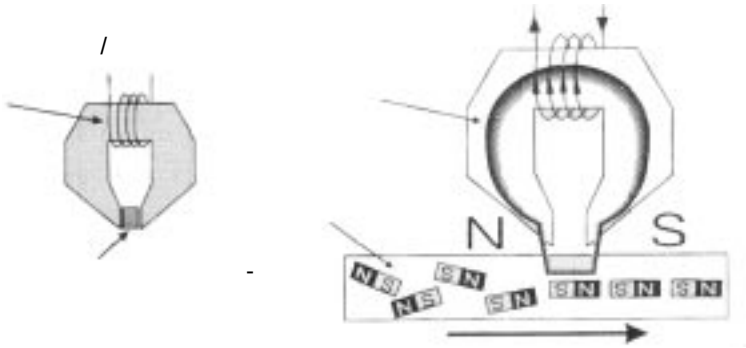
6.1 INTRODUCTION

Computers main memory 'Random Access Memory (RAM), is a 'volatile memory'. Whenever power supply is switched off, everything stored inside it is completely washed off and lost forever. As we use computers to keep many important records, it should have some facility to keep the data permanently – without any loss. Magnetic storage devices are the most popular means of storing data permanently and are also the main source of transferring data between different computers. The most common magnetic storage devices are magnetic tape and magnetic disk. These storage devices are extensively used for input as well as output and commonly termed as Auxiliary storage device or Secondary storage device. In this chapter we will study the functioning of two most important auxiliary storage devices: magnetic tape and magnetic disks.

6.2 NEED OF SECONDARY STORAGE DEVICES

Secondary storage is also known as Auxiliary Memory or External Memory. It supplements the primary memory. Secondary storage is used to store data/information permanently. Its storage capacity is virtually unlimited because a large database can be stored across a number of floppy disks/tapes. Data cannot be processed directly from secondary devices hence we need main memory also. Thus a secondary storage device cannot, in any way, replace the primary memory of the computer system. Commonly used secondary storage devices are hard disks, magnetic disks, magnetic tapes, floppy disks, optical disks, etc. Secondary storage devices with magnetic

storage media have a thin magnetic coating on the recording surface. The read-write head records the information on the media by setting the magnetic polarity of the particles. Recording takes place by inducing a magnetic field in the coil present inside the read-write head. For reading, read-write head senses the polarity of magnetic particles as 0's and 1's and signal is transmitted to the CPU as given in the figure below.



Characteristics of Secondary Storage Devices

- ***Non-volatile Storage:*** Unlike primary memory, data stored in these devices is retained even after power supply is withdrawn. The data stored in the secondary storage devices is non-volatile.
- ***Mass Storage:*** Secondary storage devices can store hundreds of giga byte on them in a very small place. Nowadays hard disks of capacity 20 to 30 GB are also available.
- ***Cost-Effective:*** Unlike the semiconductor memory, this magnetic media is cheaper and cost-effective. Hence cost of storage per mega byte is relatively very small with secondary storage devices.
- ***Reusability:*** The secondary storage devices can be reused again and again which means obsolete information can be erased from these devices and new information stored.

6.3 TYPES OF STORAGE DEVICES

Storage devices are classified into two parts according to their working and the method provided to access the information stored in it; serial access storage devices and direct access storage devices.

Serial Access Storage Devices

These devices provide only serial access to the information stored. This means that all the previous records need to be read to access the next record – one cannot directly access a particular record. In a serial access storage device simultaneous reading and writing cannot be done in the file. Magnetic tape is an example of serial access storage device.

Direct Access Storage Devices (DASD)

In a direct access storage device there is no need to read all the previous records to access a particular record. The record can be accessed directly. In DASD the data stored can also be accessed sequentially, if need be. Reading and writing can be done simultaneously in the file in a DASD floppy disk and magnetic disks. CD ROMs are also direct access storage devices.

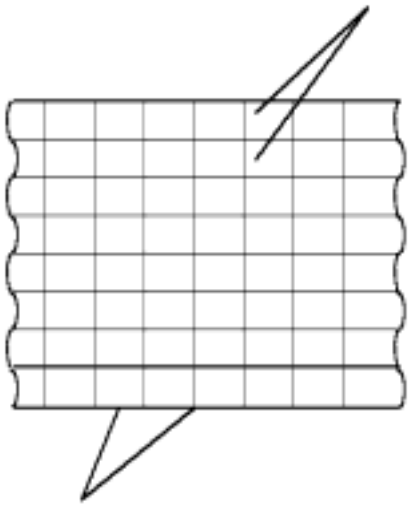
6.4 MAGNETIC TAPE SYSTEMS

Magnetic tapes are used as external storage device to keep back-up copies of precious software and data. It is a serial access storage device and provides sequential access only. Tape is a plastic ribbon that is coated on one side with a magnetic material (iron-oxide). Information is stored using binary code in the form of magnetized or non-magnetized spots. An electro-magnetic head arranges these magnetic particles to store data. These particles are interpreted when we read from the tape

and are then converted back to information. They come in the range of 12.5 mm to 25 mm width and 500 meters to 1200 meters length.

Recording Data on Magnetic Tapes

Magnetic tapes have their own coding system. Information is recorded on the tape in the form of tiny invisible magnetized and non-magnetized spots (representing 1's and 0's). Tape is divided into vertical columns called frames and horizontal rows called tracks. Only one character is recorded per frame. Data is recorded in two coding formats – BCD (Binary Coded Decimal) which is 7 bit format (6 bit BCD and 1 bit for parity checking), EBCDIC (Extended Binary Coded Decimal Interchange Code) which is 9 bit format (8 bit EBCDIC code and 1 bit for parity checking). A parity or check bit is used to detect errors that may occur due to loss of a bit from a string of 6 bit BCD or 8 bit EBCDIC format during input or output operation.



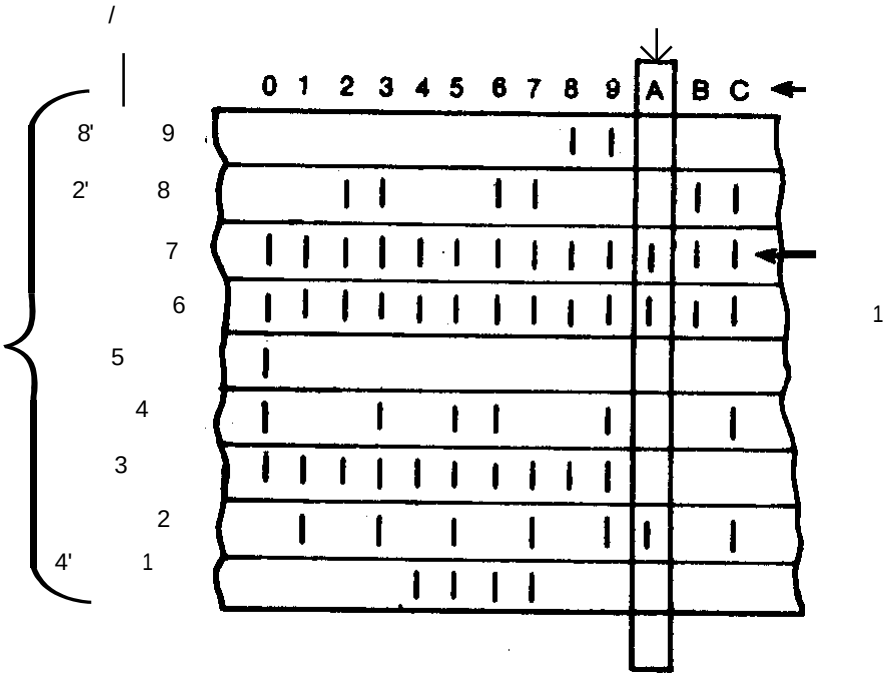
8-Track Magnetic Tape

Fixed and Variable Length Records

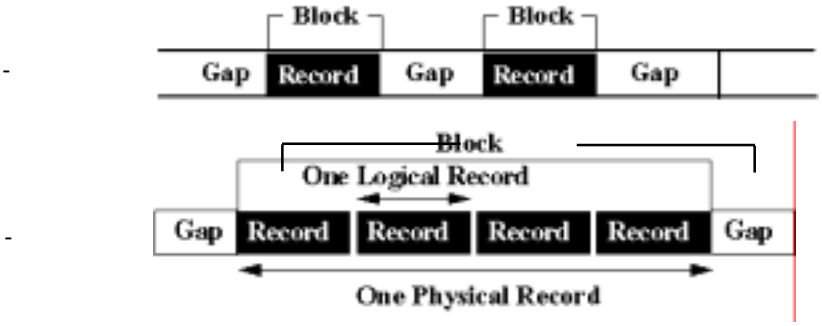
The data is normally stored on a tape in blocks. On some tapes, the block is of fixed length. It may vary in length for others. In fixed length record block, the data size cannot exceed a predetermined maximum numbers of characters. In variable length record block, there is no such limitation on number of characters and the record may contain any number of characters.

Blocking of Records

A magnetic tape alternates sections of data called blocks and regions of blank tapes (about 3/4 inch in length) called Inter Record Gap (IRG). The gap has to be provided to allow for stopping and starting of the tape. Data transfer takes place only when the tape is moving at constant speed. Also it is transferred blockwise in magnetic tapes. A block may contain one record or more than one record. Number of records in one block is known as Blocking Factor of that tape. The data between two IRG forms one physical record while it may contain number of logical records within it.



Data Recording on a 9-Track Magnetic Tape Using 8-Bit EBCDIC Code Format



Multiple Record Block

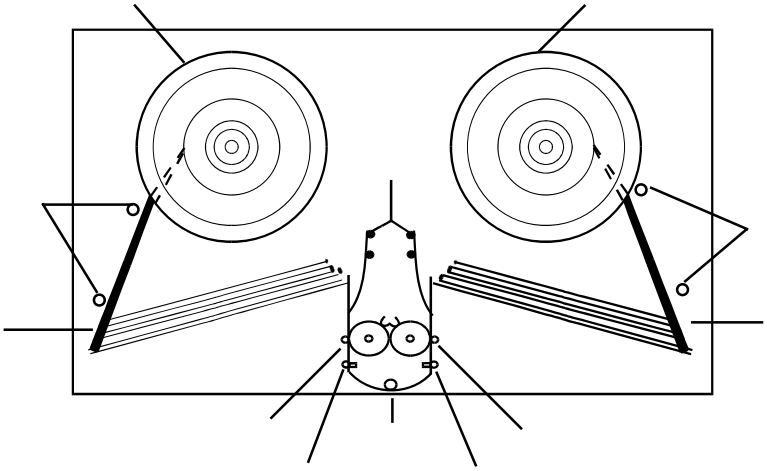
Header and Trailer Labels

In addition to the data records, each tape file contains at least two additional records.

- ***Header Label:*** It is the first record on the file. Header label contains control information for verifying the accuracy, completeness and authenticity of file name, a password, a file creation date and access control information about the file.
- ***Trailer Label:*** It is the last record on the file. A trailer label contains the number of physical and logical records contained in the file.

Magnetic Tape Drive

Magnetic tape drive are the devices that can either read data from a tape into the CPU or can write information being produced by the CPU onto the tape. Data is read from the tape with the help of a read-write assembly. There is one read-write head for each track. The structure of the tape drive is given in the figure.



Structure of Magnetic Tape Drive

Data Transfer Rate (DTR)

It is an important feature of secondary storage devices. DTR is the product of tape density and tape speed. Data Transfer Rate (bytes/second) = Packing Density (bytes/inch) x Tape Speed (inches/second). Typical data transfer rate is 100000 bytes/second or above.

Tape Density

The density of tape means number of frames recorded in 1 inch of tape. Typical tape densities are 556 BPI, 800 BPI, 1000 BPI, 3250 BPI or 6250 BPI. (Bytes per Inch).

Tape Speed

The speed of tape is measured in inches per second. It normally lies between 50-200 inches/second.

Examples

Q1. Given that a magnetic tape is moving at a speed of 100 inches/sec and has a density of 800 bytes/inch. Data is blocked in blocks along the length of the tape with a blocking factor of 6 each of 30 characters. The size of the IBG = 0.5 inches. Find the total time taken to read all the records and the effective transfer rate.

Solution

Speed = 100 inches/sec.

Tape Density = 800 bytes/inch.

Transfer Rate = Tape Density × Speed

Transfer Rate = 800 × 100 bytes/sec.

Transfer Rate = 80,000 bytes/sec.

Block Size = 30 bytes

Block Length = 30/80 inches = 0.38 inches

Effective Transfer Rate

= Transfer rate × Transfer rate of one unit block.

= (T.R. × Block Length)/(Block Length + IBG)

= 80,000 × 0.38/0.38 + 0.5 = 34545.5 bytes/sec.

Number of bytes in 1 Block	=	30
Number of bytes in 6000 blocks	=	1,80,000
Time required to transfer 80,000 bytes	=	1 sec.
Time required to transfer 1,80,000 bytes	=	1,80000/80,000 = 2.25 secs.
Time required to transfer 100 inches	=	1 sec.
Time required to transfer 0.5 inches	=	0.5/100 =1/200 sec.
Time required to transfer 6000 IBG'S	=	1/200 × 6000
	=	30 secs.
Total time taken to read all records	=	Time Required to transfer 6000 IBG's + Time required to transfer 180000 bytes
		= 30 + 2.25 = 32.25 secs.

Q2. A high speed magnetic tape drive accommodates 1200 ft. reel of standard nine track tape. The tape is moved past the recording head at a rate of 100 inches per sec. What must the recording density be in order to achieve a data transfer of 1.44 x 10^6 bits per sec.?

Solution

Given that

Tape length in inches	=	1200 × 12 = 2400 inches
Read/Write head speed	=	100 inches/sec.
D.T.R	=	1.44x10^6 bits/sec.
	=	1.44 × 8 × 10^6 bytes/sec.
Since Transfer Rate	=	Tape Density × Speed
Therefore Tape Density	=	1.44 x 8 x 10^6/100 = 11.52 x 10^4 bytes/inch

Advantages of Magnetic Tapes

- Magnetic tapes provide virtually unlimited storage. Number of tapes can be used as per requirement for storing of data.
- A magnetic tape provides high data density. A typical tape can store 6250 characters per inch. So a tape of 28,800 inches can store 180 million characters.
- Magnetic tapes are economical to use – their cost is very low.
- Rapid data transfer rate is about one million bytes per second.
- Magnetic tapes and cartridges are very easy to handle and use.
- Tape is a convenient way of carrying large volumes of information from one place to another.
- It can be erased and reused many times.

Limitations of Magnetic Tapes

One of the main limitation with magnetic tapes is that they lack direct access to records and are susceptible to environmental disturbances. Also the require human intervention for operation. The data transmission in magnetic tapes is slow as compared to disks. There is variability or tape drives, i.e. different types of tape drives are available and there is no standardization, which makes it difficult to recover from parity errors.

Student Activity 1

1. Why do we need secondary storage devices?
2. What are the characteristics of secondary storage devices?
3. Differentiate between SASD and DASD.
4. How will you record data on magnetic tapes?
5. Describe magnetic tape drive.
6. Define the following:
   (a) Data transfer rate
   (b) Tape density
   (c) Tape speed
   (d) Header label
   (e) Traiter label
   (f) IRG
7. What are the advantages and limitations of magnetic tapes.

6.5 MAGNETIC DISK

Magnetic disks are used as an input, output or external storage device. They are a popular medium for Direct Access Storage Devices (DASD). It is a thin, circular metal plate/platter coated on both sides with a magnetic material. It usually comes in the form of a disk pack, also known as hard disk. All the disks in the disk pack rotate at a very high speed of 700 or 3600 rpm. They come in two varieties according to the operations of the read-write mechanism – fixed head and moving head. Disk packs also come in two configurations – fixed disk pack, removable disk pack.

Storage of Information

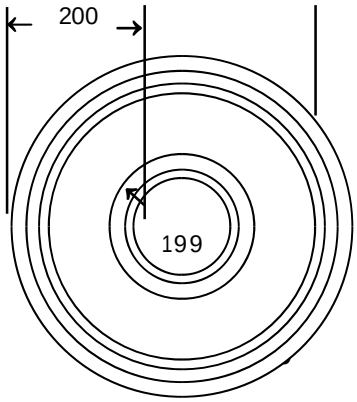
Information is stored on both the surfaces of each disk platter except the upper surface of the top platter and lower surface of the bottom platter. Each disk platter is divided into concentric circles known as tracks. A set of corresponding tracks in all the surfaces of a disk pack is called a cylinder. Data is stored in one cylinder first and then the head moves to the next cylinder, this saves time wasted in moving the head track by track for a particular disk. Information is recorded as a series of magnetized (signifying a 1-bit) or non-magnetized (signifying a 0-bit) spots. Each track contains equal number of characters. Information can be erased from anywhere on the disk and new data can be recorded on it. Normally there are 200 tracks on a disk surface numbered 0 to 199. Each track is divided into 8 or 12 equal sectors. Sectors are used to store information – about 512 bytes can be stored per sector.

Addressing of Records

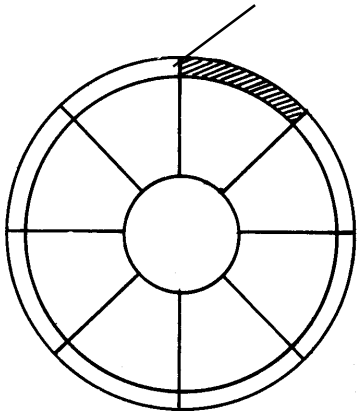
The heads are attached to access arms which are moved in and out over the spinning disk. The heads can thus be quickly located over any track to read or write data. These tracks begin at the outer edge and continue towards the centre. Each track has a unique number (000-199).

Accessing of Data

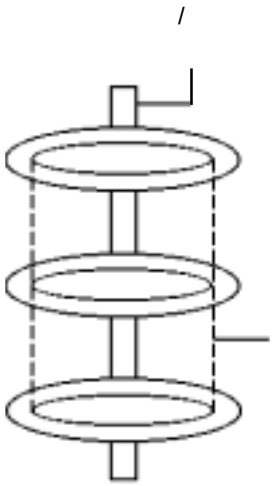
Data is recorded on the tracks of the spinning disk surface and read from this surface by one or more read/write heads. There are two basic types of disk systems – the moving head system and the fixed head system. Accessing of data is different for both.



Tracks on a Disk



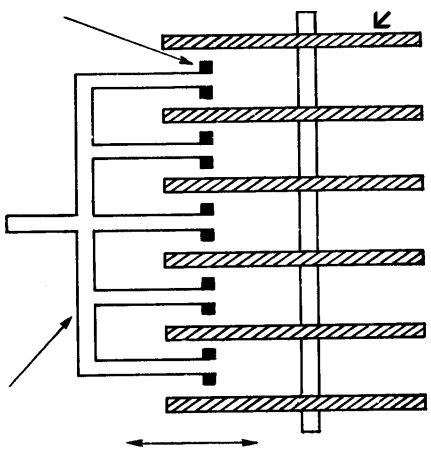
Sector of a Disk



Cylinder

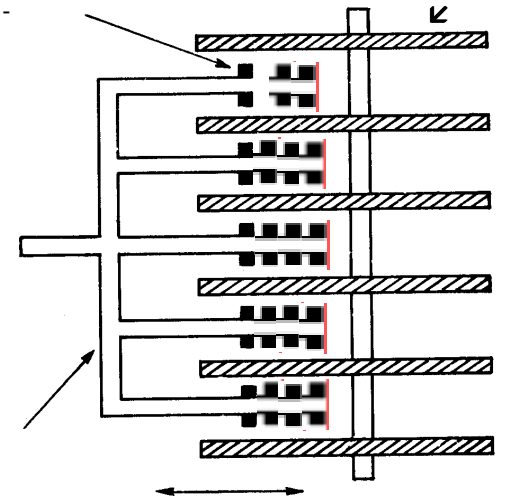
Moving Head System

Moving head system consists of one read-write head for each disk surface mounted on an access arm which can be moved in and out. Each read-write head moves horizontally across the surface of the disk. Every surface of disk pack has its own head and all heads move together. One cylinder is accessed simultaneously by the set of read-write head. Then the head moves for the next cylinder.



Fixed Head system

In a fixed head system the access arm is non-movable and a number of heads are attached on this arm. These read-write heads are distributed over the disk surface, one head for each track. As a result no head movement is required and information is accessed more quickly. Because of the space required for the additional read-write heads, fixed head disks have less capacity and cost more per byte of data stored.



Access Time

Information is accessed from the disk by referencing the disk address. Disk address is specified in terms of surface number, track number and sector number. Access time in any disk system is made up of three components – Seek Time, Latency Time and Data Transfer Time.

- ***Seek Time:*** Time required to position the head over the proper track is called the seek time, normally measured in milliseconds. For fixed head system, seek time is always zero.
- ***Latency Time:*** Time required to rotate the disk pack to bring the correct sector under the read-write head is known as latency time. Average latency time is of the order of 8-10 ms.
- ***Data Transfer Time:*** Time required to read or write the actual data on the disk is called data transfer time.

Storage Capacity

The storage capacity of a magnetic disk largely depends upon the number of disks in the disk pack and the number of tracks per inch and bits per inch of track. Total number of bytes that can be stored in a disk pack = (Number of cylinders × Tracks per cylinder × sectors per track × Bytes per sector). Storage capacity of a disk pack is in the range of 200 to 10000 megabytes (M bytes).

Examples

Q1. A disk pack has 19 surfaces. Storage area on each surface has an inner diameter of 22 cms and an outer diameter of 33 cms. Maximum storage density on any track is 2000 bits/cm and minimum spacing between tracks = 0.25 cm. Assuming data storage capacity to be the same on all tracks find:

- ♦ The storage capacity of the disk pack.
- ♦ The data transfer rate in bytes/second at a rotational speed of 3600 rpm.

Solution

a. Total disk area = 33/2 – 22/2 = 11/2 = 5.5 cm.

Minimum spacing between 2 tracks = 0.25 cm.

Number of tracks/surface = 5.5/0.25 = 22

Storage density will be maximum at the innermost track of radius 11.

Therefore circumference of innermost track = 2 per = 2 × 22 × 11/7 = 69.143 cm.

Since in 1 cm. 2000 bits will be recorded

Therefore in 1 track (69.143cm.) = 2000 × 69.143 cm. = 138285 bits will be recorded.

Storage Capacity = Track Capacity × Number of Tracks per Surface × Number of Surfaces

= 138285 × 22 × 19 = 57803130 bits = 7225391.2 bytes = 7056.046 KB

= 69.17692 MB

b. D.T.R. = Number of Bytes Stored per Track × Rotation Speed

= 138285 (bytes)/8 × 3600 (second)/60

= 1037137.5 bytes/second » 1037138 bytes/second

Q2. A fixed disk unit divides each track into 40 sectors. Each sector stores 1024 bytes. There are 20 cylinders with 10 tracks per cylinder. The disk rotates at the rate of 1000 revolutions/min. Find out the data transfer rate and the storage capacity of the disk.

Solution

Number of bytes stored per track = No. of Sectors × No. of Bytes per sec

= 40 ×1024 = 40960 bytes.

Rotation Speed = 1000 revolutions / min. = 1000/60 = 16.7 revolutions/sec.

Data trarnsfer rate = No. of bytes stored per track × rotation speed

= 40960 × 16.7 bytes/sec. = 684032 = 684 KB/sec.

Storage capacity of disk pack = No. of cylinders × No. of tracks × No. of sectors × No. of bytes/sector.

= 20 × 10 × 40 × 1024 bytes = 8192000 bytes = 8.2 MB

Advantages of Magnetic Disks

Magnetic disks are DASD devices, i.e. time taken to locate a particular record is independent of the position of that record. Disk storage is more durable than that of tape storage. Magnetic disks support on-line processing because of its direct accessing property. In a nut-shell the advantages of magnetic disks are: easy accessibility, durability, reusability, compactness and providing sequential as well as direct access.

Disadvantages

The disadvantage of magnetic disk packs is that it is costlier than tape. Tapes are more economical to use. The disk packs are not easily portable, i.e. there are difficulties in removing a diskpack. Also they are less secure because they have direct access and data can get overwritten by mistake any where on the disk or it can get corrupted anywhere along the file. In the case of tapes, since all of it is not exposed for accessing it is more secure and safe.

Student Activity 2

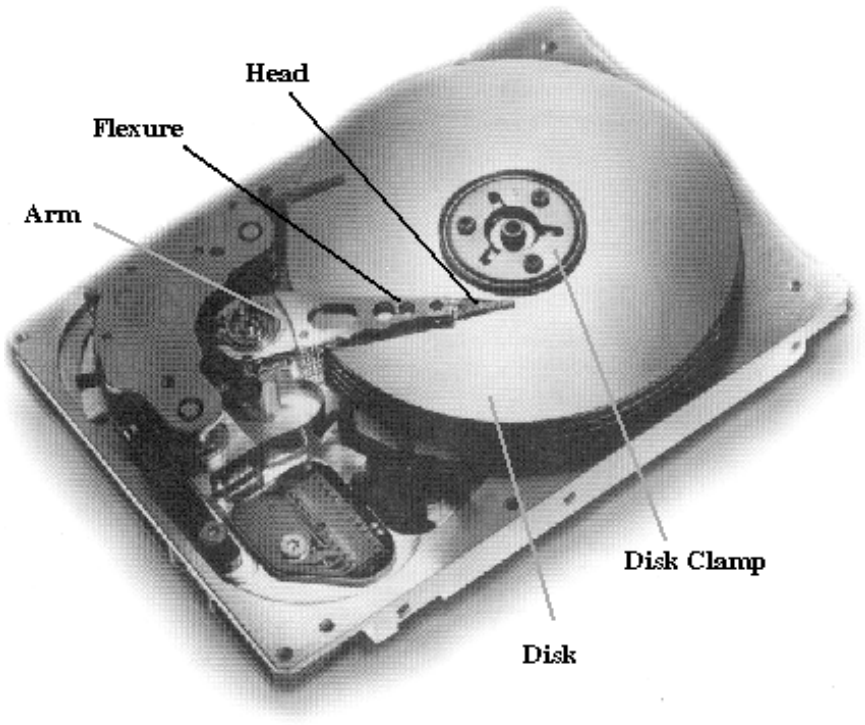
1. Define magnetic disk.
2. How will you access data from a magnetic disk?
3. Differentiate between fixed head and moving head system.
4. Define seek time and latency time.
5. How can you calculate the storage capacity of magnetic disk?
6. What are the advantages and disadvantages of magnetic disk?

Types of Disks

All magnetic disks are platters coated with a magnetic material. They come in different sizes. They are portable or permanently mounted on the computer system. The complete unit to read and write on these disks is called Disk Drive Unit. Disks can also be differentiated on the basis of their size, sectors, number of sides, storage capacity and density.

Winchester Disk/Hard Disk

It is a group of large metal or plastic disks permanently sealed in a container. Read-write heads and access mechanisms are also inbuilt within the container. These sealed containers are not generally removed from their disk drives. Smaller size of Winchester disks are used in mini computers and PCs. Winchester disks minimize contamination by prohibiting the circulation of outside air between the disk. In operation, the disk is rotated at a high speed on the spindle. There is one read-write head for each surface. The heads can move to and fro to select desired track position. During operation, heads don't touch the magnetic surface, a thin cushion of air is maintained between a rotating disk and read-write head. To store or retrieve data, the system finds the disk address used to contain the data by moving the read/write head to the appropriate track where it waits until the desired sector passes by. The capacity of hard disks is very high compared to other disks. Nowadays hard disks of capacity 4.3 GB and 8 GB are available. Although hardisks are fixed in PC, porting of disks from one place to another is more secure than before because all the disks are safely packed inside a protective covering.



Hard Disk

Floppy Diskette

Hard disks are costly and unfit to transfer data from one place to another so floppy diskettes of low capacity are used. These diskettes are economical and very flexible to use and are fixed inside the computer system. The diskette can be frequently taken out and inserted in the disk drive unit While in operation, floppy disk drive heads actually touch the surface of the magnetic disk. This results in quick wear and tear of the disks and the read-write heads. These diskettes are made up of plastic and have a magnetic coating. The disk is covered in a protective sheath with opening for editing and writing.

Nowadays two sizes of disks are commonly available – 5.25 inches and 3.5 inches. The 3.5 inch diskette comes in a rigid packet for protection so they are not really 'floppy'. These diskettes store more data due to certain advantages. They have over 5.25 inch diskettes. The 3.5 inch diskette has actually replaced 5.25 inch diskettes. Floppy diskettes hold only one disk at a time and so only one diskette can work with the disk drive unit at a time.

The capacity of floppy disks, mini disks, is very low compared to hard disks. A 5.25 inch disk has 360 KB and 1.2 MB capacity while that of 3.5 inch disk can store about 1.44 MB of data. The 3.5 inch disk is also referred to as micro floppy disk. The cover of these disks has a sliding opening for editing and writing of heads which is automatically closed when not in use to protect the disk from dust and moisture.

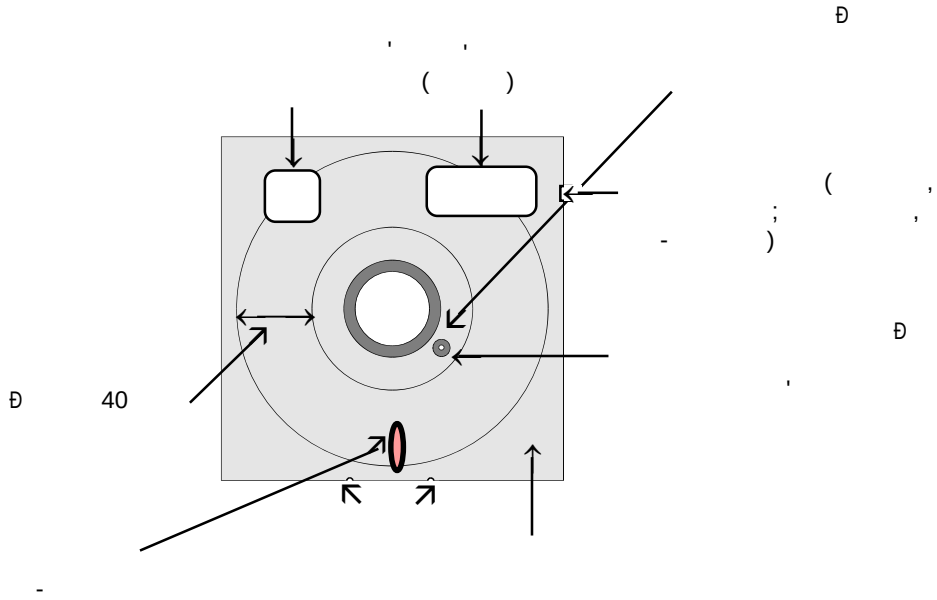


Diagram of a Floppy Disk

In the figure the index role on the recording media is used by the disk drive unit to locate the starting of the first sector. In a 5.25 inch floppy disk write protect opening is occurred by a write protect notch and writing to the disk is permitted only when the notch is open and in 3.5 inch diskette a write protect tab is used to make the diskettes read only by covering the notch and opening the tab respectively. Another hole in a 3.5 inch floppy disk is a high density detection hole. It distinguishes the 1.44 MB diskette from 720 KB low density diskette, which is of the same size and shape.

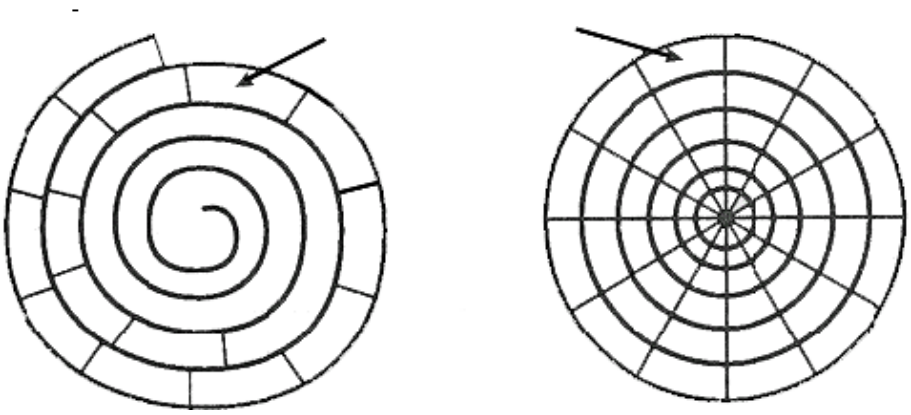
6.6 CD-ROM

stands for Compact Disk-Read Only Memory. It is a small optical disk in which a laser beam is used to store and read information. It is a read only storage device, i.e. once CD-ROM is produced the information stored on it cannot be changed by using common CD-ROM drives. It is mainly used to distribute software data, multimedia presentations, etc. It looks like a shiny aluminium foil encased in a plastic container. It is a circular disk with a 4.75 inch diameter. Another version of CD-ROM, the 3.5 inch, is not as popular as the 4.75 inch disks.

Data Storage and Retrieval

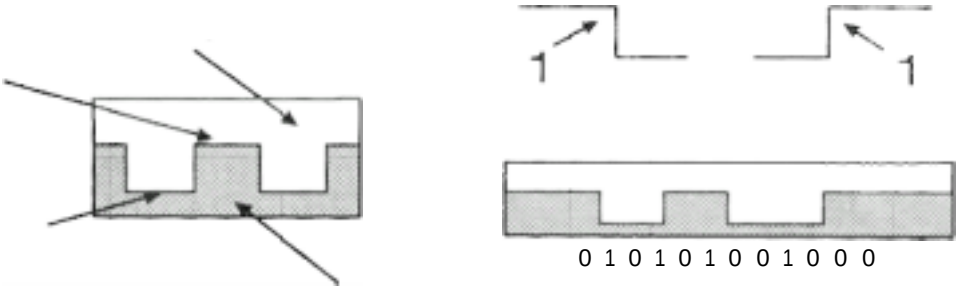
The data is stored on a CD-ROM disk in a completely different way as compared to the data storage of a magnetic disk. On a CD-ROM, data is stored in a continuous 'spiral' format, like the process of recording songs on the audio tracks. On a magnetic disk, as you move towards the center, the sector size decreases, whereas on a CD-ROM disk each sector is of the same size. As each sector of the CD-ROM is of the same size, the CD-ROM drive is rotated using a constant linear velocity. This method increases the disk storage capacity but maintaining a constant linear

velocity requires complicated logic circuits and the disk access operation also slows down as compared to the hard disk drive.



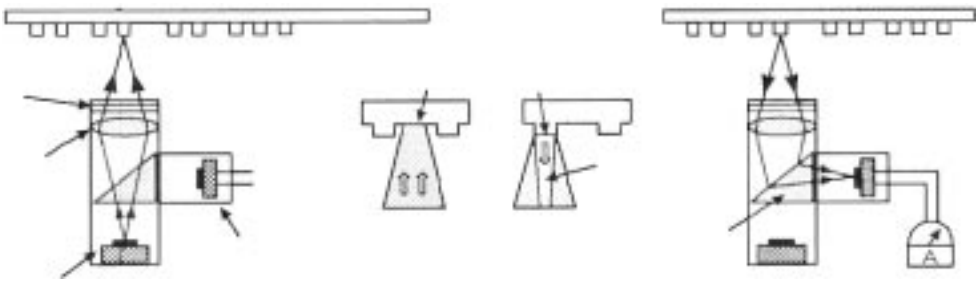
Data Storage on a Magnetic Disk and a CD-ROM Disk

The data on the CD-ROM is stored on a recording surface which is made up of aluminium or gold layer; this layer is protected by a transparent plastic coating. On this recording surface, data is recorded as 'pits' and 'lands' as shown in the following figure. The lands are flat surface on the disk surface and pits are small depressions on the disk surface. These pits are created by focussing a sharp laser beam on the disk surface.



Data Storage on a CD-ROM Disk

The laser beam actually burns the surface so a pit is created at that place. These pits and lands are recognized as 1 and 0. For reading, the laser beam is focussed on the disk surface. The beam gets reflected at land and no reflection is there at pits. Sequence of reflected light is interpreted as 0s and 1s by the drive unit and sent to the computer.



Data Reading from a CD-ROM

Writable CDs

There are blank CDs on which we can write data with the help of read-write CD-ROM drive and "CD write" software. The writing operation on a CD is done at a slower speed. For writing purposes, high intensity laser beam is used by the CD-ROM drive unit while for the reading a low intensity beam is used. Writing on CDs is done in sessions. Once the session is closed nothing more can be written on that CD, i.e. WORM (Write Once Read Many). Some CDs can be overwritten again, e.g. HP-CD permits up to 100 times write operations on a single CD. Number of tracks are equal to the number of times data is written on a CD in a single session. Three types of CD-writing is done: writing of data files, writing of audio in tracks and writing of video in tracks.

Merits and Demerits of CD-ROM

The main advantage of these disks is that unlike the magnetic storage media, if these disks are kept properly, the stored information on these disks will last forever. These CD-ROMs are not suseptible to electrical and magnetic field disturbances because whatever is stored is permanent and it is not in the form of electrical charge or magnetic polarity of particles. Another big advantage of the CD-ROM disk is its high storage capacity. One CD-ROM can store 600 MB of data. The only demerit associated with it is that it is read only storage device and data cannot be changed by using a normal CD-ROM drive.

One of the most common applications of the CD-ROM is entertainment software such as video games, etc. Many types of educational software encyclopedias requiring lot of space are now a days available on CD-ROMs. They are also being used extensively for multimedia application.

Student Activity 3

1. What are Winchester disks?
2. Write a short note on floppy diskette.
3. What is a CD-ROM?
4. How will you store and access data from a CD-ROM?
5. What are writable CDs?
6. What are the merits and demerits of CD-ROM?

6.7 SUMMARY

Secondary storage devices are an essential part of a computer system because without any mechanism for permanent storage, a computer cannot remember and store data for future usage. Magnetic media has been extensively used for storing the data. Generally, magnetic tapes are used for taking back-ups. The programs data files and software is stored on magnetic disks. The access speed of magnetic disks and storage devices directly affects the overall throughput of the computer systems. With the invention of optical media, i.e. CD-ROMs, a new revolution is taking place with secondary storage media. CD-ROMs are gaining popularity and are emerging as a cheaper media for permanent type of data storage.

6.8 KEYWORDS

Magnetic tape: External storage device with serial access of data.

Magnetic tape drive: A device that can either read data from a take into the CPU or can write information being produced by the CPU on to the tape.

Winchester disk: A disk memory in which non-interchangeable disks are used and the read/write heads are built-in with the disk.

Latency time: The time taken for a record stored in a disk track to come under the read/write head positioned over that track.

Floppy disk: A circular magnetic disk made of flexible plastic sheet coated with magnetic material.

Mass storage devices: Secondary storage devices that can store hundreds of giga byte on them in a very small place.

Seek time: The time required to position the head over the proper track of magnetic disk.

Data transfer time: Time required to read or write the actual data on the disk.

CD-ROM: Small optical disk in which laser beam is used to store and read information.

6.9 REVIEW QUESTIONS

Fill in the Blanks

1. _____ time is the time required to bring the correct sector under the read-write head.
2. Data recorded on magnetic tapes contains blank spaces called _____.
3. _____ have special tracks for recording the data.
4. A _____ in a magnetic hard disk is a set of tracks.
5. Data stored on disk can be accessed in either a direct or _____ way.
6. _____ is a group of records on a magnetic tape.
7. The seek time is zero for _____ type of disk systems.
8. The read-write head touches the magnetic media in _____ disks.
9. _____ intensity laser beam is used to write on the CD-ROM.
10. The recording density in _____ is measured in bits per inch.

Multiple Choice

1. A laser beam is used to read data from
   a. magnetic disk
   b. optical disk
   c. magnetic tape
   d. none of the above.
2. The access method used for magnetic tape is
   a. random
   b. sequential
   c. direct
   d. none of the above
3. A floppy disk is
   a. a first generation computer invention
   b. smaller and lighter than a disk in a fixed disk pack
   c. most often used with every large computer systems
   d. None of the above
4. Data stored on a magnetic disk
   a. can be read more quickly than data stored on magnetic tape
   b. are less likely to be destroyed than data stored on a magnetic tape

c. can be directly accessed

d. all of the above

5. Seek operation refers to

a. moving the head to the proper track in a floppy disk

b. loading the head in a floppy disk

c. accessing a memory location in RAM

d. none of the above

Descriptive Questions

1. Define the terms track, sector and cylinder.

2. What is a CD-ROM? How does it store data? What are its advantages over hard disks?

3. What are header and trailer labels? Why is blank space left between two physical records on a tape?

4. Compare the advantages and disadvantages of magnetic tapes, hard disks and CD-ROMs.

5. What is the difference between a physical record and logical record? Why is blocking of records preferred on magnetic tape systems?

6. How does a floppy diskette differ from a magnetic disk pack? What is the significance of index hole?

7. What is the total access time in the case of disk?

8. A disk drive has 20 magnetic surfaces and 400 cylinders of data. The rotation time is 25 millisecond. The time taken for the read-write head to move from the innermost cylinder to outermost cylinder is 75 milliseconds. The data transfer rate is 400,000 characters/sec. What is the total average time taken to read two successive blocks of 2000 characters. each in case of

a. Serial processing where the data comes in consecutive blocks.

b. Random processing when the record block can be anywhere on the disk.

9. A disk pack has 19 surfaces. Storage area on each surface has an inner diameter of 22 cms and an outer diameter of 33 cms. Maximum storage density on any track is 2000 bits/cm and minimum spacing between tracks is 0.25 cm. Assuming data storage capacity to be the same on all tracks find

a. The storage capacity of the disk pack.

b. The data transfer rate in bytes/second at a rotational speed of 3600 rpm.

10. Determine the amount of data that can be stored on a 9 track tape, 3600 feet in length, having tape density of 800 bytes per inches and IBG of 0.5 inches and Block size 1200 bytes.

11. A high speed magnetic tape drive accommodates 1200 ft. reel of standard nine track tape. The tape is moved past the recording head at a rate of 100 inches per sec. What must be the recording density in order to achieve a data transfer of 1.44×10^6 bits per sec.?

Answers to Review Questions

Fill in the Blanks:

1. seek 2. gaps 3. magnetic disk 4. Cylinder

5. Indirect 6. Block 7. Fixed head 8. Floppy 9. High 10. Magnetic tape

Multiple Choice

1. (b)
2. (b)
3. (b)
4. (d)
5. (a)

6.10 FURTHER READINGS

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

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

Elements of Computer Software

UNIT 7

SOFTWARE CONCEPTS

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Describe various components of computers.
- Describe system software.
- Describe application software.
- Describe utility software.
- Understand the benefits of licensed software.

U N I T S T R U C T U R E

7.1 INTRODUCTION

The software is the backbone of the computer industry. It provides the facility to manipulate data, maintains integrity within system components and network and provides the course of communication with other systems, etc. Hardware without software is like a human without brain. The software development is the most critical area of industry and it contributes to the national economy to a very large extent.

In earlier systems, computer software was very task oriented and not too interactive with the user. But today we have very sophisticated softwares which can be used for a variety of tasks in an interactive mode.

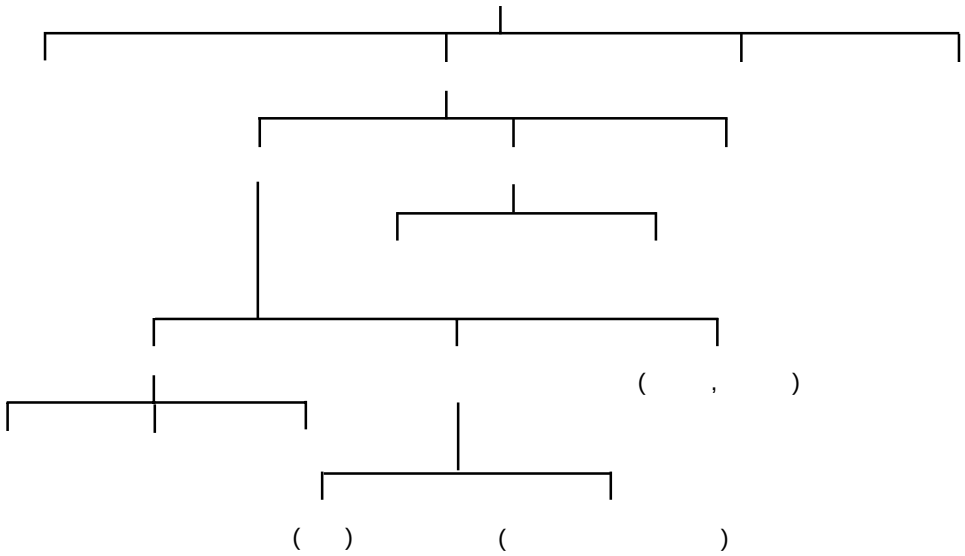
In this chapter, we will study about the types of software, their usage facilities and there implementation, etc., which provide us with better understanding of various software technologies and their use in our daily life.

7.2 COMPONENTS OF COMPUTERS

Hardware itself is nothing until it is supplemented with software, which helps it to perform various tasks. Computer system is basically made up of four main components which are: hardware, firmware, humanware (liveware), and software.

- **Hardware** of computer is nothing but a set of tangible electronic components. It consists of input/output devices and a CPU with other peripheral devices connected to it.

- **Firmware** is the strict realization of a hardware. Hardware is simulated by a microprogram running on a special microprogrammed chip. The machine language of these computer is an extremely low level micro-instruction set which is used to communicate data between memory and CPU registers, between registers themselves and from registers to processors, such as address and multipliers to other registers. This microinstruction set is basically used for defining the primitive operations and interpretation cycle for a computer.
- **Softwares** are the programs used to make the computer usable in terms of accomplishing the user's tasks. We will study them further in detail in this chapter. They use the firmware in terms of manipulating the computer resources for their work.
- **Humanware** is the people who create, modify or use the computer's resources using various software. End users use that software which is related to their task.



Computer System Components

The different classes of software are as mentioned below.

System Software

System software consists of all the operating systems, translators and languages to ensure smooth and efficient functions of the computer. These programs provide the integration of various components of computers to work together and provide the way to manipulate these resources according to your need and choice.

Application Software

Application softwares are the programs used by the user to perform some specific functions. These softwares allow the user to utilize computers for the tasks which are provided by the software itself like data manipulation, documentation, image and multimedia development and usage, etc.

Utility Packages

Utility Packages are special software which provide the helping hand to the other softwares, in terms of improvement in system performance by performing some routine task like disk de-fragmentation, disk scanning and bad sector corrections. Nortan tool kit is one of the utility tool kit which provides a lot of tools to perform the tasks which can help in managing and enhancing system performance.

1. What are the various components of a computer?
2. What do you mean by firmware?
3. What is software?
4. What is humanware?
5. What are the various classes of software?

7.3 SYSTEM SOFTWARE

System software are programs used to control the operation of the computer system and aid the programmer in doing his/her work efficiently. Some of them are held permanently in computer memory which relieves the programmer from some mundane tasks; in turn improves his/her productivity. They make very efficient use of hardware resources. System software can be further categorized as:

- Operating system and control programs.
- Translators as assemblers, compilers and interpreters.
- Database management systems (DBMS).
- Drivers and system testing tools (housekeeping programs).

NOTE: we will study DBMS Operating Systems and translators in detail in next chapters.

Operating System

It is an integrated set of specialized programs that are used to control and manage the resources and overall operations of a computer. It is a software that controls the execution of other computer programs. It provides scheduling, debugging, input/output control, accounting, compilation, storage assignment, data management and related services to all other programs running on the computer. Some of the popular operating systems are:

- Disk Operating System (DOS)
- UNIX
- LINUX
- OS/2
- Windows 95/98
- Windows NT

An operating system is a typical software to simulate a number of new operations and data structures that are not directly provided by the hardware, e.g. file management primitives.

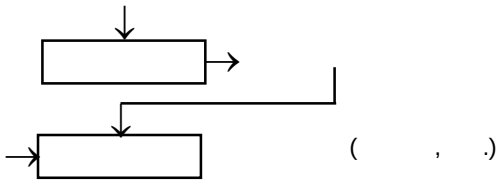
Language Translation Software/Translators

Programs which translate a program written in any computer language into machine language (understandable to the computer) code are known as translators. Translators are divided into three categories.

Assembler

An assembly language program cannot be directly executed by a computer. It has to be converted into its machine language equivalent before the computer can interpret and execute it. An assembler is a program that translates a program written in assembly language into a machine executable code.

The input to assembler program is an assembly language program known as source program and the output of assembler is a machine language program known as object program.



Once an object program is created, it is transferred to the computer's primary memory using the system's 'loader'. Here, another computer program known as 'link editor' passes computer control to the first instruction in the object program and then the execution starts and proceeds till the end of the program.

Compiler

Compilers are the translators which translate high level language programs into machine code and this machine code is executed afterwards. The translated machine code is known as object code. Functions performed by compilers are:

- They allocate addresses for all variables and statements.
- They generate the object program on tape or disk as required.
- They produce a printed listing of the source and object programs, if required.
- They tabulate a list of programming errors found during compilation.

Most high level languages are compiler-based languages. Some of the important ones are COBOL, PASCAL, FORTRAN, PL/1, Turbo C, etc.

Interpreter

Interpreters are used for translating high level language program into machine level language program line by line and executing each of the instructions alternately.

When a program is to be executed, the interpreter accesses the first instruction, translates it into one or more machine language instructions and then executes these instructions. The interpreter then accesses the next instruction and repeats these tasks. The process continues until all source language instructions have been translated and executed.

Features of Interpreter

- Interpreters are slow as compared to compilers because of line by line translation and execution.
- Debugging is easier in interpreter-based languages because interpretation process stops as soon as an error is encountered.
- Most well-known interpreter-based language is BASIC.

Simulator

Simulators are custom-made tools used in integration testing. They allow easy configuration and re-configuration of system elements. Simulators are used in situations where operation in the actual environment is impractical or in situations in which live testing of the system is impossible, e.g. Ballistic Missile Systems.

Emulator

Emulation technique is used when an organization is migrating from one computer system to another. Operating system can be used to "emulate" the previous computing environment, i.e. to make the new computer act like the old one and emulator is the software facilitating this phenomenon by creating a virtual machine.

Emulated system operations are very much inefficient as compared to the original system but provide great convenience.

Driver

A driver is a special type of software created by peripheral device manufacturers to provide the facility to the computer to communicate with the peripheral device, e.g. printer drivers, mouse drivers, etc. Drivers have the ability to convert the data supplied by the computer according to the device setting and than transfer to the device to work over it.

Student Activity 2

1. Define system software?
2. What is an operating system?
3. Name some popular operating systems.
4. What is a language translator? Name its various categories.
5. What is an assembler? Describe its functioning.
6. Differentiate between compiler and Interpreter.
7. What are simulators and emulators?
8. What is a driver?

7.4 APPLICATION SOFTWARE

Application software enables the computer to produce some useful output such as specific inventory control reports, attendance accounting, linear programming, or medical accounting tasks, etc. It is subdivided into two broad categories:

1. Customized Application Software
2. Standard Application Software

Customized Application Software

Customized application software are programs written by the user or programmer in order to perform specific jobs for the user. They are written in a variety of programming languages depending on the task at hand. Normally these are sets of programs used in conjunction with one another, e.g. Payroll System, Customized Accounting Packages for a company, etc.

Standard Application Softwares

These are a generalized set of programs used to deal with a particular application. These softwares are normally developed by specialist software developers to solve common problems faced by many users, e.g. MS-Office, WordStar, Lotus, EX, TALLY, etc.

Advantages of Standard Application Packages

- Saves programming effort and expense on the part of the user.
- User gets well tested and tried programs.
- Relatively quick implementation.

NOTE: However, they may require some adaptation to an organization's specific needs.

One major class of standard application packages is ERP (Enterprise Resource Planning) packages like SAP, BAAN, Peoplesoft, Marshal, Oracle, etc.

7.5 SOFTWARE LICENSING

The illegal and unauthorized duplication of software is called software piracy. The most frequently used deterrents to software piracy are warning and licence labels found on most software packages. Software priacy is an illegal offence.

The warnings clearly state that the user has only purchased a license to use the software on a single machine and that any copy must be made for backup purposes only. Authorized users of licensed software enjoy following benefits:

- They receive complete documentation along with the software.
- They receive all the change/modification notices about the software from the supplier.
- Upgrades to higher versions of the software which are available for nominal prices to licensed users.
- Users can benefit by sharing experiences with other licensed users through user groups.

7.6 UTILITY SOFTWARE

System utilities are a wide variety of general purpose programs that greatly speed up and simplify the use of the computer. They improve programming efficiency by providing improved system performance. Some of the main utility softwares are:

- Disk Defragmenter
- Virus Scanners
- Norton Tool Kit

Disk Defragmenter

Normally files are stored on the system in a fragmented manner according to the availability of space. Disk defragmenter are programs that reorganize information on the hard disk so that pieces of information in each file are stored as close together as possible (that is they are no longer fragmented). This makes reading from and writing files to hard disk more efficient and time-saving. They are also known as disk compaction programs.

Advantages

- Disk defragmenters speed up system performance.
- It can significantly decrease the time it takes for programs to start and files to be read.
- It is easy to implement.

Disadvantages

- Takes a long time to run most disk compaction programs.
- Can't be run from or written into another program.

Virus Scanner and Remover

Computer virus are just like biological viruses, which grow very fast and are very damaging. Computer viruses attach themselves to some file and when that file is executed, they start growing and destroying valuable data. Virus protection systems keep a watch for viruses and as soon as they detect one, they sound an alarm. Virus protection systems are basically of three types: Boot Monitors, File Monitors, Disk Scanners.

- ***Boot Monitors:*** They keep a watch over disk I/O to the boot sector and partition table. Whenever an attempt is made to read or write to this area, they sound an alarm and warn the user.

- ***File Monitors:*** They check if any attempt is being made to write to .exe or .com files of the system. Whenever an attempt is made, they sound an alarm.

- ***Disk Scanners:*** Disk scanners provide the facility to check the hard disk/floppy diskette for viruses. Most users use them to detect viruses from the floppy while copying. Vaccines can be created for specific viruses only, because functionally viruses differ greatly. Developing a vaccine for virus means studying the virus thoroughly and gathering technical details about its functioning, namely, from where it loads itself, wherein memory it stores itself, how and what resources of the computers are used and what triggers its destructive routine, what type of code they attach with the files and what algorithm is used to change this attached code each time (known as polymorphism in code generation).

Multi-virus vaccine packages have become available. Most of these scan the disks for virus by looking for their signatures and then remove the virus. Signatures are the code of virus attached to a file and can be scanned by checking them by the same algorithm used by virus to create the code.

Student Activity 3

1. What are application software?
2. Describe various categories of application software.
3. What are the benefits of software licensing?
4. What are utility softwares?
5. What is disk defragmenter? What are the advantages of disk defragmenter?
6. What is virus? How can we scan and remove it from the computer?

7.7 SUMMARY

- A computer system consists of four parts: hardware, software, firmware and liveware. Hardware is nothing but the physical and electronic functional device whereas software is a program which provides the facility to manage and use the data and other computer resource. Humanware covers, all humans involved in using and developing other computer components.

- Software can be one of three types: system software consists of the programs which provide the interaction between user and computer and within the various peripheral and computer equipment. They also let us set our own instruction set for manipulating data in the form of programs and translate them in machine language.

- *Examples:* Operating System (Unix, DOS), Language Translators (interpreters), Computers, Assemblers, DBMS (FoxPro, Oracle), Device Drivers, Simulators, Emulators, etc.

- Application software are made by the user or programmer who use programming languages, DBMS software or any other system software. They are basically designed for some particular tasks. For example payroll, accounting, resource management, etc., application softwares are of two types.

- Customized softwares are software specially designed for a particular user or an organization is known as customized software. Whereas standard software are very generalized in nature and developed by expert programmers to solve the various problems faced by many users. For example, MS-Office, Coral draw, PageMaker, Lotus, etc.

- Utility software enables the computer to improve its performance. They are very general purpose programs which enhance the computer's and the programmer's efficiency by providing fast access of files and resource management. Some important utility softwares are disk defragmenters, virus scanner, disk clean-up, etc.

- Disk clean-up provides us free space on our disks by removing the useless files whereas disk defragmenter helps us to relocate file blocks as close as possible to provide us with fast access to our files. It does so by creating and writing files in a more efficient manner.

- Virus scanners and vaccines are programs which are used to detect and remove viruses using boot monitors, file monitors and disk scanners and remove the scanned virus by using any virus vaccine program, e.g. Smart Dog, Nashot, Macaffe, etc.

7.8 KEYWORDS

Software: A set of computer programs that enables the hardware to process data.

Human ware: People who create, modify or use the computer's resources using various software.

System software: Software that controls internal computer operations.

Operating system: Software, which acts as an interface between user and the hardware.

Language translator: Software, which converts our program into machine language.

Assembler: Language processor which converts the program written in assembly language into machine language.

Compiler: Language processor which converts the HLL program into machine language in one go.

Interpreter: Language processor which converts a HLL program into machine language by converting and executing it line by line.

Simulator: Custom-made tools used in integration testing.

Emultator: A software facilitating the shifting of an organization from one computer system to another by creating a virtual machine.

Driver: A special type of software created by peripheral device manufacturer to provide the facility to the computer to communicate with the peripheral device.

Application software: The set of programs necessary to carry out operations for a specified application.

Utility software: The set of programs that assist the computer by performing housekeeping functions like backing up disk or scanning/cleaning viruses etc.

Virus Scanners: Programs used to detect viruses using boot monitors, file monitors and disk scanners.

7.9 REVIEW QUESTIONS

Fill in the Blanks

1. Firmware is a _____ used in strict _____ of a hardware.
2. Software enables user to _____ his/her own tasks.
3. Humanware is the person who _____, _____ or _____ the computer to perform the particular task.
4. _____ are special software that provide a helping hand to other type of softwares.
5. _____ language programs are translated by assembler.
6. A driver is used for communication between a computer and a _____.

Multiple Choice

1. Compiler translates:

a. line by line

b. whole program

c. using interpreters

d. none of the above

2. FoxPro is

a. utility software

b. application software

c. customized software

d. system software

3. Utility software enable users to

a. manage CPU resource

b. improve System performance

c. create different documents

d. create their own programs.

4. DBMS software comes under

a. operating systems

b. translators

c. system softwares

d. standard packages

5. Simulators

a. tools to simulate text and image

b. used to translate languages

c. used to migrate an origination from one computer to another

d. none of the above

Descriptive Questions

1. What are the various components of a computer system?
2. What do you understand by system software? Draw the software classification diagram.
3. How can you define that a software is an Application Software?
4. What is the difference between

a. Software and firmware

b. Simulator and emulator

c. Customized and standard application software

d. Interpreter and compiler

5. Write Short notes on
   a. Translators
   b. Operating system
   c. Disk defragmenter
   d. Virus scanners
   e. Drivers
   f. Liveware

Answers to Review Questions

Fill in the Blanks

1. Computer component, realization
2. accomplish
3. Create, modify, use
4. Utility packages
5. Assembly
6. Peripheral device.

Multiple Choice

1. (b)
2. (d)
3. (b)
4. (c)
5. (d)

7.10 FURTHER READINGS

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

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

UNIT

8

CLASSIFICATION OF PROGRAMMING LANGUAGES

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Describe various generations of programming languages.
- Classify programming languages.
- Define language translators
- Define linker-loader
- Define subroutines and library functions
- Describe some high level languages.
- Describe some visual languages.

U N I T S T R U C T U R E

8.1 INTRODUCTION

Language is the main tool of communication among people. Languages like English, Hindi, Punjabi, Marathi, etc., which we use to communicate with each other are known as general language in India. Each language uses its own constructs and rules for word formation known as semantic rules. Words themselves cannot communicate the full meaning until joined together to form sentences or statements under certain syntax rules. Similarly, in order to communicate with the computer, we use programming languages. These programming languages are used to communicate instructions and commands of a user-written program to the computer to accomplish the tasks assigned by the program. Learning a programming language means learning the syntactic and semantic rules and other various constructs and structures of the language.

In this chapter, we will study about the evolution and generation of languages, why we need to learn different languages, how the programs are interpreted and implemented in the computer, etc. This knowledge will help us in selecting the languages according to our work and choice.

8.2 COMPUTER PROGRAMMING LANGUAGES

A computer, being an electronic device, cannot understand instructions if provided in a general language. Therefore, a special language is used to provide instructions to a computer system. This language is known as computer programming language. It consists of a set of symbols and characters, words and grammar rules that permit the user to construct instructions in the format that can be understood and acted upon by the computer system. A major goal of computer scientists is to develop computer system which can accept instructions in normal human language – known as Natural Language Processor.

8.3 GENERATIONS OF PROGRAMMING LANGUAGES

The term 'generation' of computer languages is used to categorize the generic enhancements in various computer languages. It shows the step-by-step evolution of programming languages. Each generation indicates significant progress towards making computers easier to use. Computer languages by generation are classified as follows:

- First Generation (late 1940s)

  e.g. machine language

- Second Generation (early 1950s)

  e.g. assembly language

- Third Generation (late 1950s through 1970s)

  e.g. high level language

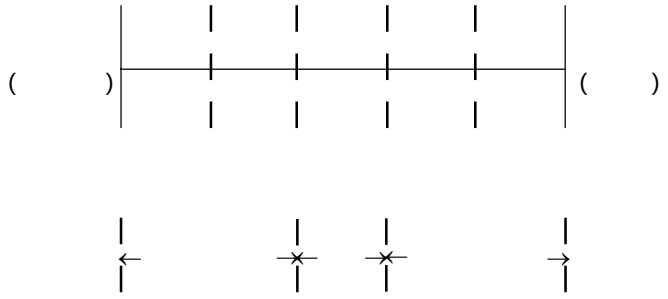
- Fourth Generation (late 1970 onwards)

  includes a whole range of query languages and other tools.

8.4 CLASSIFICATION OF PROGRAMMING LANGUAGES

Computer programming languages can be classified into two major categories:

- Low Level
- High Level



Low Level Languages

The languages which use only primitive operations of the computer are known as low level languages. In these languages, programs are written by means of the memory and registers available on the computer. As we all know that the architecture of computer differs from one machine to another, so for each type of computer there is a separate low level programming language. In the other words, Programs written in one low level language of one machine can't be ported on any other machine due to architectural changes. Because of this, low level languages are known as machine dependent languages. Examples are Machine Language and Assembly Language.

Machine Language

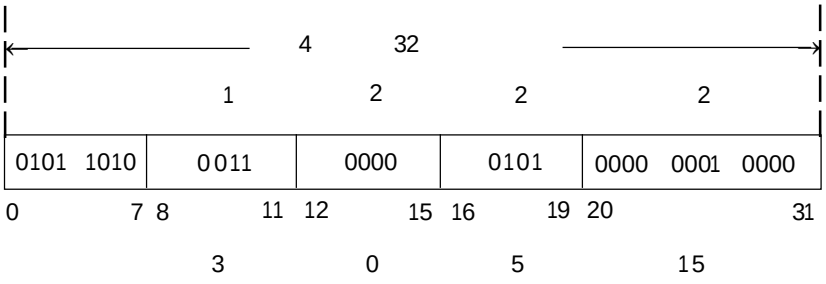
In machine language programs, the computation is based on binary numbers. All the instructions including operations, registers, data and memory locations are given in there binary equivalent.

The machine directly understands this language by virtue of its circuitry design so these programs are directly executable on the computer without any translations This makes the program execution very fast. Machine languages are also known as first generation languages. A typical low level instruction consists essentially of two parts:

- An Operation Part : Specifies operation to be performed by the computer, also known as Opcode.
- An Address Part : Specifies location of the data on which operation is to be performed.

Machine Language Instruction

There are several types of machine instructions for performing a variety of tasks. For example, one group of machine language instructions known as "RX" type, are designed to perform operations on two operands or variables. First is stored in one of the CPU registers and the other is stored in the internal memory.



This instruction requires computer to add the contents of a particular storage location (which can be calculated from values of X2, B2 and D2) to the contents of register R1. The result will be stored in register R1 and will overwrite whatever was stored there. The address part of the instruction is known as the 'operand' and it specifies to the computer where to find or store the data that are to be manipulated.

Writing programs in machine language is a tedious task since it is very difficult for humans to remember binary codes of all the operations. The number of bits in the operation part determines the number of possible unique instructions that can be framed for a computer to execute. The number of bits in the address part determines the number of directly addressable, unique storage locations in internal memory of the computer.

Advantages

Machine language makes most efficient use of computer system resources like storage, registers, etc. The instructions of a machine language program are directly executable so there is no need of translators. Machine language instructions can be used to manipulate the individual bits in a computer system with a very high execution speed due to direct manipulation of memory and registers.

Drawbacks

Machine languages are machine dependent and, therefore, programs are not portable from one computer to the other. Programming in machine language usually results in poor programmer productivity. Machine languages require programmers to control the use of each register in the computer's Arithmetic Logic Unit and computer storage locations must be addressed directly, not symbolically. Machine language requires a high level of programming skill which increases programmer training costs. Programs written in machine language are more error prone and difficult to debug because it is very difficult to remember all binary equivalent of register, opcode, memory locations, etc. Program size is comparatively very big due to non-use of reusable codes and use of very basic operations to do a complex computation.

Assembly Language

Assembly languages are also known as second generation languages. These languages substitute alphabetic or numeric symbols for the binary codes of machine language. That is, we can use mnemonics for all opcodes, registers and for the memory locations which provide us the more readable form of the program. These languages also provide us with a facility to write reusable code in the form of macros. Macros has two parts, one is macro name and the other is macro body which contains the line of instructions. A macro can be called at any point of the program by its name to use the instructions given in the macro repetitively.

These languages require a translator known as 'Assembler' for translating the program code written in assembly language to machine language. Because computer can interpret only the machine code instructions, once the translation is completed the program can be executed. A typical assembly language instruction consists of four components:

- A name or label field
- An operation code (Opcode)
- An operand
- A comment field (separated by ; (semicolon) from the executable part of the instruction).

A name or label field is optional. It is used to mark a place in a program to which computer control can be transferred. An operation code specifies to the control unit what processing tasks to perform and the operand field identifies the location of data item in primary memory. The comment field enables a programmer to write relevant notes and thereby improve the program documentation. This field is optional. In assembly language, symbols are used rather than absolute addresses, to represent memory locations, e.g. hexadecimal value can be used to represent the memory location of the data in a statement. For example, 2AH for hexadecimal where 2A represents some memory location. Similarly BX and CX can be used to represent B register and C register of the computer's ALU respectively. Mnemonics are used for operation code, i.e. short abbreviations that help programmers remember what the codes represent.

Advantages

Assembly languages provide optimal use of computer resources like registers and memory because of direct use of these resources within the programs. Assembly language is easier to use than

machine language because there is no need to remember or calculate the binary equivalents for opcode and registers. An assembler is useful for detecting programming errors. Assembly language encourages modular programming which provides the facility of reusable code, using macro.

Drawbacks

Assembly language programs are not directly executable due to the need of translation. Also, these languages are machine dependent and, therefore, not portable from one machine to another. Programming in assembly language requires a high level of programming skills and knowledge of computer architecture of the particular machine.

Student Activity 1

1. What are computer programming languages?
2. Which language is understandable by the computer? Define it.
3. What are the advantages and drawbacks of machine language?
4. Define assembly language.
5. What are the advantages and drawbacks of assembly language?

High Level Languages (HLL)

All high level languages are procedure-oriented languages and are intended to be machine independent. Programs are written in statements akin to English language, a great advancement over mnemonics of assembly language. That is, the high level languages use natural language like structures. These languages require translators (compilers and interpreters) for translating high level language programs into machine language programs for execution. The programs written in a high level language can be ported on any computer, that is why known they are known as machine independent. The early high level languages come in third generation of languages, e.g. COBOL, FORTRAN, PASCAL, BASIC, APL, etc.

These languages enable the programmer to write instructions using English words and familiar mathematical symbols which makes it easier for programmers to concentrate on the logic of problem-solving rather than technical details of the computer. It makes the programs more readable too.

Procedures

Procedures are the reusable code which can be called at any point of the program. Each procedure is defined by a name and set of instructions accomplishing a particular task. The procedure can be called by its name with the list of required parameters which should pass to that procedure.

Advantages

These languages are easier to learn than assembly languages and less time is required to write programs in HLL. They also provide better documentation and have an extensive vocabulary. Libraries of subroutines can be incorporated and used in many other programs, saving time and effort. Programs written in high level languages are easier to debug because translators display all the errors with proper error messages at the time of translation. Due to the use of natural language like structure and procedures, the programs of HLL are more readable. Also, these programs are largely machine independent. Therefore, programs developed on one computer can run on other computers also with slight or no modifications.

Compiler Based and Interpreter Based Language

A program written in HLL (source program) needs to be translated into its equivalent machine code (object program) before it can be run. Depending upon the relationship between the language translation process and its execution, HLL can be characterised as

- Compiler-Oriented Language
- Interpreter-Oriented Language

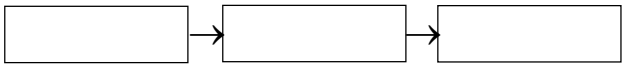
Compiler-oriented language is one in which the entire source program is analyzed and translated into equivalent machine code before it is executed. Whereas interpreter-oriented language is one in which as soon as one source code instruction is translated into its equivalent machine code, the instruction is immediately executed. Thus the language translation software, whether compiler or interpreter, takes as its input, source program written in HLL and produces equivalent machine code or object program as output.

8.5 TRANSLATOR

Programs which convert a source code in any other language 'mostly machine code' are called translator programs. Every high level language and assembly language uses a translator to translate its program. Translated programs are directly executable because they are in machine language (i.e. binary language) which is directly understandable by any computer.

"A translator is a program that takes as input a program written in one programming language (e.g. a high level language) known as source language and produces as output a program in another language (machine language) known as target language."

Compiler

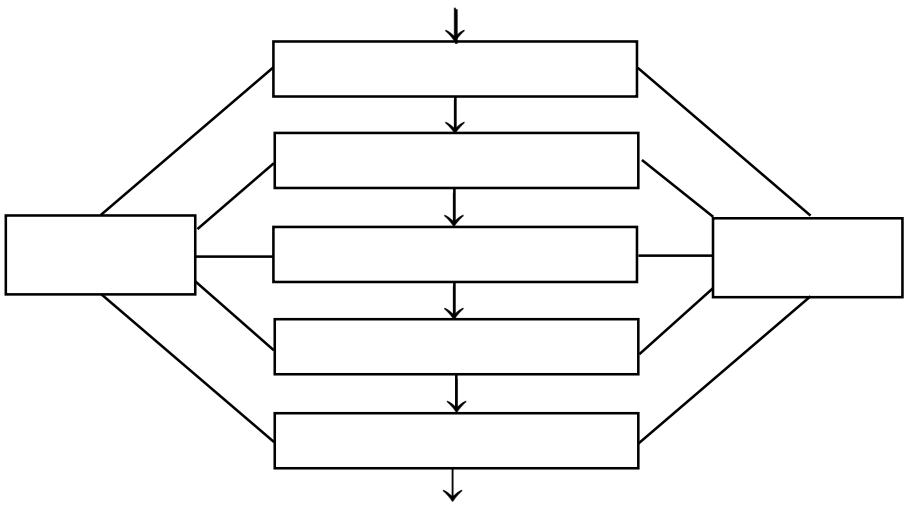


Compilation Process

Compilers are programs which translate the high level procedural language programs into machine instructions. Compiler goes through a series of steps to examine and modify source code during the compilation process. Each source code instruction typically gives a list to several machine code instructions.

"Compiler is a program which takes as input a program of a high level language and produces object program in machine code".

The steps taken by a compiler to compile a high level program into machine language are:



Phases of Compilers

Lexical Analyzer

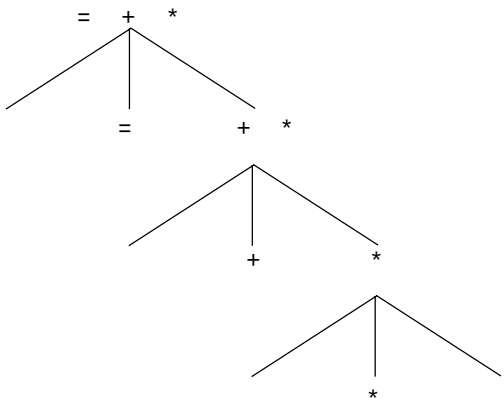
Lexical analyzer separates characters of the source program into groups which logically belong together. These character groups are called tokens which can be a keyword, variable name, operator such as +, -, >, etc., punctuation marks like (,), ", Comma (,), etc., which in isolation

provide very little meaning. For example, the plus (+) symbol shows addition but doesn't show the addition of what.

The output of lexical analyzer is a stream of these tokens which are just like the words of a language. This phase checks for error in token formation and if found any, pass it to the error handling section and then, pass the token stream to the next phase of the syntax analysis.

Syntax Analysis

The syntax analyzer groups tokens together to form a set of expressions based on the grammatic rules of the programming language. Expressions can be used further to form a statement. The syntactic structure can be represented as a tree whose leafs are tokens. The upper levels of the tree represent strings of tokens logically being together to form expressions and top of the tree (root) represents the statement.



Here A, =, B, +, C, *, E represent the leafs, C* E and B+C*E represents expressions and A = B+C*E represents a statement.

If any syntax problem occurs according to the grammar rules of the language, it is sent to the error handling phase. Then the code is passed to the next phase which is intermediate code generation.

Intermediate Code Generation

This phase uses the structures provided by the syntax analyzer and breaks them into simple instructions which can further be easily translated in machine language program. These instructions are further transferred to the code optimization or to the code generation phase if the code optimization phase is not present.

Code Optimization

Code optimization is an optional phase. It provides the facility to improve the intermediate code in such form that it provides for fast execution of the program and takes less space. The output of this phase is another intermediate code which is passed to the code generation phase.

Code Generation

This phase takes responsibility of converting the intermediate code generated by the previous phase into the machine language code known as object program or target program.

Table Management

Table management phase collects all the information of each phase, for example, what variables and intermediate variable it uses, what are the type of each variable and what data structures are used. All this information is stored for further use in a data structure known as 'symbol table'.

Error Handling

Error handling is invoked when a flaw in the source program is detected. It collects information of each error in every phase and warns the programmer by issuing error code and error information

by diagnosing them. The compilation should be completed on the entire program so that maximum possible errors can be detected in one compilation. It is also supposed to see that, if an error occurs due to the error in a previous line, it should be suspended. Table management and error handling phases interact with all the compilation phases.

Interpreter

An interpreter is the language translator for the third generation programming languages. Rather than generating object code for the entire source code, this class of translators examines and executes source code on a line by line basis. Each line of source code is scanned, parsed, translated and executed before moving on to the next line.

"Interpreter is smaller than compiler and facilitates the implementation of complex programming language construct by translating, interpreting and executing each line one by one."

Assembler

Computer hardware is capable of executing an instruction only when it is presented to it in machine language. Therefore, any instruction to the computer in any language other than machine language has to be first translated into machine language instruction before it can be executed. A program written in assembly language has to be first converted into its corresponding machine code before it can be executed. The translation or code conversion is performed by the computer itself using a specialized software called Assembler.

An assembler takes a program written in assembly language as input (known as source program) and generates its equivalent machine language code (known as object program) as output. During the process of translation, if any grammatical or logical errors are detected, these are suggested to user so that correction can take place before the final code conversion.

Interpreter vs Compiler

8.6 LINKER/LOADER

Just because a source code has been translated into object module does not mean that it is ready for execution. An important task still to be handled is that of memory address assignment to various parts of the program. A linker or a linkage editor is a software that converts the object code into a load module that can be placed in memory and run by assigning memory address to various parts of the program. Some systems use a software called loader to bypass the step of creating a loadable module and place the object module directly into memory for execution.

Binding Time

Binding time is the time when final memory locations are determined and assigned to various components of a program. There are several approaches regarding the choice of binding time.

- The first approach is to bind at the time when the program is written. This is extremely inflexible and limiting. This is known as "early binding".
- A slightly better approach is to bind at the time of translation. This permits source programs and symbolic data locations to be modified. However, once the program is translated, it can run from a single location in memory.
- A third and the most preferred option is to bind when the program is loaded into memory. This allows the program to be placed in any available memory location. However, once the program is in memory, it can't be moved or relocated.

Student Activity 2

1. What are high level languages? Name some HLLs.
2. Define a procedure. What are the advantages of a procedure?
3. What is a translator?
4. What is a compiler? Describe its working.
5. Define interpreter.
6. What is the function of syntax Analyzer?
7. Define linker and loader.
8. What is binding time?

8.7 SUBROUTINES

Subroutines, also, known as procedure, are written in such a way that they can be brought into use in other programs. They can be used within a program wherever it is needed and normally invoked through "DO" or "CALL" statements, which are written with the subroutine name. Required parameters should be passed to the subroutine for calculation purposes.

8.8 LIBRARY FUNCTIONS

Most of the programming languages come with the library of small subroutines or functions which can be used by the programmer to accomplish some tasks without creating a code for them. A library function can be called, just like other subroutines, by any program, which is including the particular library file having that procedure or subroutine to accomplish some routine tasks like sin, cos, square, square root, absolute value, etc.

Introduction of Some High Level Languages

FORTRAN: Formula Translation

FORTRAN was Developed by IBM in 1957. It is very suitable for expressing formulae, solving equations and performing iterative calculations. FORTRAN is oriented toward solving problems of a mathematical nature and has been designed as an algebra-based programming language. It is one of the oldest and most widely used high level language.

- FORTRAN I (1957)
- FORTRAN II (1958)
- FORTRAN IV (1962)
- FORTRAN 77 (1977)

It is mostly used by scientists and engineers because this language has huge libraries of engineering and scientific functions.

COBOL: Common Business-Oriented Language

COBOL was designed specifically for business data processing so that the processed output could have the appearance and structure of a business report written in English. Thus it is constructed from sentences, paragraphs, sections and divisions.

All COBOL programs must have four divisions, namely, the Identification Division, the Environment Division, the Data Division, and the Procedure Division. It is not oriented to real-time data processing. It takes inputs, stores them in a file and produces the output as a separate module.

BASIC: Beginner's All-Purpose Symbolic Instruction Code

BASIC was developed by John Kemeny and Thomas Karthy at Dartmouth College, USA. Interpreter is used to translate BASIC instructions into machine language code. It is a very simple and versatile language and can be used for different types of tasks like data file handling, graphics, games, etc. The various versions of BASIC language are:

- MS-BASIC
- QBASIC
- BASICA
- GW BASIC

Advantages

- Widely known and accepted programming language and easy to use.
- Uses English sentence like structures for instructions.
- Almost always coded in a real-time, conversational mode.
- Good error diagnostics.

Disadvantages

- Minimal language standards. As a result of this there are many versions of basic language.
- Not self-structuring or self-documenting.

PASCAL

PASCAL was Developed in 1968 by a swiss named Nikalus With and named after the french inventor Blaise Pascal. PASCAL was the first structured programming language which was designed to force us to look at a problem in a logical way. It was used for both scientific and file processing applications and was standardized by ANSI in 1983.

ALGOL: Algorithmic Language

ALGOL is an algebraic, high-level language similar to FORTRAN. It was designed by an international group of mathematicians and was first introduced in 1958. It is a modular language that is well suited for use in structured programming settings. It was primarily designed as a way of expressing algorithms.

PL/I: Programming Language/I

PL/I is a very versatile and powerful language developed by IBM. It was oriented towards applications which require both complex calculations and processing of large amount of data.

RPG: Report Program Generator

RPG was developed by IBM in 1969. It is an important business oriented programming language and primarily used for preparing written reports.

Advantages

- Problem oriented
- Limited programming skills required
- Easy to learn and use

APL: A Programming Language

APL was developed by Dr. Kenneth Inversion at IBM. It is a convenient, interactive programming language suitable for expressing complex, mathematical expressions in compact formats. It is a real-time language developed primarily for scientific purpose. It requires a special terminal for use and is usually used in an interpretive and interactive manner.

LOGO

It was developed in late 1960s by Segmour Paper at MIT and used in universities for serious scientific work. LOGO is also used as the first educational language that children can use to achieve intellectual growth and develop problem-solving skills. It has easy-to-learn graphics feature.

LISP: List Processing

LISP was developed in 1960 by Professor John Mc. Karthy. It is suitable for non-numeric applications and widely used in artificial intelligence projects. It is a functional language, i.e. each instruction is defined in LISP as a function.

PROLOG: Programming In Logic

PROLOG was designed for handling complex logical operations. The language is being used to design intelligent computer systems. LISP and PROLOG are the primary languages used in artificial intelligence research and applications for simulation of games.

Student Activity 3

1. What are subroutines?
2. What are library functions?
3. Define the following high level languages:

   (a) FORTRAN (b) COBOL (C) BASIC

   (D) ALGOL (E) PASCAL (F) RPG

   (G) LOGO (H) LISP (I) PROLOG
4. What are the advantages and disadvantages of BASIC?
5. What are the advantages of RPG?

8.9 PROGRAM AND PROGRAMMING

A computer cannot think or make decisions and judgements on its own. It cannot analyze or compute data itself by using its own methods of computation. Computer is just like an obedient servant who will only perform the instructed work.

A program is a set of instructions that are arranged in a sequence to guide the computer in what steps should be taken and how they can be computed in order to solve a problem. Writing programs is known as programming.

Why we Learn Programming Language

There are hundreds of programming languages available but we use only a few languages because it is a very tedious task to learn all of them. But in most cases, programmers are supposed to know at least about the features of many different programming languages and then decide which

language suits them the most for their work. The reasons why programming languages studied are:

- To improve the ability to develop the effective algorithms and making use of programming language features. Improper use of the programming language can cause logical errors. Solving these errors is a very time-consuming and difficult task because syntax errors can be detected by compilers but not logical errors.
- Improve programming capabilities by being able to select more suitable languages.
- It is easier to learn a new programming language, if we know the basic construct and features of different programming languages.

Programming Concepts

As we all know that programs are a sequence of instructions which tell a computer what to do and how to do it. Making programs for complex problems is a very tedious task and requires expertises and deep knowledge of the programming language with some basic concept of programming technique. Programming is a step-by-step process which involves:

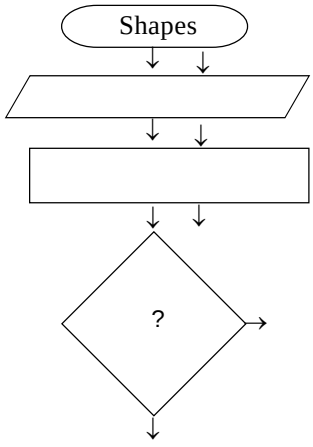
- Study of the problem.
- Breaking big and complex problems into small and easily understandable forms.
- Define inputs for each problem.
- Define outputs required for each problem.
- Define processes that are required to get desired output.
- Define the steps involved in each process.
- Develop algorithms for each process.
- Draw flow charts using algorithms.
- Write the program and subroutines according to the flow charts.

Algorithm

An algorithm is a step-by-step representation of a solution to a problem in a finite set of instructions and their iterations. That is, the solution of a problem in an algorithm should be defined in a way that it should be solved by a finite number of steps. The first statement is start and the last statement is stop. Every stop is given a unique number in sequence.

Flow Chart

Flow chart is a diagrammatic, step-by-step, representation of an algorithm or solution of a problem using different types of geometrical shapes.



Meaning

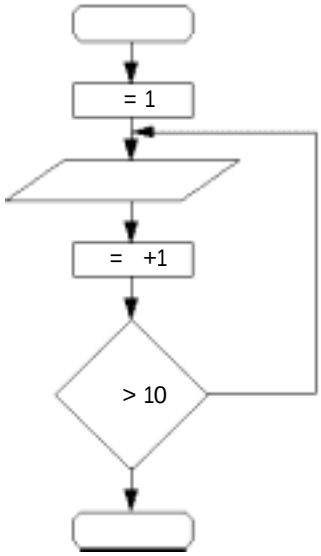
Start and End Box

Input and Output Box

Process Box

Condition Check Box

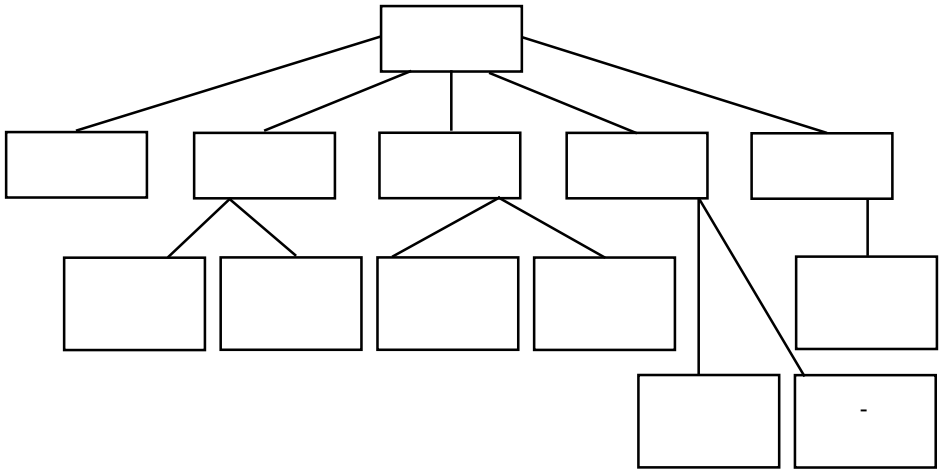
For example, the flow chart of printing 1 to 10 numbers can be represented as:



Top Down Approach

Most high level languages are procedure-oriented languages. A procedure is a set of instructions which can be called anywhere in the program. We can break a complex problem into several less complex problems which can be further divided into smaller problems and so on. Small and less complex tasks can easily be handled in terms of making procedures for them which are collectively used for solving the main problem.

The hierarchy of procedures involved in a program can be shown in the form of a tree where each upper level procedure can call the procedures from its lower level. For example, if we see the organizational structure of a company, the information system of the company can be broken down as shown.



Information System Hierarchy of an Organization

Student Activity 4

1. What is a program?
2. Why do we learn programming language?
3. What is an algorithm?
4. Define a flow chart.
5. Define a procedure.
6. Describe the top-down approach in programming.

8.10 FOURTH GENERATION LANGUAGES (4GLS)

Fourth generation languages (4GLs) are a class of software designed to simplify the task of developing a new application by making the user interface similar to natural languages. These are very easy to use languages. Some 4GLs are designed to improve the productivity of programming professionals while others are designed to be used directly by the end user.

4GLs are designed more for specification of what tasks to be accomplished as compared to third generation procedural languages which focus on how to solve a problem. These languages are developed for the purpose of making database management more efficient and is also known as database management systems. Database Management System (DBMS) is a concept to construct, organize and manipulate a large set of data in a best possible way.

Example:

- Suppose personal details of all employees are stored in a file called Employee Master File. It is required to display all the information about a particular employee, say, David.
- To accomplish the task using procedural (third generation) language, the programmer would have to write a series of instructions as follows:

  Step 1 Get a record from the employee master file.

  Step 2 Check if the record belongs to employee name "David".

  Step 3 If the answer for step 2 is "Yes", display details.

  Step 4 Otherwise, go to step 1.
- In 4GLs the task could be accomplished by giving a single instruction as follows:

  Display all for employee name = "David" from employee master file.

Many fourth generation languages either incorporate a query language or support a standard query language like SQL, which can be used to interact with the database.

e.g.: SQL statement for the above illustration will be:

[Select * from employee_master where emp_name = "David".]

NOTE: * means all the fields of record.

Advantages

- Easy to use; little or no computer knowledge is required.
- Machine independent.
- Enhanced programming productivity.
- Ease of modification and maintenance of data.
- Good documentation.

Disadvantages

- 4GL programs are less efficient from the computer resource utilization point of view.
- Programmers become less skilled over a period of time.
- Security standards are difficult to enforce in 4GL environment.

Popular 4GLs

The organization storage and management of ever-increasing quantity of information is a major problem facing modern organizations. A number of 4GL tools have been developed to address this problem efficiently. Using popular 4GL packages, users can store vast quantities of data on

the computer which can be retrieved easily either individually or organized in the form of various reports. In this section, we are going to highlight major features of some of the most widely used 4GLs.

dBase

Dbase-III plus (or later versions) is a database management system designed for use on microcomputers in DOS operating system environment. It has been developed by Ashton-Tate Inc. (USA). A maximum of 15 files can be used at a time. In dbase III+five types of data fields are permissible.

	Field type	Code	Size	
1.	Character	(C)	255	
2.	Numeric	(N)	19	in which last 9 digits are for fractions
3.	Date	(D)	8	it is taken by system automatically
4.	Memo	(M)		
5.	Logical	(Y/N) OR (T/F)	1	

It has a series of English-like commands using which data stored in the database can be manipulated.

e.g.: Create, Append, Display, List, Edit, Browse, Replace, Delete, Sort, etc.

Following operations can be performed in dbase:

- Creation of database.
- Editing of data in the database.
- Selective access and retrieval of data from the database.
- Manipulation of data using arithmetic and logical operators.
- Programming using its command language.

Foxbase

It is a database management system similar to but more powerful than dbaseIII+. It is developed by Fox Software Inc. (USA). Foxbase is completely source code compatible with dbaseIII plus, i.e. files created in dbaseIII plus can run with Foxbase without any modifications. It is significantly faster than dbaseIII plus in execution, also it can run on a variety of hardware and operating systems environments including DOS and UNIX.

FoxPro

FoxPro is one of the leading DBMS for PCs. It is an updated and enhanced version of the Foxbase software and very simple and easy to use. It helps you design database files as per user requirements and user specified formats and helps you in creating and managing database effectively through simple built-in commands. The retrieved information can be displayed on the screen or printed as per the desired report format. Flexibility is one of the key features of FoxPro, i.e. contents and the structure of foxPro file can be changed any number of times with ease.

Focus

Focus was one of the largest selling 4GL DBMS tool, at one time, but now it is not used that widely due to a very complex structure and slow performance. The command structure of Focus was also very typical.

8.11 DATABASE ENGINES

Database Engines are program modules that provide access to the function of a Database Management System (DBMS). It is also known as database manager and is used as an interface

between the Data Manipulation Language (DML) and functions supported by the DBMS. For example, Database Engine can link two or more files together and thus can be used for developing RDBMS.

It is different from a file manager which works with only one file at a time. Usually different database management systems use different database engines, i.e. FoxPro uses WATCOM Database engine whereas MS-ACCESS uses JET Database engine.

8.12 RELATIONAL DATABASE MANAGEMENT SYSTEM (RDBMS)

RDBMS is the software that manages data in more than one file at a time in an efficient manner. The files are treated as tables with rows and columns rather than as lists of records and fields. A database application forms the back-end that stores information in two-dimensional tables linked by common properties known as key fields. SQL (Structured Query Language) is used to create, manipulate and extract data from relational databases. Following features are maintained by RDBMS:

- Data integrity
- Data independence
- Minimal redundancy (repetition) of data
- Ease of use and access

Student Activity 5

1. What are fourth generation languages?
2. What are the advantages and disadvantages of UGLS?
3. Explain any two UGLS.
4. What are database engines?
5. Define RDBMS.
6. What are the features of RDBMS?

8.13 CONCEPTS OF FRONT-END TOOLS

Front-end tools are the major components of GUI environment. They include the visual tools which form the interface with other 4GLs. Generally a Windows application presents one or more screen full of objects with which users interact to determine the flow of the program. This feature leads the procedural programming towards event-driven programming. The important tools provided by them generally include button, menu, list box, checkbox, etc.

Event driven programming provides the facility of creating events like clicking on buttons, menus, list box, etc., to accomplish tasks connected with the particular event in contrast with procedural languages where programs are executed in a sequence of instructions.

8.14 NETWORK PROGRAMMING LANGUAGES

Networking programming languages are the languages which are used to write programs which can be downloaded and executed on different computers of a network. These languages are generally 'platform independent' languages. This means that the programs written in these languages can be executed on any operating system and on any computer. The common example of such languages are Java, perl, etc.

8.15 HYPERTEXT MARK-UP LANGUAGE (HTML)

HTML is the language for creating web pages which can be seen by using any web browser like Internet Explorer, Netscape Navigator, etc. This language provides formal rules for marking text which governs its display as part of the web page. It could be used, for example, to mark text so

that it appears in boldface or italics. It also provides the facility to create links to the other sites and pages shown in the form of highlighted items known as hyperlinks.

8.16 JAVA AS PLATFORM INDEPENDENT LANGUAGE

JAVA is an object-oriented programming language developed by Sun Microsystems for writing programs for running on the internet. The programs written using JAVA can be distributed on world wide web (www) and executed on a variety of computers. Programs written in JAVA are translated by the JAVA compiler in a format called byte codes which can be executed on any computer. Programs can be developed in JAVA and the executable code can be distributed on the Internet. Anyone with a program to interpret the code can download and use the program. This feature of JAVA is known as "Architecture-Neutrality". Web pages include small application programs written in JAVA, called APPLETS, which can perform a variety of tasks like animations, sound generation, video playback and perhaps most importantly, interaction between users.

8.17 VISUAL LANGUAGES

Development of visual programming languages is one more step in the direction of making it easier for non-computer professionals to make use of computers for solving their problems. Use of visual representation makes man-computer interface more user friendly and easy to use. The term "visual programming" has been used to imply the use of graphic tools and techniques in connection with programming.

A visual programming language can be defined as a language which uses some visual representations (in addition to or in place of words and numbers like buttons, check boxes, list boxes, etc.) to accomplish what would otherwise have to be written in a traditional linear programming language. Visual programming languages utilize visual representation of two things:

- Programming constructs and various ways of combining these basic constructs to develop complex problem-solving logic, are visually presented.
- Various objects to be dealt with as part of the problem-solving process, including traditional data types such as arrays, stacks, queues, and application-oriented data types, etc., are also presented visually.

Application domains of visual programming languages includes:

- Computer Graphics
- User Interface Design
- Database Interface
- Forms Management
- Computer Aided Design

Listed below are some of the well-known visual programming languages:

1. Pygmalion
2. The Xerox Star
3. Programming by Rehearsal
4. Pitch
5. Vennlisp
6. State Transition Diagram Language
7. Pascal-HSD
8. Programming with Interactive Graphical Support (PIGS)
9. Formal

10. Query-by-Example (QBE)
11. Visual Basic (VB)
12. Visual C++ (VC++)
13. Visual Java (VJ++)

Visual Basic and Visual C++ are the most widely used visual languages in the current world but the usage of Visual Java is also growing very rapidly and it is becoming very popular due to platform independence. It is used in Internet as Network Programming Language.

8.18 VISUAL C++

Visual C++ is a highly Integrated Development Environment (IDE) that allows you to create, build and debug Windows applications faster than ever before. It also serves as a fully functional vehicle for cross platform applications development. There are two major features which account for growing popularity of C++

- The Visual C++ environment itself runs in Windows so that the full set of Windows based tools become available to create and manage projects and applications in Windows.
- The Visual C++ uses visual user interface to facilitate the task of developing new applications.

The core of the Visual C++ environment is built around three basic components

- The C/C++ Compiler and Linker
- The Developer Studio
- The Microsoft Foundation Class Library (MFC)

8.19 VJ++

Visual Java is the one of the most powerful internet products. VJ++ is a programming environment based on GUI rather than CUI. It provides integrated and workable Java tools to develop the application programs. It simplifies the process of creating Java applets and applications and adds the power of Microsoft Wizard to speed up Java application development. It is useful in both Internet application development as well as in stand alone application.

Visual BASIC

Visual BASIC is a full-featured, very high level programming language. Visual refers to the way in which you develop an application's user interface. You "draw" windows, buttons, text boxes, scroll bars and other components of the user interface. BASIC refers to the type of programming code you write; the familiar BASIC language code.

Visual BASIC is the software development environment that enables you to develop Windows applications quickly and easily. Using Visual BASIC, you develop "event-driven", rather than "procedural" programs.

In a procedural program, the program itself determines which portions of the code are to be executed and when. In an event-driven program, events (i.e. user actions such as a mouse click, or system events such as the passage of a specified amount of time) determine which portions of the code are to be executed and when. Program execution depends on which and when events occur.

Advantages of Visual Languages

In general, people prefer pictures over words as they are a more powerful means of communication– they convey large information more concisely and more clearly. Pictures are easily understood by people regardless of what language they speak. It facilitates and encourages end user participation in system development.

Student Activity 6

1. What do you mean by front end tools?
2. Define HTML.
3. What is Java? Why is it called platform independent language?
4. What are visual languages? List its application domains.
5. Name some visual languages.
6. Write short note on:
   (a) Visual C++
   (b) Visual Basic
7. What are the advantages of visual languages?

8.20 SUMMARY

- Programming languages provide us with the facility to implement our own algorithms to utilize computer resources as we like and develop the outputs of our choice. There are two type of programming languages available; low level languages and high level languages. Low level languages are of two types – machine languages and assembly languages.
- Machine languages are the first generation languages. They use machine level instructions (i.e., binary number instructions) which are directly understandable to computers.
- Assembly languages use mnemonics for the opcode, memory locations and registers for calculations. Programs written in assembly language are translated in machine code using a translator known as assembler.
- High level languages provide us with an English like structure to develop our programs. These languages use interpreter or compiler to translate the code. The interpreters translate programs line by line.
- The compiler translates the complete code simultaneously and generates machine level object codes which are non-executable until loaded into the memory. This task is done by linkers or loaders. Linkers attach a code to the object code to tell where and how the program will be loaded in memory and executed.
- Fourth generation languages are basically used for database management and provide the facility to do our work in terms of telling the system what to perform rather than how to perform.

8.21 KEYWORDS

Machine language: The lowest level programming language, using binary digits, which is the only language the CPU understand; represents the first generation of programming language.

Assembly language: A lower-level programming language that is slightly more user-friendly than machine language; represents the second generation of programming language.

Assembler: System software that translates assembly language into machine language.

High level language: Computer language is which each statement is translated into many machine language statements.

Procedures: The strategies, policies, methods and rules for using an information system.

Compiler: A software program that translates a high-level language program to object code.

Interpreter: A compiler that translates and executes one source program statement at a time.

Linker: A software that converts the object code into a load module that can be placed in memory and run by assigning address to various parts of the program.

Loader: A software used to by-pass the step of creating a loadable module and place the object module directly into memory for execution.

High-level languages: The programming languages that enable the programmer to write instructions using English words and mathematical symbols.

Binding time: The time when final memory locations are determined and assigned to various components of a computer.

Data Engines: Program modules that provide access to the function of a database management system.

Relational database management system (RDBMS): The software that manages data in more than one file at a time in an efficient manner.

Hypertext mark-up language (HTML): The language used for creating web pages which can be seen using any web browser.

Visual language: A programming language which uses visual representations to accomplish what would otherwise have to be written in a traditional linear programming language.

8.22 REVIEW QUESTIONS

Fill in the Blanks

1. Database engines are _____ that provide access to the _____ of DBMS.
2. Front end tools are the major components of _____ .
3. Networking languages are generally known as _____ languages.
4. Many programming languages come with the library of small _____ or _____ used to accomplish some basic tasks.
5. Interpreters interpret programs _____ .

Multiple Choice

1. Lexical Analyzer is used for
   a. Error handling
   b. Syntactic error analysis
   c. Semantic error analysis
   d. None of the above
2. COBOL is a
   Low level language
   b. Assembly language
   c. Machine language
   d. Procedural language
3. Translators are used for
   a. Intermediate code generation
   b. Table management
   c. Code Optimization
   d. None of the above
4. Linkers are used for
   a. Generation of code for loading sequence of programs
   b. Interpretation of program
   c. Compilation of high level language
   d. None of the above
5. ALGOL was developed in
   a 1979
   b. 1958
   c 1969
   d. 1960

6. 4GLs are
   a. Front end tools
   b. Procedural languages
   c. Used for describing how to perform a task
   d. Used for describing what to perform.

Descriptive Questions

1. What do you understand by programming? Describe the features of programming languages.
2. Write down the classification and generation of programming languages with examples.
3. What is a low level language? Describe in detail.
4. Write down the programming concepts of procedural languages.
5. Differentiate between
   a. Compiler and Interpreter
   b. Low Level Language and High Level Language
   c. Assembler and Compiler
   d. Linker and Loader
   e. 4th Generation and 2nd Generation Languages
6. Write short notes on
   a. Syntax analyzer
   b. Code optimization
   c. Code generation
   d. Table management
   e. Visual programming languages
   f. Visual basic

Answers to Review Questions

Fill in the Blanks

1. Program modules, function 2. GVI environment
3. Platform independent
4. Subroutines, functions
5. line by line.

Multiple Choice

1. (a) 2. (d) 3. (a) 4. (a) 5. (b) 6. (d)

8.23 FURTHER READINGS

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

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

Operating System

UNIT

9

OPERATING SYSTEM: CONCEPTS AND COMPONENTS

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Define system software.
- Define operating system and its various types.
- Describe the evolution of operating system.
- Describe various functions of operating system.
- Describe memory management, device management and information management functions.

U N I T S T R U C T U R E

9.1 INTRODUCTION

An operating system (OS) is a system software which may be viewed as an organized collection of softwares consisting of procedures for operating a computer and providing an environment for execution of program. It acts as an interface between user and hardware of the computer system.

There are many important aspects for studying OS, such as:

- OS is primary interface between user and computer.
- It helps us to understand the inner functions of a computer system very closely.
- Many concepts and techniques found in operating systems have general applicability in other applications.

The introductory concepts and principles of an operating system will be the main issues for the discussion in this unit.

9.2 FUNCTIONS OF AN OPERATING SYSTEM

An operating system must perform at least the following functions in order to enable the computer to process user programs satisfactorily.

- ***Processor Management:*** Is concerned with allocating CPU to various competing jobs/ processes to ensure maximum output from the system.
- ***Input/Output or Device Management:*** Refers to **c**oordination and control of various I/O devices and is an important function of the operating system. This involves receiving the request for I/O interrupts and communicating back to the requesting process.
- ***Memory Management:*** OS allocates memory to itself and its resident system programs, sets aside areas for application program and user partition, arranges the I/O buffers and reserves storage for specialized purposes.
- ***File Management or Information Management:*** Computers use a lot of data/programs which are stored on secondary storage devices. File management function of an OS involves keeping track of all different files and maintaining the integrity of data stored in the files including file directory structure.
- ***Job Control:*** When the user wants to run an application program, he must communicate with the OS, telling it what to do. He does this using OS's job control language or JCL. JCL consists of a number of OS commands, called system commands, that control the functioning of the operating system.
- ***House Keeping:*** Includes all the support services necessary to ensure smooth operation of the computer system, viz., security, protection, and resource accounting, back-up and restoration, etc.

OS as a Resource Manager for four major resources.

	Resource	Examples	Examples S/W to Accomplish Task
1.	Memory	Core (Main)	Memory Management, paging
2.	Processors	CPU, I/O channels	Traffic controller, scheduler
3.	Devices	Tapes, drums, card punch	Spooling
4.	Information	Segment (system user)	File System, Library

9.3 OPERATING SYSTEM AS A PROCESS MANAGER

The concept of a process, which was first used by the designers of Multics, is an essential part of the theory and practice of modern operating system. A process is basically a program in execution, i.e., it is a running program with some specific task to do. A question arises here – why can we not refer to 'programs' running in the system? The difference between these two is very marginal. A program is a passive entity whereas a process in an active entity. The key idea about process is that it is an activity of some kind and consists of a pattern of bytes (that the CPU interprets as machine instruction, data, register and stack).

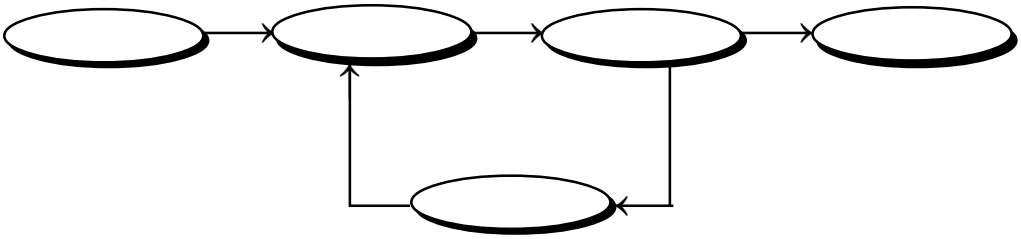
A processor is a hardware device that is capable of executing a sequence of instructions. To attain increased throughput, multiprogramming must be employed. Throughput refers to the amount of work completed in a unit of time. Multiprogramming is the interleaved execution of two or more processes by a processor.

Process State

A process may be in one of the following states:

- **New:** The process has been created.
- **Ready:** When all conditions are satisfied for the process to be in running state and it is waiting for processing.

- ***Running:*** When the instructions of process are being executed by a processor.



Process State Diagram

- ***Blocked:*** When a process is waiting for an event to occur before continuing execution.
- ***Terminate:*** When process finally stops, i.e. finishes executing its last statement.

Operating system plays an important role in managing all processes by:

- Keeping track of the status of each process.
- Selecting processes from the ready-list to be run.
- Suspending a running process when it runs out of allotted time.
- Coordinating interprocess communication.

Processor Management

Processor management is concerned with the assignment of processor to processes.

- ***The Job Scheduler:*** It schedules the processes and, in a non-multiprogrammed environment, would decide which process is to use the processor.
- ***The Processor Scheduler:*** This, in a multiprogramming environment, decides which of the ready processes receives the processor, at what time, and for how long.
- ***The Traffic Controller:*** This keeps track of the status of the process. (All processes are either running, ready for execution, or blocked).

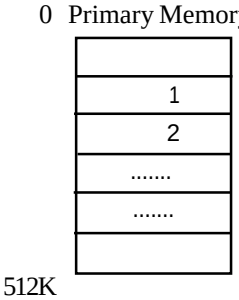
Multiprogramming

We know that to increase the throughput, multiprogramming must be employed. Multiprogramming refers to the situation in which a single CPU divides its time between more than one job. It is term given to a system that may have several processes in "states of execution" at the same time. Multiprogramming increases CPU utilization by organizing jobs when CPU becomes less idle, waiting for input, output or data transfer operations to be completed. More is the number of programs competing for resources, better will be resource utilization. In this manner multiprogramming increases the over all performance of the system.

Memory Layout for a Multiprogramming System

The idea is implemented as follows:

With multiprogramming, several jobs are resident in the main memory at any given time. The CPU is shared back and forth among them to increase CPU utilization and to decrease the total time needed to execute the jobs.



NOTE Multiprogramming OS usually supports multiple users in which case they are also called multiuser systems.

Student Activity 1

1. What is an operating system.?
2. What are the functions of an operating system?
3. What is the difference between a program and a process?
4. What are the various states of a process?
5. What is the function of processor management?
6. What is multiprogramming?
7. Describe the memory layout for a multiprogramming system.

Multitasking

The term multitasking is described as that which runs or appears to run more than one application program at one time. An effective multitasking environment must provide services both to user and to the application program it runs.

In multitasking, a single program or job is separated into two or more tasks which can be executed in parallel, each using a different part of the computer system. Multiple jobs are executed by the CPU switching between them, but the switches occur so fast that each user feels that he/she alone is using the system.

Time-sharing

Time-sharing refers to the allocation of computer resources in a time-dependent fashion to several programs simultaneously. It provides a large number of users with direct with access to the computer.

Each user is provided with separate terminals and CPU time is divided among all users on a scheduled basis. Hence it provides all user programs a brief share of CPU time. The short period of time during which a user gets attention of the CPU is known as 'Time Slice'.

Time-shared systems were developed to provide interactive use of computer system at a reasonable cost. A time-shared OS uses CPU scheduling and multiprogramming to provide each user with a small time slice of a time-shared computer. In such systems each user has, at least, one separate program in memory, e.g. one task might be using ALU while another task might be using I/O devices.

Time-sharing systems operate in an interactive mode with quick response time. In this approach programs are executed with rotating priority that increases during waiting and drops after service is granted.

Multiprocessing

Multiprocessing refers to simultaneous execution of two or more processes by a multiple, processor computer system. Additional processors are added to the system to enhance the throughput. The additional processor can be an Input-Output Processor (IOP) or a CPU. Generally, multiprocessing system is defined by a system having more than one CPU.

Parallelism

Traditionally, the computer has been viewed as a sequential device. Each instruction is executed in a sequence of operations (fetch instruction, fetch operands, perform operation, store result). Such a system is a single processor system. However, the trend today is towards multiprocessor system, i.e. systems with more than one processor.

Parallel processing refers to systems with more than one processor working simultaneously under a single, central control unit. It is based on the premise that many operations can be broken

into sub-operations and it may be feasible to work on several sub-operations simultaneously. The purpose is to speed up the computer processing capability and increase its throughput. Weather forecasting is an application where parallel processing happens.

Protection

Protection refers to the mechanism used for controlling the access of programs, processes, or users to the resources defined by a computer system. It ensures that the file, memory segments, CPU and other resources can be operated by only those processes that have proper authorization from the OS. Protection has evolved to increase the reliability of any computer system that makes use of shared resources.

Protection is used to prevent mischievous, intentional violation of an access restriction by a user. It ensures that each program component active in a system uses system resources only in a way consistent with the stated policies for the users of those resources. So protection improves reliability by detecting latent errors at the interfaces between component subsystems.

Job Scheduling

Scheduling refers to a set of policies and mechanism supported by an operating system that controls the order in which the work to be done is completed. In multiprogramming, systems the operating system schedules the loading and execution operations of programs. It is done in order to provide a continuous job processing sequence or to provide response to all events.

Scheduling is done by seeing the requirement of the jobs known as batch scheduling. Jobs requiring a large amount of peripheral time are called peripheral bound or I/O bound. Such jobs get lower priority. When equal time is given to all jobs irrespective of their I/O or CPU requirement, it is known as time-sharing.

Interrupts

Interrupts are hardware or software general signals that causes the CPU to suspend execution, save its status and transfer to a specific location. The transfer location specifies the address of a program that should be executed in response to the interrupt. This program is known as interrupt handling program.

Student Activity 2

1. What is multitasking?
2. Define time sharing operating system.
3. What do you mean by multiprocessing?
4. Define parallel processing?
5. What do you mean by protection?
6. Define Job scheduling.
7. What are Interrupts?

9.4 MEMORY MANAGEMENT FUNCTIONS

Main memory is essential within a computer first and foremost to enable processes to exist. So the organization and management of main memory has been one of the most important factors influencing operating system design. Memory management is primarily concerned with allocation of main memory of a united capacity to requesting processes.

The principle problems to be handled by the operating system's memory manager are:

- To provide the memory space to several processes to be executed at the same time.
- To provide a satisfactory level of performance (i.e. process execution speed) for the system users.

- To protect each process from each other.
- Where desired, to enable sharing of memory space between processes.
- To make the addressing of memory space as transparent as possible for the programmer.

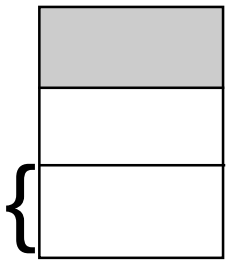
Allocation Techniques

As the program and OS, both, should be in main memory to enable processing of a program, so the main memory must accommodate both the operating system and various user programs. The memory is usually divided into two partitions, one for the resident monitor system or OS and other for user programs. Memory allocations can be done in the following ways:

- Single contiguous allocation
- Partitioned allocation
- Relocatable artitioned allocation
- Paged allocation

Single Contiguous Allocation

In a computer which is only intended to run one process at a time, memory management is simple. The memory is divided into two sections, contiguous parts for operating system program (also called monitor) and second section for user program. A single job is assigned to all of the core memory and it has complete control of CPU until completion or until an error occurs.



In this type of approach, operating system keeps track of the first and last location available for allocations of user programs. In order to provide contiguous area of free storage for user program, the operating system (or resident monitor system) resides in either the upper or lower part of the core memory. This is affected by the location of interrupt vector. Since interrupt vector is often in low memory, OS program is kept in low memory. The major problem with this system is that the computer resources are not utilized in an efficient manner. Due to lack of support of multiprogramming, this results in lower utilization of CPU and memory capacity. Since only one process is residing at a time in memory, it may not occupy the whole memory, therefore memory is underutilized. This type of memory management scheme was commonly used in single process operating systems.

Partitioned Allocation

To solve the problem of time and memory wastage, the partitioned allocation scheme is introduced. It is based upon partitioning of memory for multiprogramming. In a multiprogramming environment, several processes reside in the memory at the same time. The memory is partitioned such that each job is allocated a separate contiguous section of memory.

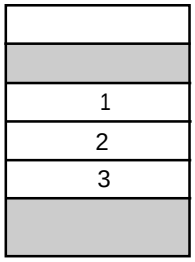
In a multiprogrammed partitioned scheme, CPU time is allocated to each job on a time slice priority basis. For a time slice, the operating system causes the processor to execute a program in its partition until one of the following four conditions occurs:

- Job is completed
- Error is deleted
- I/O is required

- Job's current time-slice runs out

In the first two cases, job can be purged from memory and processor is assigned to the next job with the highest priority. In the last two, job is temporarily suspended, and is to be resumed.

Once partitions are defined, operating system keeps track of status (whether allocated or free) of memory partitions. This is done through a data structure called partition description table.

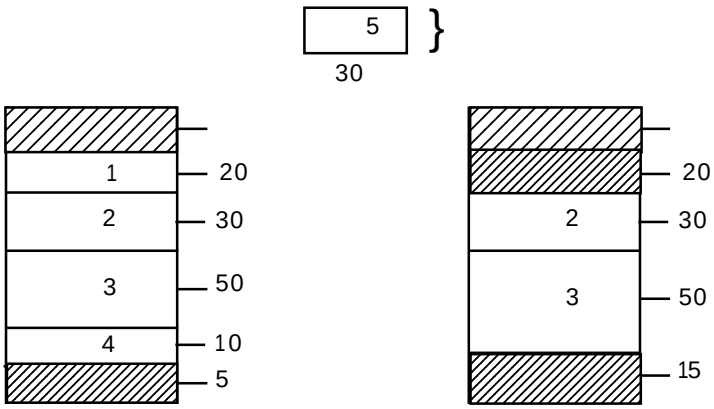


Fixed Size Partition

The two important strategies to allocate free partitions to ready process are First Fit and Best Fit. The approach followed in first fit is to allocate first free partition large enough to accommodate the process. On the other hand best fit approach allocates smallest free partition that meets the partition requirement. Fixed partition impose several restrictions:

- Its size can prevent a process from being run due to availability of a partition of sufficient size.
- It does not support a system having dynamic data structure such as stack, queue, heap, etc.
- No single program process may exceed the size of the largest partition in a given system.

Major problem of multiple partition is fragmentation, i.e. unusable "holes" or "fragments" in memory.



(a) (b)

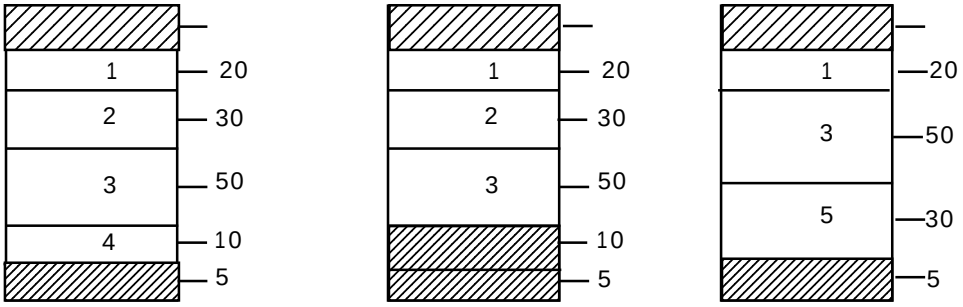
Initial After Job 1 and 4 are Complete

In figure (a), there are four jobs in memory and Job 5, which requires 30K memory, is waiting. After completion of Job 1 and job 4, as in the figure (b), we have total of 35K free memory and a new job, Job 5, is still waiting to be processed which requires 30K of core. It must wait for 30K of contiguous block before it can start. Hence in this type of partition scheme, fragments are usually developed.

Relocatable Partitioned Allocation

The relocatable allocation scheme is a solution to the external fragmentation problem. The term 'reallocate' means the ability to load and execute a given program into an arbitrary memory partition as opposed to fixed set of memory locations specified according to the programs.

In this scheme the running jobs are moved or relocated either upward or downward whereas the greater free block is available to generate a larger contiguous free block; where the new job can be loaded.



Initial Job 1 & 4 Finished Recompact and Load Job 5

Partitions are relocated efficiently with special hardware facility. A simple mechanism that serves this purpose is a "relocation register". The contents of a relocation register are automatically added to every address that is used for reference memory. Some major problems are:

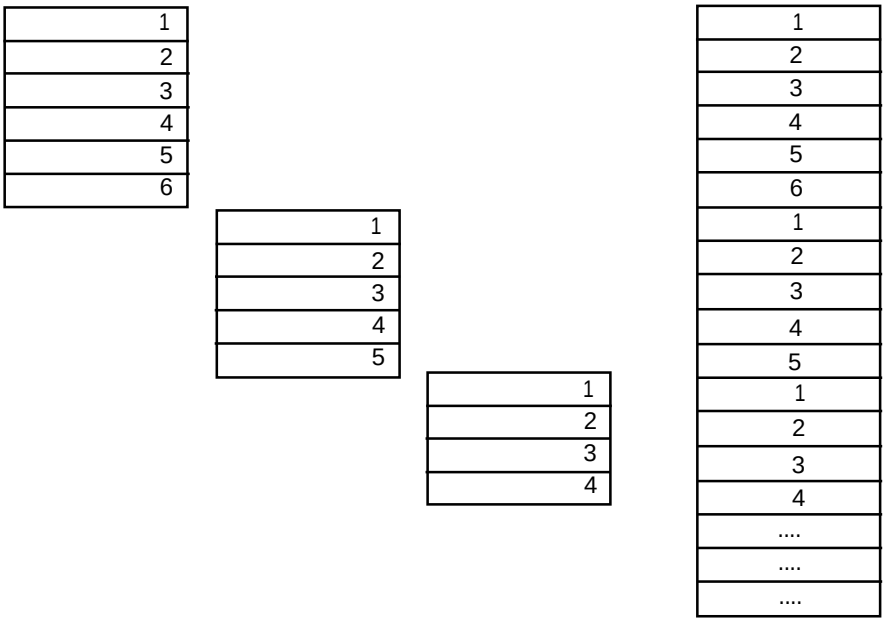
- Overhead of relocation.
- Still a small amount of core is wasted.
- We have to stop all the running processes when reallocation is happening.

Paged Allocation

We are still in pursuit of a technique which will make better use of the memory to enhance throughput of the system. Our current problem is that we create holes in available memory which can be consolidated at considerable expense of moving active processes. Paged allocation scheme is another solution of fragmentation. It permits the logical address space of a process to be non-contigious, hence it allows a process to be allocated to physical memory wherever it is available.

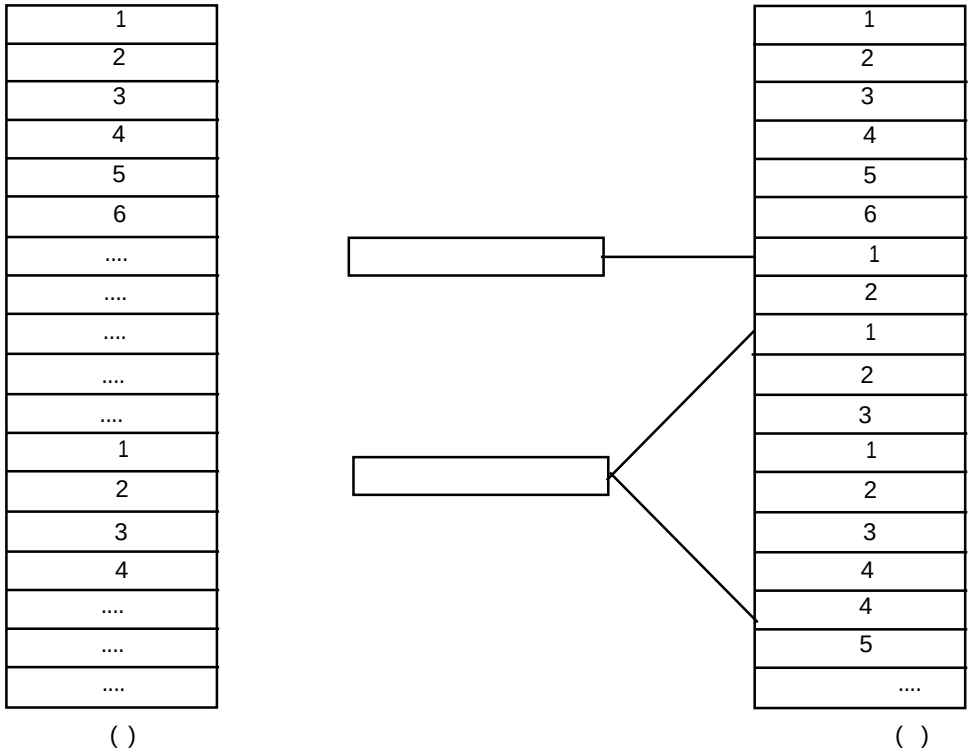
Physical memory is broken into fixed-sized blocks called "frames". Logical memory is also broken into blocks of same size called "pages". When a process is to be executed, its pages are loaded into any available memory frames from the secondary storage.

The secondary storage is divided into fixed-sized blocks that are of the same size as the memory frames. Figure (a) below shows that there are three free pages which are available for use. Now suppose process B terminates and releases its allocated pages, we now have two disconnected regions of free pages. Paging alleviates the problem of fragmented free space since a process can be distributed over a number of separate holes.



(a) Paging System Allocation

Let us assume two more processes are waiting to be loaded; process D needs two pages and process E needs five pages. These are allocated to any memory pages which are free, producing Figure (b(ii)).

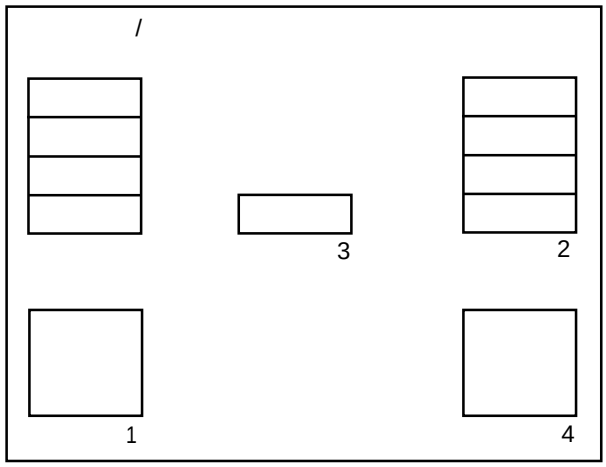


(b) Paging System Updated

A mechanism is necessary that allows the hardware to perform the mapping from user address space to physical memory. A separate register for each page called page map or page map tables are used for this purpose. However, in general, although space utilization and consequently system throughput are improved, there is still the residual problem of there being a number of free spaces available which are insufficient to hold new processes; such space would be wasted.

Segmentation

Segmentation is a memory management scheme which separates the user's view of memory and actual physical memory. Generally user prefers to view memory as a collection of variable-sized segments rather than a linear array of bytes. Segmentation supports this user view of memory.



A segment is a grouping of information that is treated as an entity like one or many programs, subroutines or database. Segmentation are formed at program translation time by grouping together logically related entities. Each segment has a name and a length. The addresses specify both the segment name and the offset within the segment. Thus a logical address consists of a two tuple <Segment number, offset>. For simplicity segments are numbered and referred through a segment number. Normally, the user program is compiled and compiler automatically constructs segments reflecting the input program.

The contrast between paging and segmentation should be noted; paging is impressed upon the physical form of the process and is independent of the programmer's structure while segmentation reflects the logical structure of process.

Student Activity 3

1. What is the role of operating system in memory management?
2. List various memory allocation techniques.
3. Describe single contiguous allocation approach.
4. What are the restrictions imposed over fixed partition?
5. Describe partitioned allocation scheme of memory management.
6. Write a short note on relocatable partitioned allocation of memory.
7. Describe paging.
8. What is segmentation?

Loading and Swapping

Loading

Generally, a program resides on a disk as a binary executable file. The program must be brought into memory and placed as a process for it to be executed. The collection of processes on the disk that are waiting to be brought into memory for execution, form the input queue. Loading is the process of selecting one of the processes in the input queue and bring it into memory.

Swapping

Swapping helps the CPU in running more jobs by keeping only those programs in memory which are currently required by the system and rest of the programs swapped out to secondary storage devices. This scheme allows more jobs to run than can fit into memory at one time. A process needs to be in memory to be executed. A job may not be needed to remain in memory continuously

till it finishes. For example, in multiprogramming environment with a round-robin CPU-scheduling algorithm, when a quantum expires, the memory manager takes the process out from memory and brings in another process. This process of taking out of a process from main memory to secondary storage and again bringing it back to memory is known as swapping.

Virtual Memory

The most common problem before programmers few year ago was how to fit large programs into the small memory. The solution of this problem was to break large programs into small pieces called **overlays**. The first overlay (overlay 0) would be loaded first, which in turn called another overlay. These overlays used to be on hard disk and swapped in or out of memory by the operating system.

Although swapping was done by OS, the work of creating a number of layers was done by the programmer. The virtual memory is a memory management technique which does splitting of program into number of pieces as well as swapping.

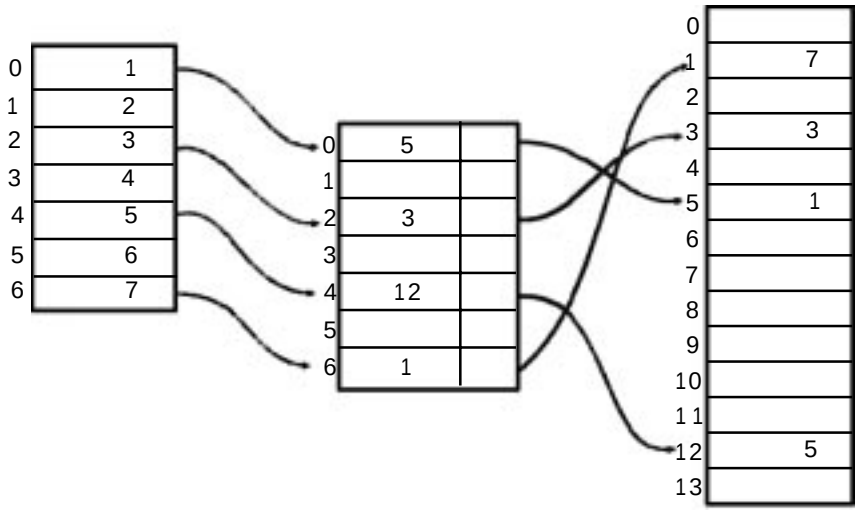
The main idea behind virtual memory is that the combined size of the program, data and stack may exceed the amount of physical memory. The operating system keeps only those parts of the program in the main memory which are required during execution and rest on the secondary storage device.

Virtual memory can be implemented as an extension of paged or segmented memory management scheme, also called demand paging and demand segmentation.

Let's discuss demand paging scheme for implementing virtual memory concept.

Demand Paging

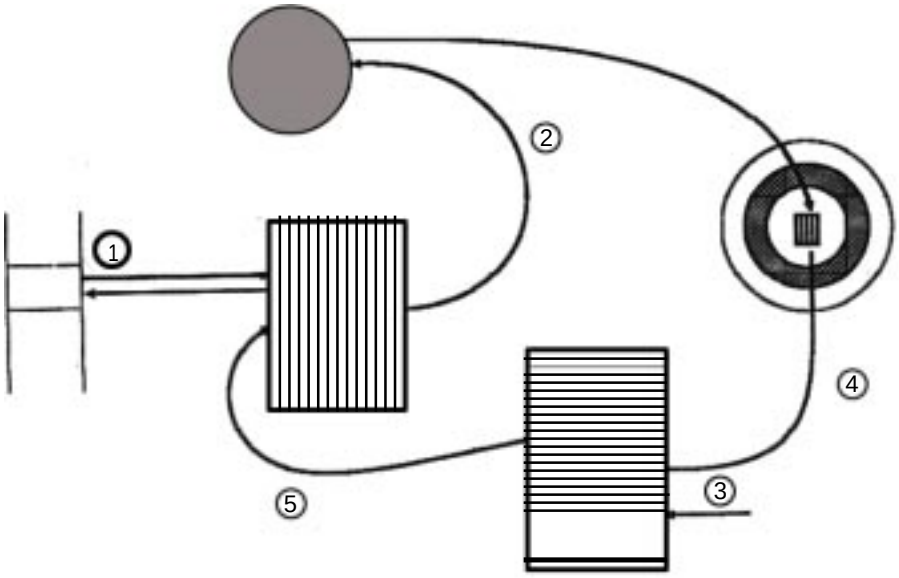
In this scheme, the pages are loaded in memory on demand only, not in advance as in paged allocation scheme. Rather than swapping the entire program, only those pages are swapped which are required currently by the system.



Implementation of Demand Paging Scheme

When a new process initiates, the system loader must load, at least, one page into real memory that contains the execution start point of the process. This can continue as long as memory references generated by this page are also within the same page. In this process suppose a program tries to access a page that was not swapped in memory, what will happen? In such a case, page fault trap occurs. The page fault generates an interrupt, effectively asking for the referenced page to be loaded – hence the term demand paging is used for this technique. When a running program experiences a page fault, it must be suspended until missing page is swapped in main memory.

The process of handling page fault is illustrated in following figure.



Student Activity 4

1. What is loading?
2. Define swapping.
3. What is virtual memory?
4. Define overlays.
5. Describe demand paging for implementing virtual memory concept.
6. How is a page fault handled in demand paging?

9.5 DEVICE MANAGEMENT FUNCTIONS

Device management means coordinating the operations of a central processing unit with its peripheral devices. Operating systems use the following techniques for its device management function:

- Buffer Memory
- Overlapped Data Processing
- Spooling

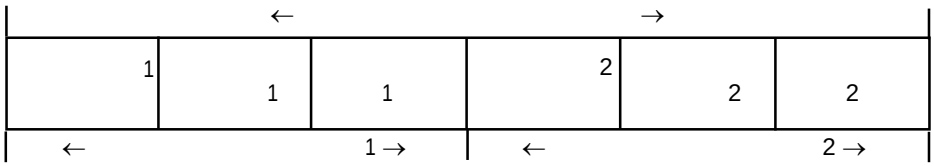
Buffer Memory

A buffer is an intermediate main memory storage area under the control of the operating system which holds data in transit between the user's work area and the device.

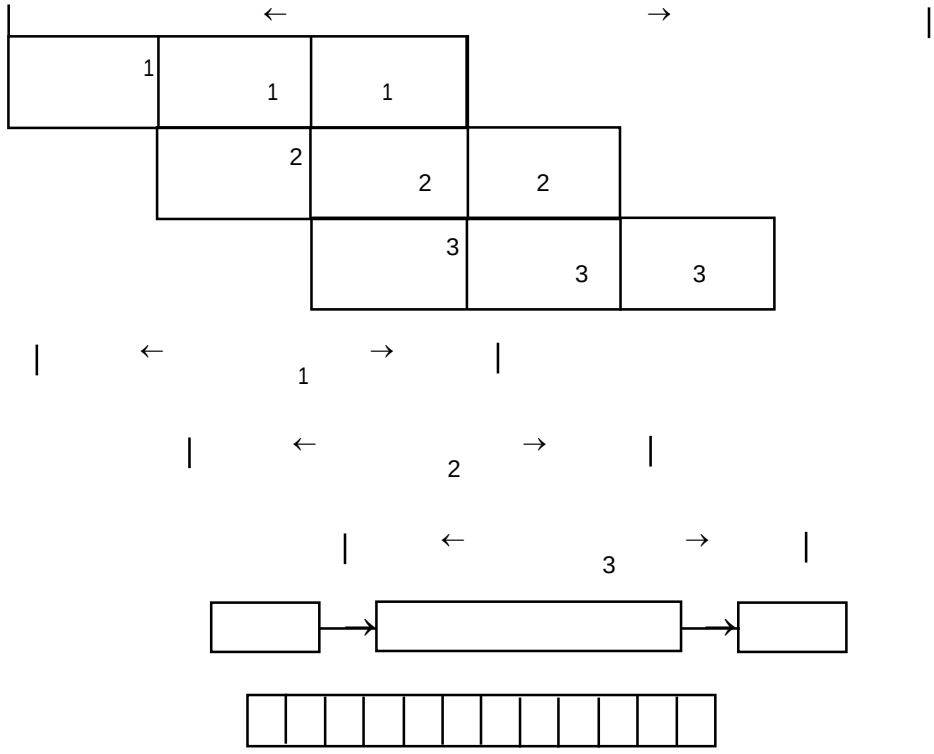
Buffer memories are high speed intermediary memories that store input or output data temporarily. Input data is first stored in an input buffer and then the assembled data is transferred into the CPU at the high transfer speeds of the buffer. Similarly, the output of the processing task is stored in the buffer memory and then transferred to the printer at a slower speed. Use of buffer frees the CPU and reduces processor idle time.

Overlapped Data Processing

Overlapped data processing means performing multiple data processing jobs simultaneously. This increases the throughput of the system and reduces the idle time of processor. You can easily compare that processing time is faster in overlapped data processing than in non-overlapped processing.



Non-Overlapped Processing



Overlapped Data Processing

Spooling

Spooling stands for "Simultaneous Peripheral Operation Online". With spooling, the CPU output is not sent to the printer directly but is redirected to a disk file. The disk file contains the printer image format of the file to be printed.

In the second step, these printer files can be downloaded to a printer, one at a time, during off hours, when processing time is not at a premium. It improves the processor utilization by paralleling the I/O tasks with the processing tasks.

Student Activity 5

1. What do you mean by device management?
2. Which techniques are used by operating system for its device management function?
3. What is a buffer?
4. What are buffer memories?
5. What do you mean by overlapped data processing?
6. Define spooling.

9.6 SUMMARY

- System software is oriented to the needs of hardware and facilitates the development and running application. Operating system is system software which acts as an interface between user and computer hardware. Evolution of operating system can be traced as : Serial Processing, Batch Processing, Multiprogramming. Operating system can be categorized into: Single User Operating System, Multiuser Operating System, Network Operating System, Distributed Operating System. An operating system performs the function of: Process Management, Input/Output or Device Management, Memory Management, File Management or Device Management.
- Parallel processing refers to systems with more than one processor which are simultaneously under a single, central control unit. Memory allocation can be done in the following ways: Single Contiguous Allocation, Partitioned Allocation, Relocatable Partitioned Allocation, Paged Allocation.
- Segmentation is a memory management scheme which separates user's view of memory and actual physical memory. Virtual memory can be implemented as an extension of paged or segmented memory management scheme, also called demand paging and demand segmentation. Device management means coordinating the operations of CPU with its peripheral devices. The techniques used by OS for device management are Buffer Memory, Overlapped Data Processing, Spooling. Information management is most visible component of operating system and is concerned with storage and retrieval of information.

9.7 KEYWORDS

Operating system: This is a system which acts as an interface between user and hardware of the computer system.

Process: A program in execution.

Processor: A hardware device that is capable of executing a sequence of instructions.

Multiprogramming: The situation in which a single CPU divides its time between more than one job.

Multitasking: The situation in which a single CPU runs or appears to run more than one application program at one time.

Time sharing: The allocation of computer resources in a time-dependent fashion to several programs simultaneously.

Multiprocessing: Simultaneous execution of two or more processes by a multiple, processes computer system.

Parallel processing: Systems with more than one processor working simultaneously under a single, central control unit.

Protection: The mechanism used for controlling the access of programs, processes, or users to the resources defined by a computer system.

Scheduling: A set of policies and mechanism supported by an operating system that controls the order in which the work to be done is completed.

Interrupts: Hardware or software general signals that causes the CPU to suspend execution, save its status and transfer to a specific location.

Segmentation: A memory management scheme which separates the user's view of memory and actual physical memory.

Overlays: Small pieces of large programs.

Buffer: An intermediate main memory storage area under the control of the operating system which holds data in transit between the user's work area and the device.

Buffer memories: High speed intermediary memories that store input or output data temporarily.

Overlapped data processing: Performing multiple data processing jobs simultaneously.

9.8 REVIEW QUESTIONS

Fill in the Blanks

1. An operating system is _____ software.
2. There are two ways to interact with OS. First through _____ and second through _____.
3. In _____, number of users can use the system at a time.
4. A _____ _____ is one that looks like ordinary centralized operating system but runs on multiple independent CPUs.
5. The _____ schedules the processes and, in a non-multiprogrammed environment, would decide which process is to use the processor.
6. The _____ keeps the track of the status of the process.
7. _____ are the hardware or software signal that causes the CPU to suspend execution, save its status and transfer to specific location.

Multiple Choice

1. _____ provide the interface to running program and the operating system.
   a. System software
   b. System calls
   c. Kernel
   d. None of these
2. _____ refers to a situation when a single CPU divides its time between more than one job.
   a. Multiprocessing
   b. Multiprogramming
   c. Time sharing
   d. Multitasking
3. The _____ allocation scheme is a solution of external fragmentation only.
   a. Single continuous
   b. Partitioned
   c. Relocatable partitioned
   d. Paged
4. The memory scheme which separates the user's view of memory and actual memory is
   a. Virtual memory
   b. Swapping
   c. Demand paging
   d. Segmentation

5. The system area does not includes
   a. Boot block/Record
   b. File allocation table
   c. Root directory
   d. None of the above

Descriptive Questions

1. Define operating system, its need, function and usage.
2. Trace the evolution of operating systems.
3. Define
   a. Multiuser OS
   b. Network OS
   c. Distributed OS
4. Define
   a. Multiprogramming
   b. Multitasking
   c. Timesharing
   d. Job scheduling
   e. Multiprocessing
   f. Protection
5. Describe the memory management allocation techniques that can be used by an OS.
6. Define swapping, demand paging and segmentation.
7. Give the details of device management function of OS.

Answers to Review Questions

Fill in the Blanks

1. System
2. user, hardware
3. Multiprogramming
4. Multiprocessing
5. Multitasking
6. Job scheduling
7. Interrupts.

Multiple Choice

1. (d)
2. (b)
3. (c)
4. (d)
5. (b)

9.9 FURTHER READING

V. Rajaraman, *Fundamentals of Computers*, Prentice Hall of India.

UNIT

10

INTRODUCTION TO DOS

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Define DOS as an operating system.
- Describe the structure of MS-DOS.
- Understand the file naming rules in MS-DOS.
- Understand DOS internal and external commands.
- Understand DOS directory structure.
- Use wild card characters.
- Create batch files.

U N I T S T R U C T U R E

10.1 INTRODUCTION

DOS, which stands for Disk Operating System, is the most popular single user operating system. It was designed and introduced in 1980 by Microsoft. It became the market leader and choice of millions of users immediately due to its simple interface and easy management capablities. In this unit, we will have a brief look at its development, structure, booting sequence and file management

capabilities. We will also learn about its directory structure, some internal and external commands and security provided by it.

10.2 INTRODUCTION TO DOS

We know that an operating system is a set of programs that acts as an interface between computer system and user in order to help him/her to perform the job quickly. The evolution of MS-DOS dates back to 1980. Seattle Computer Products needed an operating system to support their INTEL8086 microprocessor. At that time, there was a popular operating system, written by Tim Patterson, known as QDOS (Quick DOS, some people also used to call it quick and Dirty Operating System). By the end of 1980, next version of QDOS came by the name of 86-DOS.

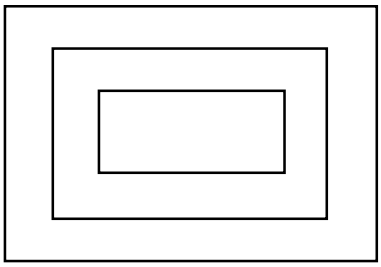
Microsoft had bought rights of 86-DOS. A team of microsoft's programmers, using 86-DOS as a base, developed the now renamed MS-DOS on a prototype IBM personal computer. Then microsoft purchased the exclusive rights of 86-DOS from Seattle Computer and renamed it as MS-DOS.

MS-DOS, acronym for Microsoft Disk Operating System, is a single user operating system which acts as an interpreter between the user and computer. The system became very popular due to its cost, easy to use versatility and high portability.

10.3 STRUCTURE OF MS-DOS

The structure of MS-DOS operating system is shown in the figure. It contains three parts

- BIOS
- DOS Kernel
- Command Processor



Structure of MS-DOS

Basic Input Output System (BIOS)

BIOS performs most basic control and supervisory operations for the computer. For example, it ensures that if you press numerical 5 key, the digit 5 appears on the screen. It also handles the basic needs of the hardware involved, which include all I/O devices. BIOS is specific to the individual computer system. It is provided by the manufacturer of the system. It contains hardware dependent drivers for the following devices:

- Command Display and Keyboard (CON).
- Printer (PRN).
- Date and Time (CLOCK).
- Auxiliary Device (AUX).

It is stored in ROM and also in IO.SYS (IBMBIO.COM ON IBM PC).

DOS Kernel

DOS Kernel is a program that communicates with device drivers through I/O request. It provides a collection of hardware independent services called System Functions. Programs can access system functions by loading parameters and then transferring control to the O.S. by means of software interrupts. A Kernel also performs various managerial functions like file management, memory management, and device management, etc. It is supported by MSDOS.SYS (IBMDOS.COM on IBM PC).

Command Interpreter/Processor (Shell)

Command interpreter provides user interface between an operating system running on a computer and the user. It is supported by COMMAND. COM file. (in both MS-DOS and PC-DOS). A command interpreter is responsible for parsing and executing user's commands including the loading and executing of other programs from a disk or other mass storage device. COMMAND. COM file has two portions.

- ***Resident Part:*** This part is available at all times once it has been loaded in RAM at the time of booting. It is kept in protected mode. It contains Internal Commands.
- ***Transient Part:*** This part of COMMAND. COM resides on a disk. It contains External Commands in the form of files which get loaded into memory when you use that particular command.

Student Activity 1

1. What is Ms-Dos?
2. Describe the structure of MS-Dos.
3. What is BIOS? What does it contain?
4. Describe DOS kernel.
5. Describe command interpreter.
6. Describe various parts of command.com.

10.4 MS-DOS BOOTING PROCESS

When a computer is switched on, it does not know what to do, because it does not have any program loaded into its memory to instruct it. However, it has two special built-in programs. One of these programs helps to perform limited self-testing to see that essential parts of the computer are in working order called POST. The second one helps to load the operating system in the memory from external storage. This start-up program is usually called a 'bootstrap loader' which works in two stages:

- The first part of the start-up program reads the part of a disk where a program knowing how to activate DOS is stored.
- The second part of this start up routine gets the rest of DOS going; it reads the rest of DOS from the disk and then the DOS is ready to receive and execute user commands. This process is known as booting. So booting is the process of loading the operating system from disk to the main memory.

POST (Power On Self Test) checks hardware functionality, determines the memory available with the system, and initializes certain parameters for startup of the computer. Then Boot Strap Loader reads the first sector of the disk, i.e. Boot sector, in order to load the disk boot strap program into memory. The name of the process originates from an American expression, 'put yourself by your boot strap' which means, to prepare one self. Boot Strap Program, stored in Boot Sector, after getting loaded into memory checks the first sector of the root directory on disk for the presence of IO.SYS and MS-DOS.SYS files. If found, these files are loaded into the memory by boot strap loader.

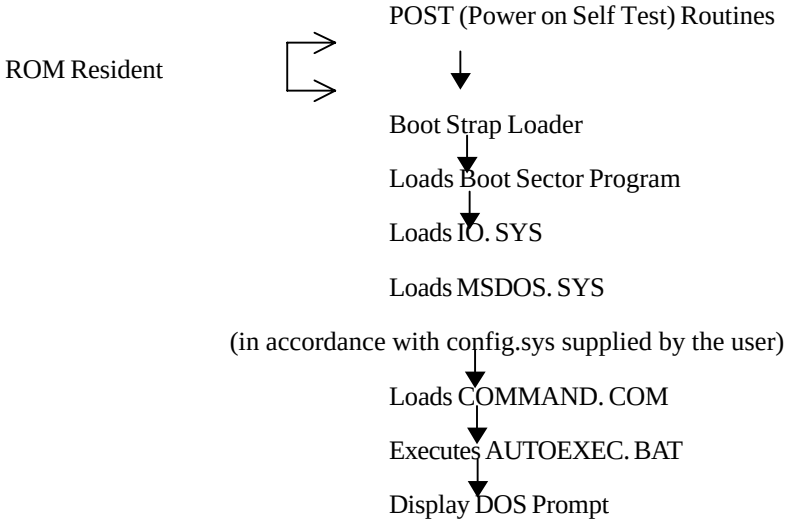
Three system files are necessary to be present on the boot disk in order to boot the system with MS-DOS Operating System.

Two optional external files may also be used to configure the system, while booting.

- CONFIG.SYS
- AUTOEXEC.BAT

Config.sys adjusts the system's configuration according to the commands contained in the file while Autoexec.bat facilitates automatic execution of command lines included within the file when system is turned on.

When the power supply to the computer is switched on, following sequence of operations are executed before the computer is ready to receive user commands.



10.5 FILE NAMING RULES

Every file used by the system should have a unique name. It has two parts separated by a period (.)

1. Primary name (Maximum 8 characters)
2. Extension name (Maximum 3 characters)

The primary name can be 1 to 8 characters long. The secondary (extension) name consists of three or fewer characters and is optional, e.g. ATTRIB.EXE. Here, ATTRIB is primary name and EXE is extension name.

Valid characters allowed for naming a file are:

- The alphabets a through z.
- The digits 0 to 9.
- Special symbols like $ # & @ ! % ( ) - _ ' ^ ~ { }

Student Activity 2

1. Describe booting process of MS-DOS.
2. What is POST?
3. What is bootstrap loader?

4. Which system files are required to boot the system with MS-DOS operating system?

5. Describe the rules for naming files in MS-DOS.

10.6 SYSTEM FILES

Files with system attributes are known as system files. These files contains DOS's core program.

Three basic system files are:

- IO.SYS
- MS DOS.SYS
- COMMAND.COM

The first two are needed for basic input/output task. Basically, these files are hidden files of the system and stored in root directory. When they are loaded in memory, these two programs take over the running of the system. The third one acts like command interpreter. DOS expects Command.com file in the root directory of boot drive.

- ***Autoexec.bat file:*** Stands for Autoexecutable batch file. As the name suggests, it is automatically executed whenever system starts. Various settings like date, time, path, etc., can be batch programmed in it.
- ***Config.Sys Files:*** Is an optional file and one needs to create it if he/she wants to redefine the working environment of one's system. For example, if you want to add a new device to your PC or your software needs to open more files than default, then you have to configure your system for it.

10.7 COMMANDS OF DOS

DOS commands are predefined instructions which can be issued at MS-DOS command prompt. When anyone issues these commands, they direct the operating system to perform a particular task using hardware resources. DOS commands can be divided into two types:

- Internal Commands
- External Commands

To get help on any DOS command, type command name followed /? at the DOS prompt.

Internal Commands

Internal commands are memory resident commands. They are built into the command processor and reside in memory with DOS. They don't have their own program files, rather they are directly executed by resident part of command.com. The general command format is as follows:

Command-name [parameters] [switches]

Switches include various options of the command. Parameters may take a file name, or directory name or a drive name.

Basic DOS Commands

CLS Command

This command clears the screen of visual display unit and puts the cursor in the top left corner. It has no parameters.

Syntax: CLS

DIR Command

This command displays the contents of one or more directories.

Syntax: DIR [filespec] [/P] [/W] [/A] [/S] [/B] e.g. : C:\>DIR / P <Return>

Parameters and Switches:

none	Lists the current directory
filespec	Identifies the directory and/or file(s) to be listed
/P	Displays one page at a time
/W	Displays the listing in wide format, with as many as five names per line
/A	Displays all entries, including system and hidden ones
/S	Lists the contents of subdirectories
/B	Suppresses heading and summary information and lists full filespecs (including path) for all selected entries

COPY Command

This command copies one or more files from a source to a destination.

Syntax: COPY Source [destination] [Y¦ -Y]

Parameters and Switches:

Source	Identifies file(s) to copy.
destination	Identifies location or name of copy.
Y	Replaces destination files without warning.
-Y	Prompts before replacing destination files.

e.g.: C:\> COPY Old.doc New.doc <Return>

DEL Command

Deletes one or more files.

Syntax: DEL filespec [/P]

Parameters and Switches

filespec	Identifies the file(s) to delete.
/P	Prompts for confirmation before each deletion.

e.g.: C:\> DEL New.doc <Return>.

REN Command

This command changes the name of file(s) with new name(s). For a group of file(s) only the extension name can be renamed.

Syntax: REN filespec newname

Parameters:

filespec Identifies the file(s) to be renamed.

newname Specifies the new name.

e.g.: C:\> REN Old.txt New.txt <Return>

TYPE Command

If you want to see what is written in a file, then you can use Type command. This command displays the contents of a file:

Syntax: TYPE filespec

Parameter:

filespec Identifies the file that is to be viewed. This command cannot be used for a group of files.

e.g.: TYPE New.txt <Return>

VOL Command

VOL command displays a disk's volume label and serial number, if they exist.

Syntax: VOL [drive]

Parameter and Switches:

none Displays the volume label and serial number of current drive.

drive Specifies a drive whose volume label and serial number we want to see.

Ver Command

Ver Command gives you the DOS version number.

Syntax: VER

SET Command

This command sets or changes value of environmental variables or displays current values.

Syntax: SET [variable = [string]]

Parameter and Switches:

none Displays the current values of all environment variables

variable Identifies the environment variable to be set.

string Specifies a new value for an environment variable; if omitted, the current value is cleared.

Date Command

This command gives you the current date and allows you to change it.

Syntax: Date

Time Command

This command gives you current system time and allows you to change it.

Syntax: Time

Student Activity 3

1. What are system files? Name basic system files.
2. Describe the following:
   (a) Auto exec. bat file
   (b) Config. sys. file.

(c) Command.com file.

3. What are DOS commands?

4. What are internal commands?

5. write the DOS commands for the following:

   (a) to clear the screen.

   (b) To see the directory page wise.

   (c) To copy a file old. doc into floppy disk.

   (d) To delete the file old. doc.

   (e) To rename the file new. doc. in floppy to sample. txt.

6. What is the function of following DOS commands?

   (a) Type (b) Vol (c) VER (d) Data (e) Time

10.8 THE WILDCARD (?, *) CHARACTERS

These characters are useful when you have to refer to a group of files instead of a single file.

- ***The '?' WildCard Character:*** This character can replace one character, e.g. suppose you want to see the listing of all the files which have primary name made up of any five characters and have an .EXE extension. The command to be given is:

  C:\> DIR ????? .EXE <Return>

  This command will give you the list of all the files having extension .EXE and a primary name which is equal to or less than five characters.

- ***The '*' WildCard Character:*** If you want to see the list of all the files having an extension .EXE and do not know the length of longest file name then the command using '?' option will be:

  C:\> DIR ????????.EXE

  Instead of using 8 eight '?' you use the '*' character which can replace any number of characters, unlike the '?' which replaces only one character. So the command is:

  C:\> DIR *.EXE

  The WildCard characters can also be used in conjunction with other commands like COPY, REN, DEL, etc.

10.9 DOS DIRECTORY STRUCTURE

DOS has certain features which help in organizing files. One can do it by creating directories. Suppose you want to club the files of the same purpose separately, you can accomplish this task by creating various sub-directories.

DOS supports a tree like hierarchical directory structure. Initially when no directories have been created, all the files reside under one main directory called root directory. Each disk has a root directory. To the root directory, one or more subdirectories can be added. Each new directory branches out from its parent directory and in turn can have a number of subdirectories under it.

Each directory contains two special files

- (.) to represent current directory.
- (..) to represent the parent directory.

10.10 SOME DIRECTORY COMMANDS

- ***CD Command:*** This command changes default directory or displays the name of a default directory.

  Syntax: CD [drive] [pathname]

  Parameters:

  none — Displays the name of a default directory on the specified drive.

  drive — Displays the name of the default directory on the specified drive.

  pathname — Specifies the name of a new default directory. Path name must represent an existing directory.

  e.g.: CD C:\DOS <Return>

- ***MD Command:*** MD (Make Directory) command creates a new directory.

  Syntax: MD [path] name

  parameters:

  path — Identifies the parent of the new directory.

  name — Identifies the name of the new directory.

  e.g.: C:\> MD USER <Return>

- ***RD Command:*** RD (Remove Directory) deletes a directory which must be empty.

  Syntax: RD pathname

  Parameter:

  pathname — Identifies the directory to be deleted.

  e.g.: C:\> RD USER <Return>

- ***PATH Command:*** It defines a search path for external executable files.

  Syntax: PATH [pathname [; pathname ....]]

  Parameters:

  none — Displays the current search path.

  pathname — Identifies a directory to search for program files.

10.11 EXTERNAL COMMANDS OF DOS

External commands are the ones which require certain special DOS files for their execution. External Commands are disk resident commands. These files have a primary name which is the same as command and an extension name which is either .COM or .EXE. The program files reside in transient part of Command.com file.

Disk Manipulation Commands

- ***FORMAT:*** Format prepares a disk for use. It is necessary to format a new diskette prior to use. By formatting, a disk is divided into 'tracks' and 'sectors'. Tracks are concentric circles. These tracks are further divided into sectors and data is stored on these sectors.

  Syntax: FORMAT drive [/V : label] [/S] [/U]

  Parameters and Switches:

  drive — Identifies the drive to format.

/V : label Specifies the volume label for the formatted disk, label can be upto 11 characters long.

/S Makes the disk bootable.

/U Specifies an unconditional format.

e.g.: Format A : /V

NOTE Format erases all the data that exist on a disk, if you are formatting old floppy disk.

- ***DISKCOPY:*** If you want to copy the contents of one disk to another, this can be done with the help of Diskcopy command which allows you to maintain the duplicate copy of a disk, and copies the contents of disk in source drive to the disk in destination drive. If you have a single floppy drive unit the same drive will be source as well as destination. For diskcopy ,the type and capacity of both the disks must be same.

  Syntax: DISKCOPY [drive1] [drive2] [/V]

  Parameters and Switches:

  none Uses the current drive for both the source and destination disks

  drive1 Identifies the drive holding the source disk

  drive2 Identifies the drive holding the destination disk

  /V Verifies that the copied data is correct

  e.g.: Diskcopy A: A:

- ***DISKCOMP:*** This command compares two floppy disks. Generally, it is followed by the diskcopy command to check if both disks are identical or not.

  Syntax: DISKCOMP [drive1] [dirve2]

  Parameters and Switches:

  drive1 Identifies source drive for comparison

  drive2 Identifies destination drive that holds a disk for comparison

  e.g.: DISKCOMP A: A:

- **LABEL:** This command is used to display and change the volume label of a disk.

  Syntax: LABEL [drive] [label]

  Parameters and Switches:

  none Displays the volume label of the current drive and enables user to change or delete it.

  drive Identifies the location of the disk whose label is to be displayed or changed, default is current drive.

  label Specifies a new volume label for the disk. The label may contain upto 11 characters.

  e.g.: Label A: Uptec

10.12 MORE EXTERNAL COMMANDS

- ***ATTRIB:*** This command is used to display or change file and directory attributes.

  Syntax: ATTRIB [+R ¦ -R] [+A ¦ -A] [+H ¦ -H] [+S ¦ -S] filespec [/S]

  Parameters and Switches:

none	Shows the attributes of all files in the current directory
+R ¦ -R	Turns on or off the read only attribute
+A ¦ A	Turns on or off the archive attribute
+H ¦ -H	Turns on or off the hidden attribute
+S ¦ -S	Turns on or off the system attribute
filespec	Identifies the file(s) or a directory to process
/S	Process all files in the branch headed by the current directory

- ***UNDELETE:*** If you may have deleted any file or files accidently then you can recover them by using UNDELETE command. This command recovers file(s) after deleting them.

  Syntax: UNDELETE filespec/LIST

  Parameters:

Filespec	Identifies the files which are to be recovered.

- ***XCOPY:*** XCopy stands for extended copy. With the help of this command you can copy files as well as directories and its subdirectories also.

  Syntax: XCOPY source [destination] [/P] [/S] [/E] [Y ¦ -Y]

  Parameters and Switches:

source	Identifies the files to be copied
destination	Specifies the location where the copy should be written
/P	Prompts the user for permission to copy each selected file
/S	Extends copying to the entire branch headed by the source directory
/E	Copies empty subdirectories when copying to the entire branch. /S must be used with /E
/Y	Replaces destination files without warning.
/-Y	Prompts before replacing destination files.

10.13 BATCH FILES

Sometime, you may find yourself typing a series of commands over and over again to perform some repetitive task. Suppose, at the end of each day you have to take the back up of all the data from C: to A:. For doing this following command is to be issued:

C:\ > Copy C:*.TXT A: <Return>

Copy C:*.BAK A: <Return>

Copy C:*.DBF A: <Return>

Copy C:*.RPT A: <Return>

So, in such a case, you have to type these commands at the end of each day. In this situation you can create a batch file to simplify your operations. A batch file contains commands for a sequence of operations. Batch files have one advantage single commands can replace a series of command. Extension of these files must be .BAT.

10.14 BATCH FILE COMMANDS

There are certain DOS commands for batch files. These commands are known as batch file commands. Some special batch file commands available are:

- ***ECHO:*** In general, every command is displayed on screen when it is being executed. You can turn off these commands by giving the command Echo off. Echo on turns on the display of commands. So:

  Echo ON : display all subsequent command.

  Echo OFF : does not display all subsequent command.

  Echo command can also be used to display a message. For this, first you should set Echo off. Then Echo command can be entered followed by at least one space and then text of your message.

Consider the following example:

c:> Copy Con Sample.Bat

Echo off

Copy C:\ abc.txt c:\Backup

Echo Insert disk in derive A:

Copy C:\abc.txt a:

^Z

When you execute this file, the screen looks as follows:

C:\>Sample

C:\> ECHO OFF

1 File(s) copied

Insert disk in drive A

Not reading drive A:

Abort, Retry, Fail ?_

- ***PAUSE:*** In the above example we got a surprise message at last, why ? Because in some situations when there is no floppy in derive A:, this message is displayed on your screen. In the above example, although we have a prompt for inserting the disk, but batch commands are executed in a sequence in non-interactive mode, so it may happen that before inserting a floppy, the next command gets executed.

  In such a situation we can use PAUSE command. When PAUSE command is encountered, the execution of the batch file stops and the following message is displayed on screen:

  Press any key to continue.....

  At this point, you complete your tasks and then key can be pressed to execute subsequent commands of the batch file.

- ***REM:*** This command allows you to include comments in batch files. Rem stands for Remark.

  e.g.: REM this batch file is for creating back-up.

  Here, the text followed by REM command will not be executed.

- ***IF:*** The batch command IF is used for conditional execution.

  e.g.: IF EXIST C:\BACKUP\Report.bak COPY C:\BACKUP\Report.bak C:\

- ***GOTO:*** Commands in batch file are executed in sequence. However, you can make the batch file branch off to a specific point. The GOTO command can be used for this purpose.

  e.g.: C:\> Copy con printfl.bat

  IF EXIST C:\ABC.TXT GOTO PRFL

  COPY C:\BACKUP\ABC.BAK C:

  REN C:\ABC.BAK ABC.TXT

  :PRFL

  type abc.txt>prn

  ^Z

10.15 SECURITY AND RECOVERY OF DATA

DOS provides some utilities to protect the data against loss and recovers it when it is necessary. We can preserve information about deleted files for a few days, so that they can be undeleted. Microsoft Anti-Virus detects and removes computer viruses. Disks are formatted before use. If accidentally a disk containing data is formatted, it can be unformatted. We can write – protect the files, to prevent them from being changed or deleted. CHKDSK program can identify and fix the bad data. It allows to take back-ups of files.

Back-ups

A copy of file(s) or drive is called back-up. The process of copying a file for safe keeping to another location, often on removable media, is known as back-up. DOS provides the utility MS-Back-up to achieve the task.

Student Activity 4

1. What are wild card characters?
2. What is a root directory?
3. What is the function of following DOS commands?

   (a) CD (b) MD (c) RD (d) PATH (e) FORMAT (f) DISKCOPY (g) DISK COMP

   (h) LABEL (i) ATTRIB (j) X Copy
4. What are DOS external commands?
5. What are batch files?
6. What is the function of following Batch file commands:

   (a) ECHO (b) PAUSE (c) REM (d) IF (e) GOTO
7. What are back-ups ? Why are they required?

10.16 SUMMARY

- MS-DOS, which stands for MicroSoft Disk Operating System, was developed by MicroSoft Corporation in 1980. DOS is a single user operating system having features like lowcost, easy to use, versatility and high portability. The structure of DOS can be divided in three parts: (i) BIOS, (ii) DOS Kernel, and (iii) Command processor.
- Booting is the process of loading the operating system from disk to main memory. The files with system attributes are known as system files. Three basic system files are IO.SYS, MS-DOS.SYS, COMMAND.COM. DOS commands are predefined instructions which can be issued at MS-DOS command prompt. Commands can be categorized in two types, internal commands and external commands. Internal commands are memory resident commands. External commands are disk resident commands. WildCard characters can be used to refer to a group of files. DOS supports heirarchical directory structure. A batch file contains commands for a sequence of operations.

10.17 KEYWORDS

DOS: Disk operating system, is the most popular single user operating system.

BIOS: System which performs most basic control and supervisory operations for the computer.

DOS Kernel: A program that communicates which device drivers through S/o request.

POST (Power on Self Test): A program which checks hardware functionality, determines the memory available with the system, and initializes certain parameters for startup of the computer.

System files: Files with system attributes.

Autoexec. bat file: Autoexecutable batch file is automatically executed whenever system starts.

Config. Sys files: An optional file and one needs to create it if he/she wants to redefine the working environment of one's system.

Internal commands: Memory resident commands which are built into the command processor and reside in memory with Dos.

Root directory: All the files reside under one main directory called root directory.

External commands: disk resident commands which require certain special DOS files for their execution.

Back-ups: A copy of file (s) or drive.

10.18 REVIEW QUESTIONS

Fill in the Blanks

1. _____ provides user interface between an operating system running on a computer and the user.
2. A file can have maximum _____ characters in its primary name and maximum _____ characters in its extention name.
3. Three basic system files are _____, _____ and _____.
4. To refer to a group of files _____ characters are useful.
5. _____ command defines a search path for external executable files.

Multiple Choice

1. Transient part of command.com stores
   a. Internal commands
   b. External commands
   c. Disk manipulating commands
   d. Batch file commands
2. To adjust the system configuration, we can use the file
   a. COMMAND.COM
   b. MSDOS.SYS
   c. IO.SYS
   d. CONFIG.SYS

3. To view the contents of a file we can use the command
   a. Copy b. DIR
   c. Type d. REN
4. To copy the files as well as directories and its subdirectory, we can use
   a. DIR/S command
   b. Disk-copy comand
   c. Copy command
   d. XCopy command
5. '*' wild card can replace maximum
   a. 8 characters b. 1 character
   c. 3 characters d. 11 characters

Descriptive Questions

1. Define the structure of MS-DOS.
2. What do you understand by 'booting'? Define the booting process of DOS.
3. Describe the word 'command'. What do you mean by internal and external commands?
4. Define DOS directory structure.
5. What are batch files? Why are they used? Give at least five batch file commands and their usage.

Answers to Review Questions

Fill in the Blanks

1. command interpreter 2. 8,33. IO. Sys, MSDOS. Sys, command.com 4. wild card 5. PATH

Multiple Choice

1. (d) 2. (d) 3. (c) 4. (d) 5. (a)

10.19 FURTHER READING

Sumita Arora, *Informatics Practices*, Sultan Chand & Co.

UNIT

11

GRAPHICAL USER INTERFACE AND WINDOWS 98

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Define graphical user interface and its need.
- Describe the functions of mouse.
- Define windows and its components.
- Compare GUI and CLI.
- Work with windows 98.

U N I T S T R U C T U R E

11.1 INTRODUCTION

MS-DOS was the most popular operating system before the advent of Windows. The concept of Windows provided a better interface and an easier way of interacting with the user. The Windows concept employs graphics and an extensive use of a pointing and selecting device, generally a mouse. The graphical interface gained popularity and was easy to use. Programmers and system developers started using GUI concept for the success of their softwares and programs. MicroSoft Corporation of USA launched a new operating system WIN95 which was GUI based. Although

Macintosh Operating System (Mac OS) was already in the market, WIN95 became popular. The new version, WIN98 with advanced features and internet capabilities added to the success of Microsoft Corporation. Nowadays WIN95 and WIN98 have almost replaced the traditional textual operating system, DOS. In this chapter you will study the features of GUI based software and WIN98 as an operating system.

11.2 USER INTERFACE

An interface is the common boundary between the user and the computer system application. This is the only way through which a user can interact with the computer application. A good interface enhances user efficiency and reduces the frequency of mistakes and errors committed by him.

Need

An interface makes conversation possible between the user and the systems. The series of exchanges between user and system occur through this interface. The interface helps to have a dialogue. All the inputs to the system are provided through the interface and all responses, as outputs and messages, are sent back to the interface. Without an interface users cannot communicate with the computer system.

11.3 GRAPHICAL USER INTERFACE

Before the advent of GUI, user interface with the computer was command line-based. You interact with the computer by typing in your instructions and similarly receive the output in text form. DOS and Unix have Command Line Interface (CLI). The main limitation with CLI was that the users had to learn commands for interacting with the system. This was both cumbersome and slow.

Then came graphical User Interface (GUI) which is both faster and more convenient to use. The GUI (as pronounced gooey) provides a means of interaction with the system using a windows and mouse-driven environment. In addition to supplying routine facilities, a GUI also provides additional opportunities to enhance the interface of application systems. It has helped to overcome the problem of learning different sets of commands to run different programs and applications by providing a consistent and simple way of operations. Once the user learns to use one program, he or she would already be halfway to learning another program. A GUI is based on the following concepts:

- ***Consistency:*** Consistency in operating the programs should be maintained, i.e. there should be only one way to call a menu, execute a file, etc.
- ***What You See is What You Get (WYSIWYG) Concept:*** The program should appear exactly the way it will appear when printed with all the formattings.
- ***Window:*** The programs should operate within windows on the screen. These windows are movable, resizable, minimized, etc., i.e. completely under the users control.
- ***Dialog Box:*** For communicating with the user dialog box is used in a GUI systems.
- ***Mouse:*** Mouse is a primary device used to point and interact with the applications. You can move on a screen by moving the body of the mouse. Normally a window pointer is an arrow tip. Windows programs take action when you click the mouse after placing this pointer on the desired menu, options or button.

The mouse is a relative device; if you pick it up and place it somewhere else the pointer on the screen does not change its location. The only way to move the mouse pointer on the screen is by dragging it on a flat surface.

Some of the basic mouse functions are pointing, clicking, double clicking and dragging.

11.4 MOUSE FUNCTIONS

- ***Pointing:*** Point the arrow at an item on the screen by moving the mouse.

- ***Clicking:*** Click on an item by pressing the left mouse button (or right button on mouse, if it has been set that way). Clicking of left mouse button or right mouse button causes different events to occur. You left click to open menus, re-size windows, select a command, etc. Right click is generally used to open shortcut menus.

- ***Double Clicking:*** This means clicking the mouse button (left or right) twice rapidly. Double click is done to start applications, open and close windows, etc.

- ***Dragging:*** Dragging means to point at the item, click the left mouse button, hold the button down, move the item to the desired place by moving the mouse on mouse pad and release the button. You drag an item to make space or to move application from one group to another.

- ***Shape of Mouse Pointer:*** Different shapes of a mouse pointer are used for different purposes. For example, a double arrow head is used while dragging the borders and during resizing of a window.

A cross-hair is used to draw lines in a drawing application, e.g. paint brush. An I-beam is used to point and select the text.

11.5 IMPORTANT TERMS

- ***Icon:*** It is a graphical representation of an element in window. Icons are used to represent all sorts of items, including application programs and documents, when they are not currently opened. The user can run the application program or open the document that he selects by double clicking on the icon.

- ***Cascade:*** Cascade refers to the overlapped manner of arranging all the open windows on desktop. One can view the contents of the first window (active window) only. During cascading all the back windows are visible partially.

- ***Tile:*** This is another way to view the contents of all windows simultaneously; it causes all open windows to be equally sized and lined up in tile form. In tile form the size of every window is equal and in proportion to the space available on the screen.

- ***Maximized Window:*** A window which uses the whole screen is called maximized window. No other previously opened window is visible and all the details of Desktop are hidden behind the maximized window.

- ***Minimized Window:*** A window can be sized down to an icon so that it occupies only a small portion of the screen.

In GUI the screen is called the Desktop and the workspace is referred to as a Window.

- ***Desktop:*** The background of screen on which MS-Windows icons and dialog boxes appear is called a Desktop. It resembles the desk top of a manager with various files and folders kept on it.

- ***Window:*** It is a rectangular area on the screen which contains applications or documents you are working with. More than one window at a time can be opened on the desk-top. You can open, close, move windows and change the size also.

Student Activity 1

1. What is an interface ? Why is it required?
2. What is GUI? How is it different from CLI?
3. What is a mouse? Describe various functionings of the mouse.
4. What are Icons?
5. What is a desk top?

11.6 WINDOWS

Window is an area bounded by rows and columns on the screen. The feature of splitting a screen into different parts is called Windowing. Microsoft Windows is a graphical user interface software for MS-DOS that makes the computer easy to use. GUI uses pictorial icons, rather than text, to help the user interact with an application program. In a window a user can run programs, enter and move around the data, and perform other DOS operations by pointing at the objects on screen through mouse.

Besides this, it also reduces complexities involved in running other software packages because running and operations under a window are general and applicable to different applications. Windows allows you to use multiple packages simultaneously and view them on separate screens. Different applications run in their respective windows and number of windows can be opened to run different programs. It saves valuable time of loading/unloading packages as one can very comfortably switch between packages (currently opened) without closing the previous one.

Data can also be shared/switched between packages. For example, a company's balance sheet can be cut from an Excel file and pasted onto its annual report very easily that is being composed under any word processing packages like MS-Word.

DDE (Dynamic Data Exchange) and OLE (Object Linking and Embedding) features allow the data to be linked accross packages, i.e. any change made on to source application (Lotus) will automatically update destination (DTP) application data as well.

Types of Windows

Windows are broadly categorized into two types:

- ***Application Window:*** Is that window which contains an application menu and a program, currently running, in the application work area. The application or the program is opened within this application window.
- ***Document Window:*** Is a window inside application window; each document window contains a single document or data file of that application.
- ***Dialog Box:*** It is a method of interaction between the applications and the user. It appears when we select a command having ellipses (...) after it. It appears temporarily to represent or supply information. Dialog Box may have several options in it.

11.7 COMPONENTS OF A WINDOW

- **Title Bar** It is the place where the name of each program or document appears, normally at the top of its respective window. Title bar indicates which window is currently active. At any time only one window can be active. When a window becomes active, its title bar changes its colour (or intensity in monochrome VDU). Double clicking on the title bar causes window to maximize and restore its size.
- **Menu Bar** The horizontal bar containing the menu items of an application is called a menu bar. It appears below the title bar. Some of the menu options in each application are alike, but some may change depending upon the application currently running. Options like File, Edit and Help are generally available with all the applications.
- **Control Menu Box** It is the button at the left most corner of the title bar having a dash (–) sign in reverse video. This box has two functions:
  - ♦ Firstly, this icon opens a control menu for a window. Most of the commands help in resizing a window.
  - ♦ Secondly, it helps terminate the program or close the document by just double clicking this control menu box.

Control menu commands are:

- ***Restore:*** To change the size of a window to its original size.
- ***Move:*** To move the window on a desk top from one place to another.
- ***Size:*** Change the size of the windows.
- ***Minimize:*** Shrink the open window to an icon.
- ***Maximize:*** This option is used to spread the window so that is covers the full screen.
- ***Close/Alt+F4:*** Closes the open window.
- ***Switch to/Ctrl+Esc:*** Switch between multiple windows.
- ***Maximize Button:*** It is a small button containing an up arrow at the right edge of the title bar. Click the maximize button to enlarge a window to its maximum size.
- ***Minimize Button:*** It is a down arrow button placed at the right edge of title bar. Click the minimize button to reduce a window to an icon.

NOTE: You can also use control menu command to maximize or minimize a window.

- ***Scroll Bar:*** Scroll Bar appears at the right end/or bottom edge of a window or list box whose contents are not completely visible. Each scroll bar contains scroll arrows and a scroll box, which enable you to scroll through the entire contents of the window or list box.
- ***Slider*****:** It is a small rectangular shaded box present within a scroll bar. It shows the position of information currently visible in the window or list box relative to the contents of entire window.
- ***Border:*** Window is covered on all four sides by a border. You can make the border of windows widen to distinguish between windows visually. Whenever mouse pointer touches the window at border, pointer changes to double arrow headed pointer, and now by dragging the mouse, window can be resized manually.

Student Activity 2

1. What is a window?
2. Describe various types of window?
3. What are the basic components of a window?
4. What are scroll bars?
5. What are sliders?

11.8 SPECIAL INDICATORS IN MENU/DIALOG BOXES

- ***A greyed command:*** It means the command is deactivated, i.e. not currently available for us to use. If a document is not yet opened then the options like save or closing a document remain disabled because they are not meaningful at that point of time. These commands cannot be selected by the user.
- ***Tick mark:*** It is a toggle command, i.e. clicking over on it will select it if command is not selected previously. One the other hand, if it has already been selected and user clicks or chooses the option then the command gets deselected. When the option is selected in this menu, a tick mark is displayed along with the options name.
- ***Triangle:*** If a triangle appears to the right of the option then a submenu is associated with that command.
- ***Hot key:*** When the menu is activated pressing the hot key, it opens the menu or executes the command. A hot key is represented by an underlined character in a menu name.

- ***Short cut key:*** It allows the user to execute the command with opening the menu whenever the combination of a key is pressed. The key combination is displayed after the option name.

- ***Ellipses (...):*** It indicates the presence of a dialog box on choosing the option or command. Buttons on a dialog box may also contain ellipses which indicate that dialog box will follow if a button with ellipses is chosen.

  Dialog box may contain following types of control:

- ***Text box:*** It is a box for entering data. When it is selected, an insertion point appears in the box, also called as I-beam of 'I' pointer. It is mostly used for specifying file names while loading or saving document and application or specifying search for in a word processing document.

- ***Check box:*** It is a small square box. When the box is empty, the command is not activated. To activate the command, select the option by clicking, a cross sign (x) appears in the box if the option is selected.

- ***Option button:*** These are exclusive settings. They are round shaped. Clicking on the desired button turns it on and the previous selection gets turned off.

- ***Command button:*** It is a rectangular shaped button used to execute or cancel a command immediately. Common command buttons available on nearly all dialog boxes are the OK and Cancel button.

- ***List box:*** List box shows you a list of options or items from which you can choose the required item. Some list boxes may have scroll bar on the right side of the box when the box is too small to display all the contents.

11.9 COMPARISON OF GUI AND CUI

GUI (Graphical User Interface)	CUI (Character User Interface)
Symbols and pictures are used to represent represent the commands.	Set of characters and words are used to Commands.
For execution of a command just clicking type full command line.	For execution of a command, user has to by mouse is required. command on the
General menu structure and commands are commands.	Different applications have their own set of used for all the applications.
Number of applications can be opened and executed in different windows at the same time.	Only one application runs at a time.
Minimum use of keyboard while mouse is extensively used.	Keyboard is extensively used.
Easy to learn and operate because of its for different user friendly graphical interface.	Difficult to learns different set of commands application and doesn't have user friendly interface.

Windows as an Operating System

First thing that users interact with is the operating system. An OS has its own interface to interact with the user. Commonly used disk operating system has a command line interface instead of a graphical interface. With the advent of GUI-based packages and Windows 3.1 gaining popularity, the need to modify the interface of operating systems was but obvious.

Launching of WIN 95 by Microsoft Corporation of USA gave a new revolution in the working of Operating Systems. The users of WIN 95 feel comfortable with its graphical easy-to-use interface.

WIN 95 provided easy execution of commands and file handling operations. In 1998 Microsoft came up with its next version of Windows Operating System – Windows'98 with online Internet capabilities.

With GUI based operating systems of Microsoft gaining popularity, other s/w giants have also understood the essential need of GUI interface. Even Novell, Oracle and SCO Unix have come up with new GUI-based versions.

11.10 WINDOWS'98

Windows'98 is an operating system. You may have heard of some other types of operating systems such as the DOS, or Mac OS used on Macintosh computers. There is also UNIX and Windows NT used mainly in large businesses. Windows'98, on the other hand, is geared to home users and small businesses.

Windows'98 is the next generation of a series of operating systems named Windows. Windows 3.0 was introduced in 1990 (not an OS). Windows'95 followed in 1995 and now we have WIN 98. The goal of this evolution is to make new versions more powerful than the previous one and at the same time, to make each new version a little easier and more interesting to learn and use. Windows'98 as an OS:

- is easy to learn and use,
- works with virtually every kind of program available today, and
- supports new forms of electronic communications and entertainment technologies coming your way over the next few years.

Windows'98 Desktop

The starting screen of Windows'98 is mostly a blank screen with a taskbar at the bottom of the screen and some icons located along the left hand side of the screen.

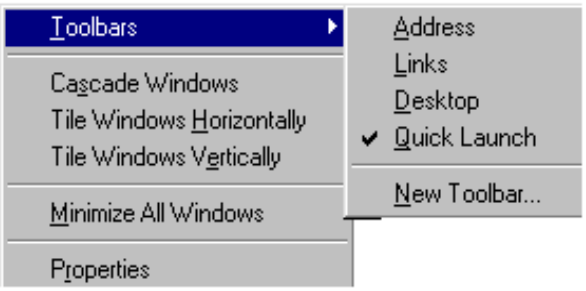
Taskbar

At the lower left corner, on the taskbar, there is Start button. On clicking it, we get a menu of choices. Taskbar appears at the bottom and contains the start menu button and other helpful tools. Every open program has a button on the taskbar associated with it. One can switch between programs just by clicking on these buttons. You can adjust the task bar at any edge by dragging it. To get more room on the desktop you can make it disappear it while you are doing other jobs. To do this follow these steps:

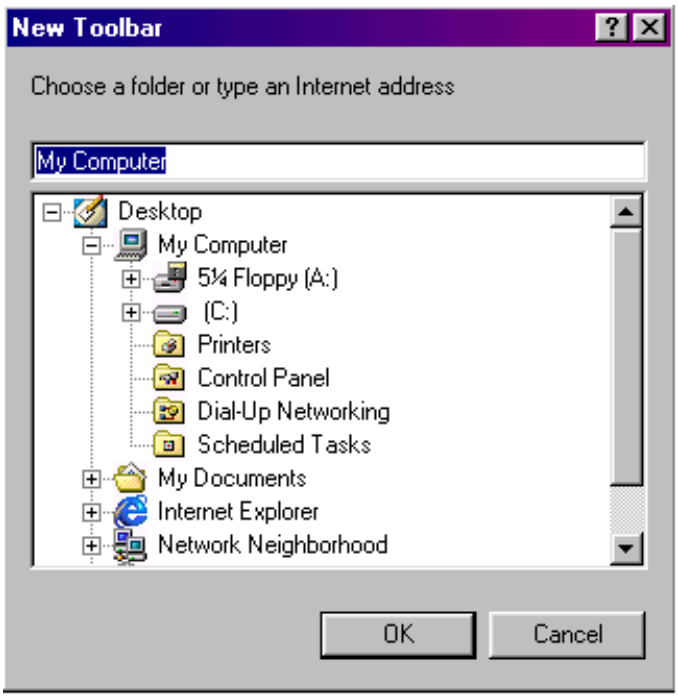
- Click the start button and choose settings ? Taskbar & Start Menu.
- On the taskbar option page, select Auto hido.

- If you want to access the Taskbar even when you're running a full screen program, choose always on Top.
- Click APPLY to preview the changes and OK to accept them.

Taskbar also contains Quick Launch toolbar with buttons that can be used to access Internet Explorer, launch the Windows'98 mail program, Outlook Express, change the view of Desktop, and use Windows'98 channels to access information. The Taskbar contains a series of different toolbars. To display a toolbar, select the toolbars option and then the toolbar you want.



You can create your toolbar by choosing New Toolbar option from Toolbars shortcut menu. In New toolbar window select a folder and click OK button. The items of that folder will appear as a Toolbar.



Some Desktop Icons

My Computer

This icon is present on every Windows ’98 Desktop. It contains icons for all drives, a folder for control panel, a printer folder and folders used in creating dial-up connections. My computer is one of several ways to access information about the drives and printer.

Recycle Bin

The Recycle Bin contains all the deleted files and folders. Whenever you delete a file it moves in Recycle Bin. From the Recycle Bin you can retrieve it after some days or even weeks depending on your settings.

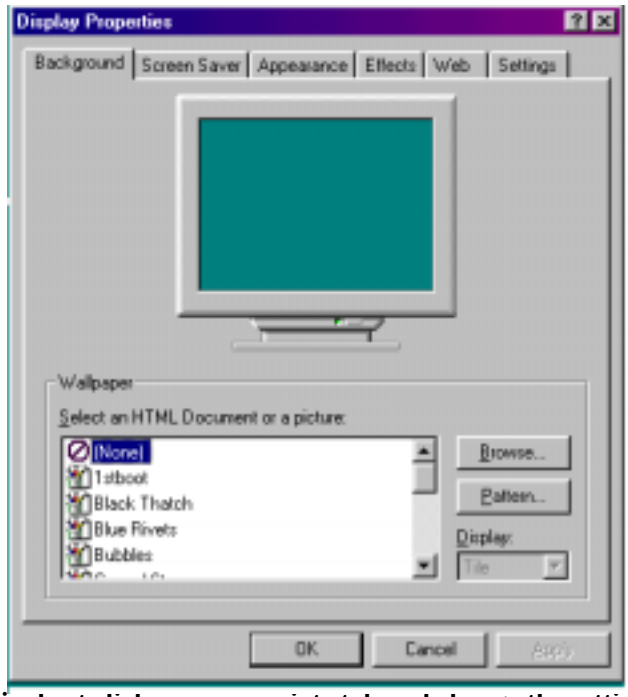
The Recycle Bin cannot be renamed or deleted. Files that are deleted using DOS programs or any program that is not part of Windows'98 are not sent to the Recycle Bin.

The Properties Sheet

Sometimes, you may want to have some information about files, folders and programs. You can get this information by right-click on the object and selecting properties. By choosing it you get a properties sheet. You can get some valuable information about the object you selected in properties sheet.

Setting Up Desktop

If you don't like the default settings of Windows'98, you can change them easily. You can change the appearance of the Desktop and almost any of the elements it contains. To change the settings that affect your Desktop, right click at any blank position on the Desktop and select properties from pop-up menu. You will get a display Properties dialog box with seven tabs.



From this sheet click on appropriate tab and change the settings you want.

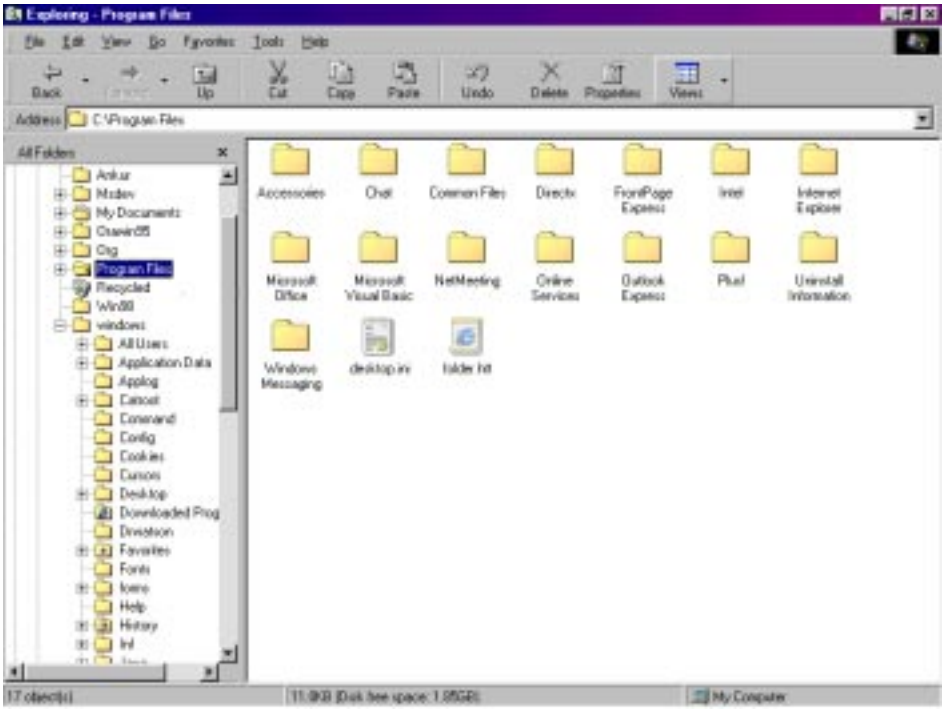
Creating Shortcuts

In Windows'98, there are many ways to complete the same task. For example, you can run a program using program menu or by run command or by opening Windows Explorer or My Computer and clicking on the program application. There is another convenient method to accomplish this task. You can create shortcut and place it on Desktop. Whenever you want to run that task just click on that shortcut icon.

You can get shortcut menu at many different places. To create a shortcut of the object, choose Create Shortcut option. A new Shortcut will be created and you can place it to any new location. To create a shortcut when object is not visible, right click at any blank spot on Desktop and select new shortcut. In the dialog box that appears, type in the name and location of original object. You can click the Browse button if you don't know the path of object, click Next and give the name of shortcut and then on finish. The shortcut will appear on your screen.

Windows'98 Explorer

Windows Explorer provides you the tools to work with files and folders and associate files with applications on your storage medium. To work with Explorer, click the start button and select Windows Explorer within programs.



If you will give a close look to explorer's window, you can see that folders are shown in left pane and contents of that folder are displayed in right pane. You can expand the view to see subfolders using plus sign or collapse them into one using minus sign associated with the folders that contain subfolders.

In the Explorer's window, the Desktop appears on the top of hierarchy with My Computer and all its pieces connected to it. You can explore any folder by right clicking on it and selecting Explore. The folder will open with the hierarchy of folders in the left pane and the content of the folder shown in right pane. You can cycle through the different views of Explorer by clicking the views button on the Explorer Toolbar.

Student Activity 3

1. What are hot keys?
2. What are short cut keys?
3. What are command buttons?
4. Differentiate between GUI and CUI.
5. Write a short note on windows 98.

6. What is the function of the following desktop icons:
   (a) my computer
   (b) Recycle bin
7. How will you create short cuts in windows?
8. What is the function of windows explorer?

Managing Files and Folders

File management is a very important part of any operating system. Windows'98 provides a log of tools for easy manipulation of files and folders.

Selecting Files and Folders

You have to select a file or folder before performing any action on it. One can select a file or folder just by clicking on it. If you want to perform same action on all the objects, select Select All option from Edit Menu. You can also use Ctrl+A key combination for the same.

To select some but not all the items, hold down the Ctrl key and pass the pointer over each file or folder you want to select. To select the items in a continous range, click the first item, then hold down the Shift key and click on the last item in the series. The items you select always appear in reverse video.

Creating a New Folder

Folders are just like directories in MS-DOS. You can create a folder on DeskTop or inside another folder on your disk. To create a new folder on your Desktop, just click on any blank spot on your screen and from popup menu select New >> Folder. A new folder will be created on your Desktop with a cursor blinking inside it, so that you can name the folder.

To create a folder inside any folder follow these steps:

- Open the explorer, select the folder in which you want to create new folder.
- Expand the existing folder by clicking it.
- Now, in the right pane at any unoccupied space, click the right mouse button.
- From popup menu select New >> Folder option.
- Give the name to new folder.

You can also create new files on the Desktop or in any other folder using the same method as above but by selecting the type of file you want to create instead of folder option from popup menu.

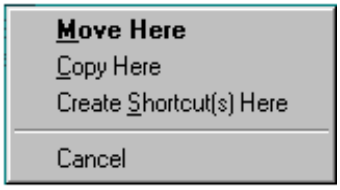
Moving and Copying Files and Folders

Moving and copying files and folders is important part of file management. When you move a file or folder, it is no longer in the original place where it was created. When you copy a file or folder it is created at destination but original still remains.

Moving or Copying Using Right Click Drag-and-Drop

To move or copy a folder using this method required minimum effort. To do this follow the following steps:

- Create the file or folder in the My Computer or Explorer window. You must be able to see the file or folder to drag it.
- Right-click the object and drag it to destination.
- Release the mouse button and choose Move Here or Copy Here from the pop-up menu.



Moving or Copying Using Left Drag-and-Drop

This method requires more attention because when you use left mouse button, the result is move only if the source and destination are on the same hard drive. If they are on different drives the result will be copy.

You can copy the files or folder using this method on same drive. For this you have to hold down the Ctrl key then move the selected items to destination. You will see a plus sign in the transparent icon as you drag. This means that a copy will be made when you release left mouse button.

Moving or Copying Using Cut/Copy and Paste

To move or copy folders using this method:

- Select the files or folders you want to move or copy, using Windows Explorer.
- Right click on the object and select cut or copy from the pop-up menu to move or copy objects.
- Find the destination folder and open it.
- At any blank spot in the folder window, click the right mouse button and select paste option from the pop-up menu.

You can also use the Edit menu for the cut, copy and paste options.

Deleting Files and Folders

To delete a file or folder, right click on that object and select Delete from the short cut menu. You can also perform the same task by highlighting the items with the left mouse button and press the Del key on your keyboard or choose Delete option from File menu.

You will be asked if you want to send the items to Recycle Bin. On clicking OK the files will be moved to Recycle Bin.

If you want to delete the item permanently, select the object in Recycle Bin and choose Delete from the pop-up menu which will be displayed when you right click the object.

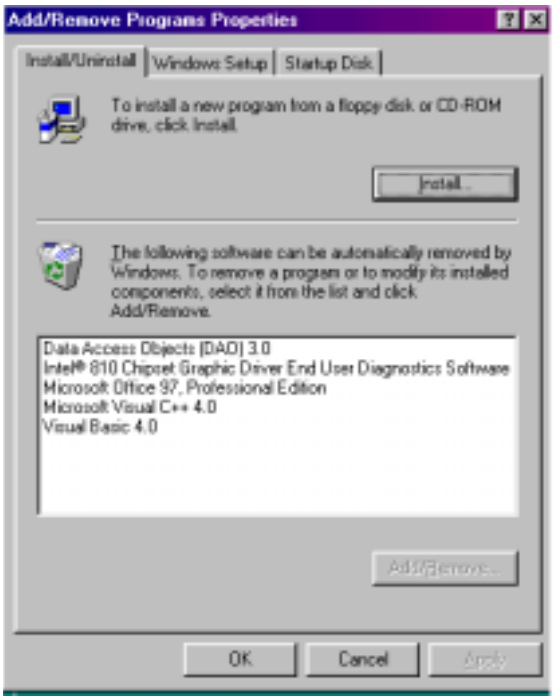
Renaming Files and Folders

To rename a file or folder, right click on that object and select Rename from pop-up menu, a cursor will blink inside the name box of that object. Type the new name and press enter or click any blank spot.

Installing Windows Based Package

Installing a new program is a very easy job in Windows ’98. To do this, steps to be followed are:

- Insert the first floppy disk of program into floppy disk drive or if the program came on a compact disk, insert the CD in the proper drive.
- Select Program >> Settings >> Control Panel from start menu.
- Click on the Add/Remove Programs icon.



- Click Install/Uninstall tab and then on Install button.
- The program prompts you to insert first installation disk or the appropriate CD-ROM and then the install routine of the program takes over.

Some Common Windows Based Applications

All the GUI operating systems come with a complement of smaller programs such as calculator and paint programs. Because of their usually limited capabilities, these programs are called applets rather than applications. Generally, the name applet applies to programs that come with the operating system. Some common applets are:

NotePad

Notepad is a text editor program. It has single document interface and very less features except speed. The text written in Notepad is unformatted text.

To start with Notepad, click start >> Programs >> Accessories >> Notepad.

In Notepad, you can insert date and time into your document, you can copy, cut and paste text. Setting of margins, paper orientation to set up a page can also be done.

WordPad

Worpad is also a text editor like Notepad but it is more elaborate. In WordPad you can create formatted text.

To start WordPad, click Start >> Programs >> Accessories >> WordPad.

It has a lot of tools for formatting text. It can hold big documents also. Unlike Notepad. it is completely integrated into Windows 98. Also, the document of Microsoft Word (.DOC), Windows Write (.Wri), Text (.Txt), and Rich text format (.RTF) are instantly recognized by WordPad.

Paint

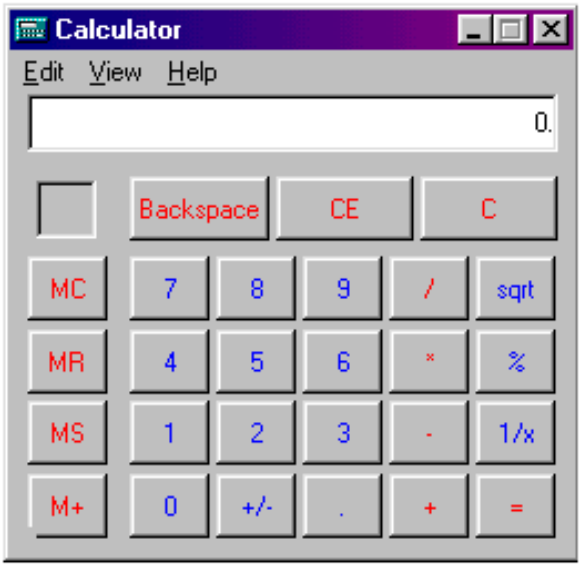
Paint is a very useful tool for creating and modifying simple graphics. It has tools to draw boxes, ellipses, lines and polygons. It also has free hand pencil, brush and spray to make pictures as you like.

To start Paint, click Start >> Programs >> Accessories >> Paint. Use the tools, create a drawing, you can save it using File >> Save option. You can also set this file as a wallpaper on your Desktop.

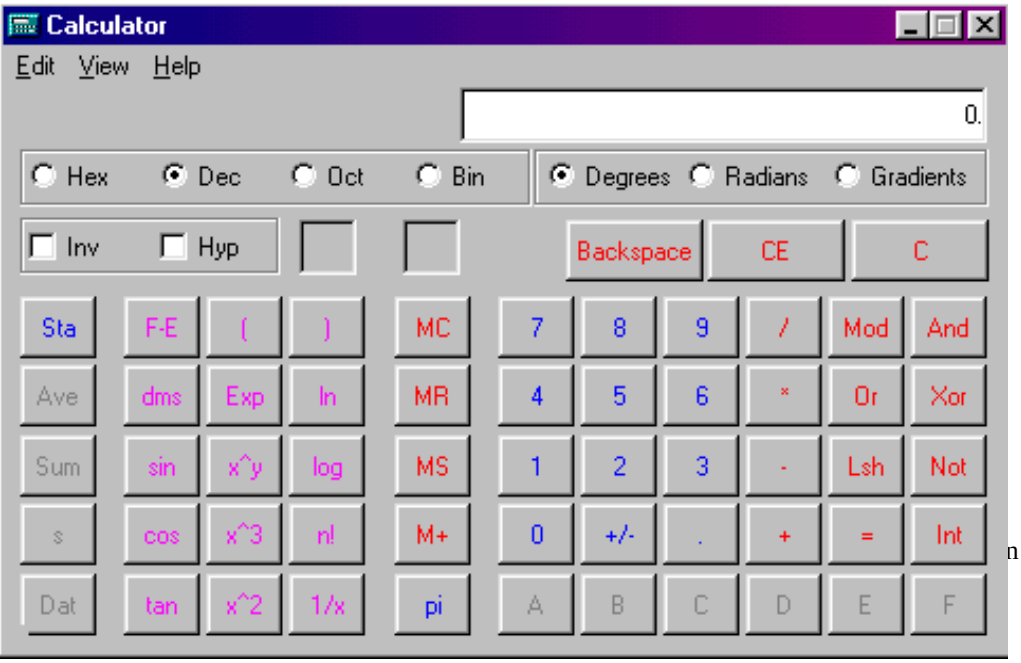
Calculator

For doing some calculations, you can use the facilities of calculator provided with Windows 98. This calculator has two views; standard view and scientific view.

To Start Calculator, click Start >> Programs >> Accessories >> Calculator.



To change the view, pulldown the View menu on the calculator and select Scientific.



n use the

1. How will you create a new folder?
2. What is the difference between moving and copying files and folders?
3. How will you delete files and folders?
4. How will you rename a file or a folder?
5. What is the difference between notepad and wordpad?

6. Describe the usage of paint?
7. How will you use calculator in MS-windows?

11.11 SUMMARY

- An interface is the common boundary between the user and the computer system application. CLI (Command Line Interface) is based on typing the instruction and seeing the result in text form. GUI (Graphical User Interface) provides a means of interaction between user and system using windows and mouse driven environment. Windows is an area bounded by rows and columns. The feature of splitting a screen into different parts is called windowing. Windows can be broadly categorized into two types.
- Application Window
- Document Window
- Windows has components like title bar, menu bar, control menu box, maximize and minimize buttons, scroll bar, and slider, etc.
- The advent of GUI-based packages and Windows-based operating system like WIN 95 and WIN 98 has brought a new revolution in the computer field. Windows 98 is easy to learn and use, works with virtually every kind of program available today and supports new forms of electronic communications and entertainment technologies coming your way over the next few years. You can get information about any object just by right clicking it and choosing properties from the pop-up menu.
- Window '98 Explorer provides you the tools to work with files and folders, and associate files with the applications on your storage medium. Moreover, Internet Explorer helps you to browse enough Internet in a very easy way.

11.12 KEYWORDS

Interface: Common boundary between the user and the computer system through which a user can interact with the computer application.

Graphical user interface: A user interface which provides a means of interaction with the system using a windows and mouse-driven environment.

Clicking: Pressing the left mouse button.

Double clicking: Clicking the mouse button twice.

Icon: Graphical representation of an element in window.

Maximized window: A window which uses the whole screen.

Desktop: The background of screen on which MS-windows icons and dialog boxes appear.

Window: A rectangular area on the screen which contains applications or documents.

Title bar: The place where the name of each program or document appears, normally at the top of its respective window.

Menu bar: The horizontal bar containing the menu items of an application, normally appears below the title bar.

11.13 REVIEW QUESTIONS

Fill in the Blanks

1. _____ is a common boundary between the user and computer system application.
2. A _____ shape of mouse pointer is used to draw lines or boxes or ellipses in a drawing application.

3. _____ and _____ features allows the data to be linked in two packages.
4. A taskbar contains _____, _____ and _____.
5. _____ contains all the deleted files and folders.

Multiple Choice

1. A window inside the application Window is called
   a. Dialog Box window
   b. Desktop window
   c. Document window
   d. Properties window
2. Deleted items are stored in
   a. My Computer
   b. Recycle Bin
   c. Windows Explorer
   d. None of these
3. The icon present in every Windows'98 desktop that contains icons for drives and folder for control panel and printer is
   a. My Computer
   b. Internet Explorer
   b. Windows Explorer
   d. All the above
4. _____ indicates the presence of dialog box on choosing the option or command

a. Check box
b. Triangle
c. List Box
d. Ellipses

5. All the open applications have a button associated with it on

a. Desktop
b. Status Bar
c. Toolbar
d. Taskbar

Descriptive Questions

1. What do you understand with User Interface? Define the need and advantage of GUI.
2. Define a window, types of windows and components of windows.
3. Compare and constrast between GUI and CLI.
4. Describe Windows ’98 Desktop, the task bar and its properties
5. Explain the following
   a. My Computer
   b. Recycle Bin
   c. Windows Explorer
   d. Notepad and Wordpad
   e. Shortcuts

Answers to Review Questions

Fill in the Blanks

1. Interface
2. plus

3. Dynamic data exchange, object linking and embedding.
4. Start button, system clock, other helpful tools.
5. Recyclebin

Multiple Choice

1. (c)
2. (b)
3. (a)
4. (d)
5. (d)

11.14 FURTHER READING

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UNIT

12

UNIX

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Give Overview of unix.
- Describe shell and kernel.
- Understand unix system architecture.
- Understand basic commands of unix.
- Describe editors of unix.
- Understand how to create user in unix.

U N I T S T R U C T U R E

12.1 INTRODUCTION

Unix is a multiuser, multitasking and time-sharing operating system which provides users with an environment which facilitates sharing of information. In this chapter we will discuss some basic features of Unix, its system architecture, Unix file system and its directory structure.

We will also see the booting sequence, basic commands and security provided by Unix. By the end of this chapter you will be able to understand what Unix is and how one can work on it.

12.2 OVERVIEW OF UNIX

Unix was developed by Ken Thompson, Dennis Retchie and others at Bell Laboratories. There are several reasons that are attributed to the popularity and success of the Unix system:

- The system is written in high-level language, making it easy to port on different machines.
- It has simple user interface with the power to provide the services that the user wants.

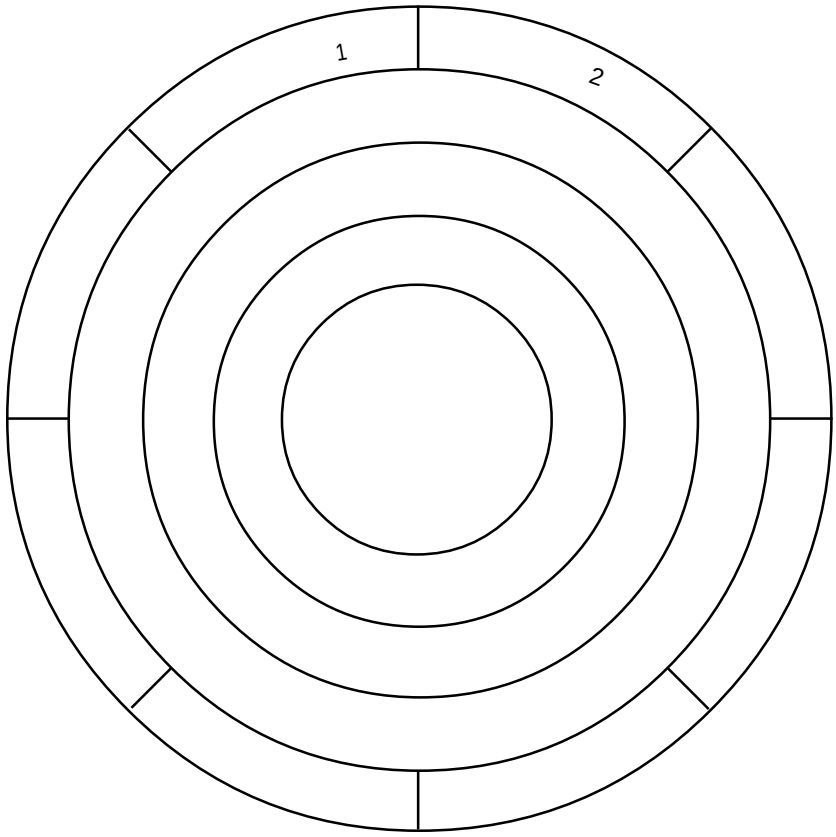
- It provides features that allow complex programs to be built from simpler programs.
- It uses a hierarchical file system that allows easy maintenance and efficient implementation.
- It uses a consistent format for files, the byte stream, making application program easy to write.
- It is a multiuser and time-sharing operating system.
- It hides machine architecture from the user, making it easier to write programs that run on different hardware implementation.
- It includes the Kernel and all essential programs like compilers, editors, command language, etc.

12.3 CONCEPTS OF SHELL AND KERNEL

The Shell

Shell is a utility program on all Unix. It acts as an interface between user and kernel. It is a command interpreter, translating user requests, to be understood and executed by Kernel. The shell interprets the first word of command line as command name. For many commands, the shell 'forks' and the child process 'execs' the command associated with the name, treating the remaining words on the command line.

The shell usually executes a command synchronously, waiting for the command to terminate before executing next command line. However, it also allows a synchronous execution, where it reads the next command line and executes it without waiting for the prior command to terminate. A shell provides facilities like, interactive environment, shell scripts, input/output redirection, piping mechanism, metacharacter facilities, background processing and customized environment.



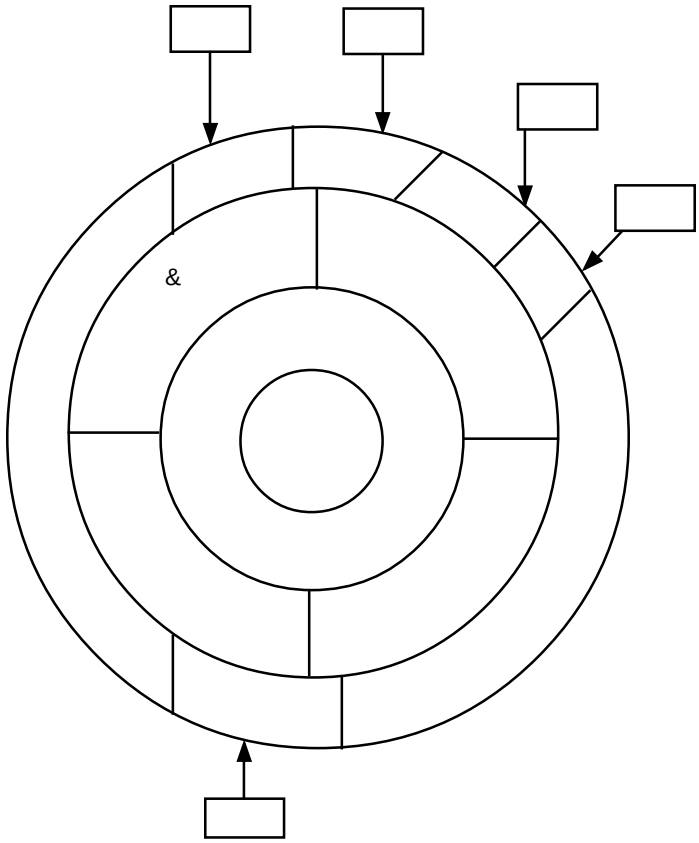
The Kernel

The Kernel is the core of the Unix Operating System. It interacts with a hardware part, manages the computer's memory, executes the applications of the users and handles errors. It generates the shell process and interacts with the user through shell. A kernel provides the file system, CPU scheduling, memory management and other operating system functions through system calls.

The system calls instruct the kernel to do various operations for the calling programs and exchange data between kernel and the program. Kernel is loaded into memory when computer is turned on and remains running no matter which software or shell is running.

12.4 UNIX SYSTEM ARCHITECTURE

Unix consists of two separable parts: The kernel and system programs. One can view Unix Operating System as being layered as shown in the figure.



Kernel helps in isolating the system from the hardware. As programs are independent of the underlayering hardware, it is easy to move them between Unix systems running on different hardware, if the programs do not make an assumption about underlayering hardware.

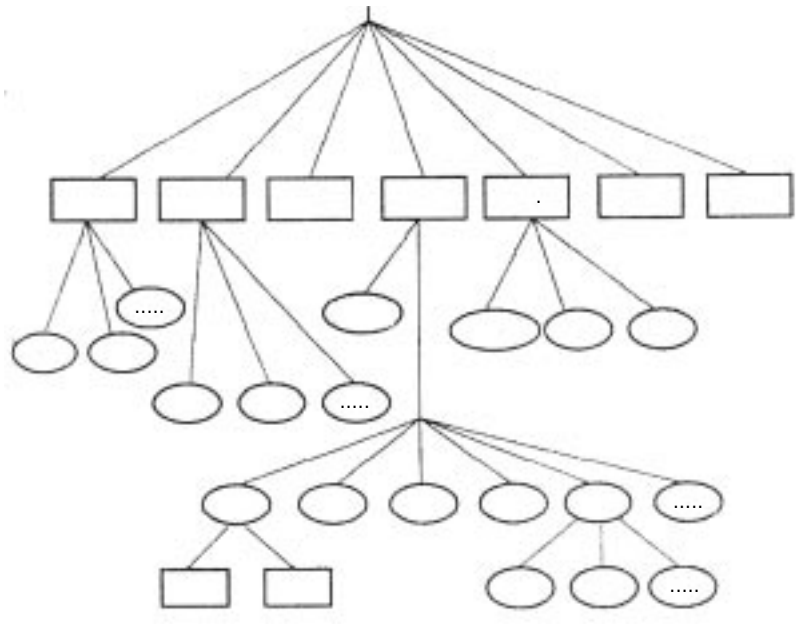
The programs such as shell and editors shown in top layer interact with kernel by invoking a well defined set of system calls. The system call instructs the kernel to do various operations for calling programs and exchange data between the kernel and program.

The system calls for Unix can be categorized in three groups: File Manipulation, Process Control and Information Manipulation. Since devices in Unix are treated as (special) files, the same system calls support both file and directories.

Unix File System

A Unix file is a sequence of bytes. The files are organized in tree-structured directories. The directories are themselves files that contain information on how to find other files. A path name to a file is a text string that identifies a file by specifying a path through the directory structure to the file. The figure below shows the typical Unix file system organized as a tree with a single root

node called root (written "/"); every non-leaf-node of the structure is a directory of files and files at the leaf nodes of the tree are either directory or regular files or special device files.



Programs in the Unix system have no knowledge about the internal format in which kernel stores data, treating the data as unformatted stream of bytes.

Directories are like regular files (stream of bytes) but the data contains the names of the files in the directory in a predictable format so that the operating system and programs such as is (lists the names and attributes of files) can discover the files in directory. The Unix system treats devices as if they were files. Devices occupy node positions in the file system directory structure. Thus, the Unix file system is characterized by:

- A hierarchical structure
- Consistent treatment of file data
- The ability to create and delete files
- Dynamic growth of files
- The protection of file data
- The treatment of peripheral devices as files.

I-nodes

Associated with each file in Unix is a little table (on disk) called an I-node. An internal representation of a file is given by an i-node, which contains a description of disk layout of the file and other information such as file owner, access permissions and access times. The term i-node is a contraction of the term index node and is commonly used in the literature of Unix system.

I-nodes exist in a static form on disk and the Kernel shifts them into the main memory and manipulates them. When a process refers to a file by name, the Kernel parses the file name one component at a time, checks that the process has permission to search the directories in the path and eventually retrieves the i-node for the file.

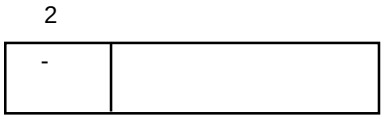
Student Activity 1

1. Why is unix so popular?
2. Define shell.
3. What is the kernel?
4. Describe unix system architecture.
5. Describe unix file system.
6. What are the characteristics of unix file system?

Directory Structure in Unix

Directories are the files that give the file system its hierarchical structure. A directory is a file whose data is a sequence of entries, each consisting of an i-node number and name of a file contained in the directory.

The directory structure used in Unix is extremely simple as shown in figure. Each entry contains just a file name and its i-node number. All information about the type, size, time, ownership and disk blocks is contained in the i-node. All directories in Unix are files and may contain arbitrarily many of these entries.



When a file is opened, the file system must take the file name supplied and locate its disk blocks.

-
(2)

0	83	
16	2	..
32	1798	
48	1276	
64	85	
80	1268	
96	1799	
112	88	
128	2114	
144	1717	
160	1851	
176	92	
192	84	
208	1432	
224	0	
240	95	
256	188	

Some Unix Directories and Files

It will be useful and interesting to get acquainted with the Unix system directory structure. Let's see some system directories and its contents.

The directory/bin contains the executable file of Unix system commands. These include the commands like ls, cd, pwd and who, etc.

The directory/dev contains special device files concerned with hardware like printers, terminals and hard disks.

The /etc directory contains many commands which are reserved for the use of system administration. It also contains some text files such as /etc/issue that contains message before login and /etc /motd has text message you see just after login. /etc/group has name and group number of all groups and /etc /passwd contains users login name, identification number and encrypted password.

/lib contains system libraries used with 'C' compiler. /temp is used for storing temporary files.

/user /bin holds Unix systems commands which are more of utilities. /usr /include contains the header files used with 'C' programs.

12.5 BOOTING SEQUENCE

Booting is the process of loading OS from secondary storage to main memory. The following four processes are invoked while booting : init >> getty >> login >> logon. On switching on the computer the common task Post (Power on Self Test) is executed which loads the bootstrap program in turn to run the above four processes.

This init is the 1st process which checks for hardware and invokes the next process getty.

Getty process monitors a terminal line, invokes the login process which asks the user to enter the login name. Login process after getting the login name asks for password. On entering the password, login process invokes the logon process. Logon process shows the terminal type message and gives the prompt to user.

12.6 LOGIN AND LOGOUT PROCESS

To boot the system one has to switch on the console and then the system. Once the system has been booted up, all the terminals connected to the system get login prompt.

Login

To access a Unix system, so that one can use its facilities, one has to enter a valid login name and password. The information entered by the user is checked by the system to confirm its validity. The file etc/password is used by the system for this purpose. The /etc/password file contains the following information: Login Name, Password (encrypted), User Identification Number (UID), Group Identification Number (GID), Remarks, Home Directory, Login Program (shell in which user wants to work).

The home directory contains the following files: Login file, cshrc File, Profile file. After the login message you see a prompt, which is a sign that Unix is ready for your commands.

Logout

In order to come out of the working directory, the user has to logically end the session with logout command at the end of every login session. The process is similar to that of login. A special file logout is related to logout. After execution of this command, the system searches for logout file in home directory. If the file is present in the home directory then the commands placed in it are executed in sequence.

12.7 BASIC COMMANDS OF UNIX

Commands in Unix are utility programs which instruct Kernel to do various operations. A command in Unix has basic syntax as:

Command [-option(s)] [<filename(s)]

Here we have some basic commands of Unix

- ***Current Directory:*** Every user who has an account on a Unix system also has a directory where he reaches after logging in. This directory is known as *Home Directory*. The current directory is known as the directory in which you are working. You can find out your current directory by issuing the command

  $ pwd

  pwd stands for Print Working Directory. The output of this command is full path name of current directory.

- ***Listing Directory Contents:*** The ls command is used to list the contents of a directory. It can be used with the path of a directory to list its contents. The format of command is:

  $ls [-option] [pathname]

  the option can be

  -l : to see the long listing of the files and directories.

-a : to see all files including hidden files.

-x : to see several names per line.

-R : to see contents of directory and its sub directory.

e.g., $ ls - l /usr/vibhor

-rwxr-x--x	1	Manish	user	22	March	19	22:03	bil 1
drwxr-x--x	2	Amit	user	25	Feb	05	16:02	dic1

In this output, first column of first field tells you that file is a directory or not. Rest nine columns are the permissions on that file. Next field indicates links to the file. Third field shows owner of file and fourth shows the group name. The other details are file size in bytes, date and time of last modification and file name respectively.

- ***Making a Directory:*** To create a new directory inside a directory mkdir command is used. This command can take one or more arguments and creates the directory as specified.

  e.g. $mkdir /usr/bill/mydic1 /usr/bill/mydic1/mydic2

  This command will create a directory mydic1 under bill which is in usr directory of root and then create mydic2 under mydic1.

- ***Deleting a Directory:*** You can delete an empty directory by using rmdir command which stands for remove directory. Remember, there should not be any file or directory under the directory that you want to delete and it should not be the current directory.

  e.g., $rmdir /usr/vibhor/mydic1/mydic2 /usr/bibnor/mydic1

  This command will delete the directory mydic2 under mydic1 and then mydic1from vibhor directory. The reverse sequence of arguments will not work as in that case mydic1 will not be an empty directory.

- ***Changing to a Directory:*** You can change your current working directory by specifying the cd command. cd stands for change directory.

  e.g.:

  — $cd /usr/bin

  After issuing this command, your current directory will be bin under usr directory of root.

  — $cd ..

  This command will bring you back in the parent directory.

Student Activity 2

1. Describe the directory structure in unix.
2. Which processes are invoked while booting in unix?
3. Describe Login and Logout process in unix.
4. How will you create a directory in unix?
5. Which command is used to change to a directory?

12.8 FILE SECURITY

The first level of system security provided by UNIX system is in the form of access control. Every one who wishes to use the system must have an account in /etc/passwd file. This security is provided by the super user who assigns a login and a password for the individual user.

- ***Login Name:*** A user should have a account in /etc/passwd file, then only he can log into the system. The account would have been created by the system administrator.

- ***Password:*** To protect one's files from other users, UNIX has the facility for defining password. To maintain the security of password it does not get displayed on the terminal and is stored in encrypted form in /etc/passwd file.

12.9 FILE ACCESS PERMISSIONS

Let's explore what file permissions are and what effect they have on its accessibility. Every file has a set of permissions associated with it, which determines which user can work with that file upto which extent. You can see that the file permission for a file is a long listing of files.

```
$ ls -l
drwxr-xr-x1  vibhor  user  26  May  18:02  Deep
drwxr-xr-x1  vibhor  user  26  May  18:03  Madhvi
drwxr-xr-x1  vibhor  user  26  May  18:04  Amit
```

The first column of the first field has a 'd' in it, if it is directory. Then you will see the 9 columns which specify the file permission. The user community in Unix is divided into three categories – owner, group and others. The owner is the person who creates the file. All group members form second category of users. Finally the rest of the community is lumped under others. Every file has three mode of access–read, write and execute, represented in directory listing by r, w and x.

A file can be read by you if you have read access. If you have write access than you can alter its contents and in case of executable file, you can execute it if you have executed permission on it.

So the nine columns are divided into three parts – owner, group and others – of three columns each. So if you are owner of a file and want to have all permissions, while denying group members write permission and allowing others only execute permission, the permission mode should be rwxr-x–x.

For a directory file, a permission bit has a somewhat different meaning. A read permission on directory means you can cat it and it follows that you can do an ls on the directory. A write permission means that you can create, rename or delete files in that directory. Lastly, talking about execute permission, the execution of directory does not make sense normally. For a directory execute means weather you can cd to the directory or can copy files from that directory. This permission is often called search permission.

Some File Commands

- ***Looking At File Contents:*** To see the contents of any file on the terminal cat command is used. The cat stands for concatenate and actually cat can be given with any number of files as an argument. The cat joins all the files in specified order of arguments and then sends them to the terminal screen, e.g. to see the contents of a file like /etc/passwd, issue the command

  $ cat /etc/passwd

- ***Copying Files:*** To make copy of a file you have to give the cp command. By this command you can copy a file from one directory to another.

  syntax: cp [source] <filename> [[destination] <filename>]

  e.g., $ cp /etc/shadow shadows

  This will copy shadow file from, etc., directory to your current directory by the name of shadows.

  $ cp /usr/include/stdio.h /usr/bin

  This command will copy the file stdio.h from include directory to /usr/bin directory.

- ***Renaming Files:*** To change the name of any existing file use mv command of Unix.

  e.g. $ mv shadows shadow. This command will rename your file shadows to shadow. You may be surprised that a command called mv is used for renaming files instead of moving. The main objective of mv is to move files from one location to another. In this process you can change the name of the file at destination also. So if move is done in the same directory then this operation can be successful only if you change the name.

- **Deleting Files** If you want to delete a file then you can use the facilities of Unix rm command.

  e.g. $ rm shadow.

  This command will delete shadow file from your current directory. You can use the option -i (interactive) for confirmation before deleting and -v to wipe out everything in your current directory.

  e.g. $ rm-i shadow.

Changing Access Mode

You can change the permission modes of files and directories by using chmod command. There are two forms in which you can use chmod command.

i. Octal or absolute method

ii. Symbolic method (rwx)

The format of command is $ chmod mode filename. In absolute method, the presence of permission is indicated by 1 and absence by 0. The resulting 9 bit number is then converted to octal. Thus rwxr-xr-x can be written as 111101101 whose octal conversion is 755. So, if you want to give the permission rwxr-xr-x on a file, you can issue the command.

$ chmod 755 myprog

In symbolic method, the permission types are r, w and x. In addition you have to specify the group of users for which permission will be applied. They are u(users), g(group), o(others), and a(all of these). The + is used to add the permission while - is used to remove the permission.

e.g.: $ chmod a + rx myprog

This will give read and execute permission to every user.

12.10 EDITORS OF UNIX

Text editors are different from commands you type on your terminal because they allow you to change existing files directly. There are two types of editors:

- ***Line editors:*** Work on a line at a time.
- ***Screen editors:*** Allow you to work on a full screen of text.

  ex and ed are two line editors in Unix and vi is a screen editor. Besides this, there is a stream editor sed similar to the line editor ed.

Screen Editor (vi)

vi is a full screen editor. vi has a couple of links in which the most important link is the line editor ex. vi offers cryptic, and sometimes mnemonic commands, for editing work. For text editing vi uses 24 of the 25 lines. The last line is the ex commands, as well as the messages shown by the system such as name of file and its size in characters and lines.

Modes of vi

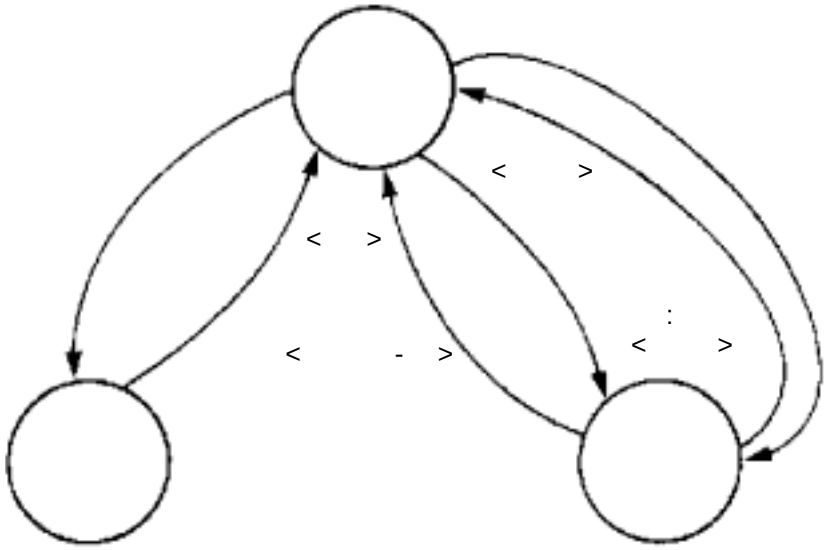
Many editors put you in some default mode when you start working with them. Usually you are in a mode where you can start typing at insertion point right away. With vi there is no such thing and when you start you have to explicitly tell vi what you want it to do. vi works in three modes:

- **Command mode:** Where keys are used as commands to act on text.
- ***Input mode:*** When any key depressed is entered as text.
- ***Ex mode:*** Where ex commands can be entered in the last line to act on text.

Command Mode

Command mode is the default mode of vi–when vi is invoked it goes into the command mode. There are innumerable commands that can be passed on to text.

e.g.: Space Bar: to move one character ahead.
Back Space: to move one character back.



Three Modes of vi

Input Mode

The input mode is used to enter text. Before entering the text, it is necessary to come into input mode from the default command mode. "Esc" key is used to change the mode from command to input.

Ex Mode

It is used to enter ex commands such as File Saving and Quitting Commands.

Invoking vi

vi [file name]

Purpose :	This command is used to invoke visual editor vi		
Options :	+ n	Positions the particular line in the middle of the window and the cursor at the beginning of that line.	
	+/pattern	This positions the first line containing the pattern in the middle of the window and places the cursor at the beginning of that line.	
e.g. :	vi +10 filename	Edit the file positioning from 10th line	
	vi +/all filename	Edit the file from the line containing the "all".	

Keys	Action
zz	Write edited text to the file and exit the editor
:w	Write the text to the file
:q	Quit the Editor
:q!	Quit and throw away edited text
Q	Quit *vi* and go into ex mode

12.11 CREATION OF USER

Whenever a new person wants to work on the system, he can't do so until he has been introduced in the/etc/passwd file. This job is done by the system administrator. He assigns a login to the new user and makes corresponding entry in the /etc/passwd file. Unless he has been introduced to the system, he can't be allowed to work upon it. Following steps are involved for user administration.

Introducing a User

- First of all, super user will have to make an entry in /etc/passwd file. This file includes login name, Password, UID, GID, Remarks, Home Directory, Login Program.
- Then create the user's home directory using the mkdir command.
- To change the owner of the directory from the super user, type in the name of user by using the chown command.
- Copy special files known as parameter files to user's home directory. These are .login,. profile and .cshrc file.
- When all the above formalities have been completed then changes are made in the /etc/ group file to add to the group of user.

Sometimes it is required that the operating system should have the facility of storing and retrieving the information about resource utilization. In order to facilitate this, Unix has provision of sophisticated collection of programs – shell scripts. These scripts keep the data regarding disk usage, memory usage, characters read/write, number of blocks read/write, amount of time logged in by user and command used during login session. This entire process is termed as System Accounting. It keeps track of all the details of all the processes which are executed by users and later on this information is stored on disk. Step to create system accounting are:

- A system accounting set-up is made by super user and thus there should be entry in the password file of his name. Thus there should be a user named ADM on the system ./etc/ passwd file should have entry as : ADM : UID : GID : ADMIN : /USR/ADM :
- Then login as ADM.
- In the system, following directory structure with owner as ADM should be present.

  /USR/ADM

  I

  ACCT
- In the profile file of above directory specify the path name as : Path = /usr/lib/cct :$path
- The system accounting should be turned off before system shutdown.

Student Activity 3

1. Describe various file access permissions in unix.
2. Give the unix command for the following:
   (a) Copying files
   (b) Renaming files
   (c) Deleting files
3. How will you change access modes in unix?
4. Name the unix editors.
5. What is the usage of exmode?
6. How will you introduce a user in unix?

12.12 SUMMARY

- Unix was developed by Ken Thompson, Dennis Retchie and others at Bell Laboratories. It is written in HLL, making it easy to port on different machines. Shell acts as interface between User and Kernel. It is command interpreter, translating user requests to be understood and executed by Kernel. Kernel is core of UNIX OS. It interacts with a hardware part, manages the computer's memory, executes the applications of the users and handles errors.
- A Unix file is a sequence of bytes which are organized in tree-structured directories. A Unix file system is characterized by its hierarchical structure, consistent treatment of file data, the protection of file data and treatment of peripheral devices as files. Associated with each file in Unix is a little table called an I-node which contains a description of disk layout of the file and other information such as file owner, access permissions and access time. Commands in Unix are utility programs which instruct Kernel to do various operations.
- The first level of security provided by Unix system is in the form of access control. The super user provides a login and a password for the individual user. Every file has a set of permissions associated with it which determine which user can work with that file and up to which extent. You can change the permission mode by using any method.
  i. Octal or absolute method or
  ii. Symbolic method.

12.13 KEYWORDS

Unix: A multiuser, multitasking and time-sharing operating system which provides users with an environment which facilitates sharing of information.

Shell: Utility program on unix which acts as an interface between user and kerner.

Kernel: The core of unix operating system which interacts with hardware, manages the computer's memory, executes the applications of the users and handles errors.

Directory: A file whose data is a sequence of entries, each consisting of an i-node number and name of a file contained in the directory.

12.14 REVIEW QUESTIONS

Fill in the Blanks

1. Unix is written in _____, making it easy to port on different machines.
2. Unix uses _____ file system.
3. Unix consists of two separable parts, _____ and _____.

4. _____ command can be used for changing access mode.

5. The user community in Unix is divided into three categories, _____, _____ and _____.

Multiple Choice

1. Commands, reserved for system administration are stored in

   a. /etc directory b. /adm directory

   c. /lib directory d. /bin directory

2. The text message you see after login is stored in file

   a. /etc/passwd b. /etc/issue

   c. /etc/group d. /etc/motd

3. The first process invoked by bootstrap program

   a. login b. logon

   c. init d. getty

4. To see the contents of any file on terminal, the command used is

   a. ls b. ls -l

   c. cat d. ls -R

5. The screen editor of Unix is

   a. cd b. ex

   c. sed d. vi

Descriptive Questions

1. Describe the Unix system architecture.
2. Describe the Unix file system and its characteristics.
3. Give the details of some Unix directories and files.
4. What are the file access permissions? How you can change the access mode?
5. Describe the editors of Unix.

Answer to Review Questions

Fill in the Blanks

1. high-level language
2. hierarchical
3. shell, kernel
4. ch mode
5. owner, group, others

Multiple Choice

1. (a) 2. (d) 3. (c) 4. (c) 5. (d)

12.15 FURTHER READINGS

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

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

UNIT

13

WINDOWS NT

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Describe windows NT.
- Define Multithreading.
- Define booting sequence.
- Describe login and logoff process.
- Describe client-server architecture.
- Describe NT server domains.
- Describe how to create a user.

U N I T S T R U C T U R E

13.1 INTRODUCTION

Windows NT is used widely as an operating system of the current era. It has got a complete set of capabilities which are essential for network administration as well as for a software professional. It is a very flexible, easy to handle, multiprogramming, multitasking, multiprocessing OS which is useful for any multiuser environment and also very effective on a stand-alone machine. Due to a fear of the power and strength of Windows NT other software companies indulged in developing operating systems and jumped into a large-scale marketing campaign, but were not able to create any breakthrough in NTs popularity. The main aim behind this chapter is to give a brief idea about the Windows NT features. In this chapter, you will find a variety of features, booting process and administrative tools of Windows NT which will make you familiar with it. It will provide you an easy way of learning and working over Windows NT.

13.2 OVERVIEW OF WINDOWS NT

Windows NT is a multiuser, corporate-oriented operating system developed by Microsoft Corporation. It is an architecture independent, multithreaded multitasking system which can work like a single machine OS, as well as a server for a network to provide client-server architecture. It supports DOS, Windows, Unix, OS/2, Win 32GUI and character-based applications with integrated network, network security and administrative tools.

NT stands for New Technology. The first thing that comes to our mind is – what is new in it? Most of the features of NT were available before its birth. It looks like Windows'95, it facilitates network like Novell Netware, it is very much similar internally to Unix operating system. The main feature of Windows NT is that it provides common interface with many common tools encapsulated in a single operating system. Windows NT has got the following main features:

- Architecture independent
- Multiprocessor support
- Multitasking
- Multithreading
- Centralized user profile
- Enhanced printing capability
- Enterprise feature
- Remote login
- Domain and workgroup

13.3 MULTITHREADING

All the tasks in any operating system can be defined as processes. Any multitasking or multiprogramming system can perform several processes simultaneously. During any given period of time, NT can execute a wide variety of processes. This includes running user processes, checking other user's password, data from a disk and quick retrieval.

Windows NT, Windows'95 and later versions can break these processes further in threads. Each thread can be defined as an event of a process. NT is basically scheduling events in terms of threads; not as a seperate process. Most of the process contains only one thread but can contain several threads also. Windows NT allow threads in a single process or application to be distributed to secondary CPUs if the system is a multiprocessor system for further smoothing of thread execution.

13.4 BOOTING SEQUENCE

When we switch on a computer the first thing to do is the Power on Self Test (POST) to check the required hardware resources done by the CMOS or any other input output checking system program supplied with the computer. It checks for the type of VDU card, hard disk, memory (RAM, Cache, etc.), serial and parallel ports.

The second step is loading of Master Boot Record (MBR) and Partition Boot Record (PBR) to tell the system from where to boot the system. If we have partitioned hard disk containing different operating systems, PBR provide us the information of multiboot option and tells the computer from where to load the operating system. Assuming that the boot-up drive's boot record was modified to load Windows NT loader program known as NTLDR.SYS, the following things happen:

NTLDR runs and tries to load the kernel of Windows NT. The kernel of Windows NT consists of four files

- ***BOOT.INI:*** It keeps the information of multiple partition used for windows NT.

- ***NTDETECT.COM:*** It checks the computer's hardware attributes (type of video display unit, hard disk, ports and memory, etc.) and compiles a list of hardware resources. This information is placed in the registry under the appropriate hardware keys.
- ***NTBOOTDD.SYS:*** This file is the main file which initiates all the booting processes and is called NTDETECT.COM.
- ***NTKERNEL.SYS:*** This is the actual kernel of Windows NT and provides the actual user machine interface.

BOOT.INI is an ASCII text file read by NTLDR. This file determines which are the other operating systems on the partitioned hard disk. This file is created during set-up and located in the root directory of the boot partition.

NT LDR.SYS (NT Loader)

BOOT.INT

NTDETECT.COM

NTBOOTDD.SYS

BOOTSECT.DOS

NTOSKERNEL.SYS

AUTOCHK.EXE

SMSS.EXE

WINLOGON.EXE

NTKERNEL.SYS is the actual Kernel of NT. After loading kernel a small program is loaded containing:

Autochk.EXE: Checks the disk, if there is any problem, corrects it.

SMSS.EXE: Initiates service manager process.

Finally WINLOGON.EXE gives the opening dialog screen with press Ctrl + Alt + Del.

Student Activity 1

1. What is windows NT?
2. What are the main features of windows NT?
3. Define multithreading.
4. What is booting sequence?
5. List the files contained in the kernel of windows NT.

13.5 BOOTING ANOTHER OPERATING SYSTEM

A person may need to store the previous OS on his/her computer while installing the new operating system. Windows NT provides this facility. It simply relocates the boot record of previous OS in the file BOOTSECT.DOS. This file is loaded and used as boot record when the optional OS is selected for booting. Only one optional alternative OS can reside with NT. This file should be available in the root directory of the boot partition.

13.6 LOGIN AND LOGOFF PROCESS

Login

Once we boot our system from Windows NT, it loads and displays the Welcome dialog box asking to press ctrl + Alt + Del. After pressing this key combination, login process starts by loading the

WINLOGON.EXE. We get new Welcome dialog box where we have to enter user name and password (if needed). It takes default Domain Name. Domain name tells us to which server we are connecting. We can change the domain server if there are other NT servers present.

Finally we press Enter or OK to enter in the system. WINLOGON.EXE includes the following value entries:

- ***Legal Notice Caption:*** The caption to be displayed in the title bar of dialog box.
- ***Default Password:*** The user password to be used in the logon process.
- ***Auto Adminlogon:*** To enable automatic logon, set this value to 1 and to disable it, set it to 0. Bydefault it is 0.
- ***Shutdown without Logon:*** To enable the shutdown button, set this value to 1. To disable it, set it to 0.

Logoff

From Program Manager we have to select File >> Logoff or press Alt + F4 keys or select File >> Shutdown. Logoff Windows NT warns the user about ending the Windows session. If we select OK or press enter key it asks to close the running applications if required. After closing the application it displays the Welcome screen.

If nobody is logged onto the system, the Welcome screen on it doesn't mean that you can switch off your computer. Before closing a Windows NT machine, some one must be logged on to the system and shutdown the system properly either through the start menu or from the dialog box that appears when you press ctrl+alt+delete again. You should wait until a dialog box appears that says "Its now safe to turn off the computer," before the user actually does so.

13.7 CONCEPT OF CLIENT-SERVER ARCHITECTURE

In traditional computing, the database is on the same computer which is running the application. A Client-Server Architecture divides the application into two or more separate parts or processes.

- **A Front-end Client:** Provides the user with the power to run the data-entry part of the application. Optimized for user interaction with the system.
- **A Back-end Server:** Can be local or remote. Provides data management, administration, system security features and manages information sharing with the rest of the world.

13.8 WINDOWS NT SERVER

It generally manages the user and resources. The server property of Windows NT in control panel allows:

- To manage shared and open resources
- To view which users are connected
- To issue alerts to computers connected to the server.

13.9 INTRODUCTION TO ADMINISTRATIVE TOOLS

Administration, in terms of a multiuser operating system like Windows NT, consists of three main parts.

- File Server Administration
- User Administration
- Back-ups

File Server Administration

File server administration is the routine task done by NT administrator. It includes decisions like which type of file system we should use (FAT, NTFS), how files will be managed, software loading, software updation, deletion of unnecessary and temporary files, configuration of workstations, organizing program groups, replicating directories accross the network, etc.

User Administration

User administration includes creation of user, allowing the various access to different directories and resources, deleting of users which are no longer part of the network, accounting of time and resource utilization and many other user-related tasks. We can say that user administration includes managing users by providing permissions, password access rights and groups users.

Back-ups

Creating backups of file server hard disk is a very important task. Back-ups are created for the security purposes of data. If by-chance a file gets corrupted, it can be reloaded from the back-up.

Tools which are needed to administer the NT system for the above task are known as administrative tools. These tools are used to manage the server as well as each workstation. Following are some of the administrative tools.

Control Panel

Besides actual system administration involving passwords, user profiles and disk management, the majority of NT configurations can be accomplished by using the Control Panel. Each user on any given system can have unique control panel setting such as screen savers, background, mouse sensitivity, screen colours, taskbar settings, printers, fonts, port settings, setting virtual memory file size, etc.

Any changes made in control panel settings are stored in the registry in the active account's section (user memory area) in the directory tree.

Student Activity 2

1. How will you boot another operating system from windows NT?
2. Describe login and logoff process.
3. Describe client-server architecture.
4. What are the main parts of windows NT?
5. What is control panel?

13.10 NT SERVER DOMAINS

NT server's most important advance feature is its domain-based naming and logon system. By combining your NT servers into domain, you can greatly enhance your control over access to your data and also simplify administering your file servers. All the servers in a domain share a single user database. You could create multiple domains to allow departments, divisions, or subsidiary to manage their own network without granting too much administrative control to anyone outside the business unit.

The NT server domain is a group of NT servers and LAN Manager 2.1 server and all have the same user database along with the workstation they serve. Sharing that common database means that users don't have to log on to each file server on the network individually; they just have to log on to the domain as a whole. As soon as users are logged onto the domain, their access to all the file servers in the domain is established.

Domains Versus Workgroups

Windows NT servers and workstation can be members of workgroups like domains, groups servers together in users dialog box so that users can easily find the resources they are looking

for. Now you have NT server domains also. This brings forward a equal–question "How are domains and work groups different?"

Workgroups	Domains
Workgroups are casual affiliations of servers.	Domains are a more formal and more secure grouping of servers.
To allow user access to all the servers in a workgroup, you need to create user's ID on individually.	Domain servers share common user database,i.e. they don't have to log on to each file server, individually. server; individually they just have to log on to the domain as a whole.
Workgroups can be made up of both Windows NT and Windows for workgroup servers. Windows NT servers can't be members of a workgroup.	Domains are made up of Windows NT servers and Windows NT workstations and, to some extent, Windows for workgroups 3.11 workstations.

Creating a Domain

A domain is created whenever you install Windows NT server on a computer and configure that computer to be the domain controller. To set up a new domain follow these steps:

- Open the network window from Control Panel.
- The current machine and domain name appear on Identification page of Network window. If you want to change the name, click the change button.
- Type the name of new domain in the appropriate box. When you click OK, your server sends a query over the cable to make sure that the domain you are creating doesn't already exist.

To configure a server as a member of domain, select the Server in Domain option when setup asks you to define this system as a server or domain controller. The domain controller must be available on a network to join a domain. To maintain the domain's exclusive nature, domain controller must create an account for a server before it can join the domain.

Managing a Domain

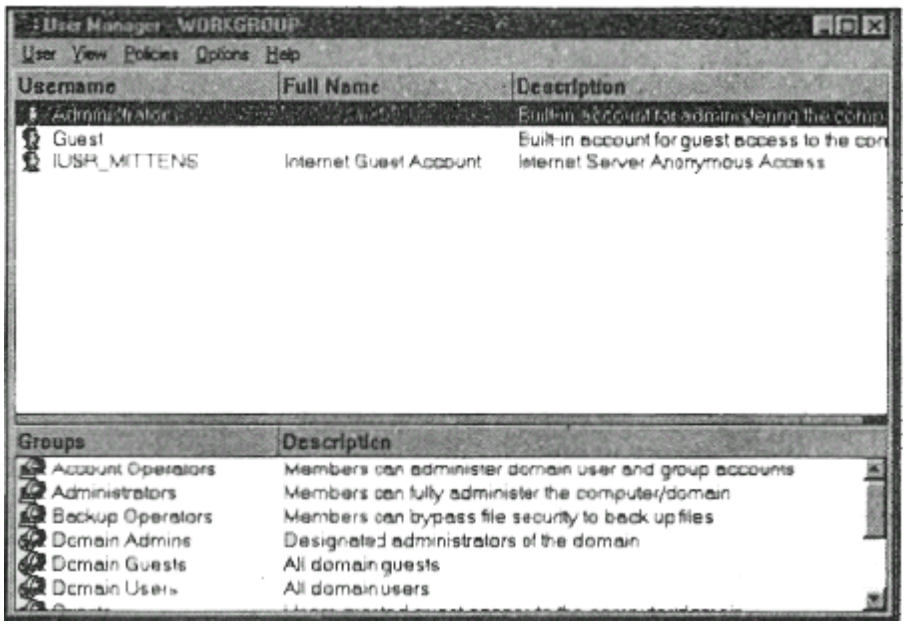
Whenever you log on to NT Server Domain with an administrative ID and open Administrative Tools groups from program menu, you will find some option different from standard Windows NT machine. Some options like User Manager have changed into User Management for Domains and you have few new tools like Server Manager and User Profile Editor. These give you better control of users, groups and the file server than you had with work groups.

These tools let you control which user will have access to your domain, when they have access and what their computing environment and desktop look like when they are logged in at a Windows NT workstation. With Server Manager, you can control Windows NT Servers throughout you domain.

13.11 CREATING A USER

You'll probably use User Manager in Windows NT administrative tools figure (a) or User Manager for Domain figure (b) in Windows NT Server Administrative Tools more than any other administrative tool.

( )



( )

Working with User Manager

User Manager is one of the six applications found in the Administrative Tools group under the programs menu. You can perform following tasks with the help of User Manager:

- Add new account to the workstation.
- Modify existing account settings.
- Set a logon script that executes when user logs on.
- Delete user account from workstation.
- Assign a user to one of several permission sets, called groups.
- Assign or Reassign the permissions given to each group.

- Set workstation polices such as minimum password length and account locking.
- Define which items you want in an optional audit trail of system activity.

You can run User Manager by selecting its name from Administrative Tools menu. Not all the users can operate user manager equally. Depending on privilege level, one might not be able to execute all the menu commands. In some other case, it might look as if you are executing the command but changes you made would not actually come into effect.

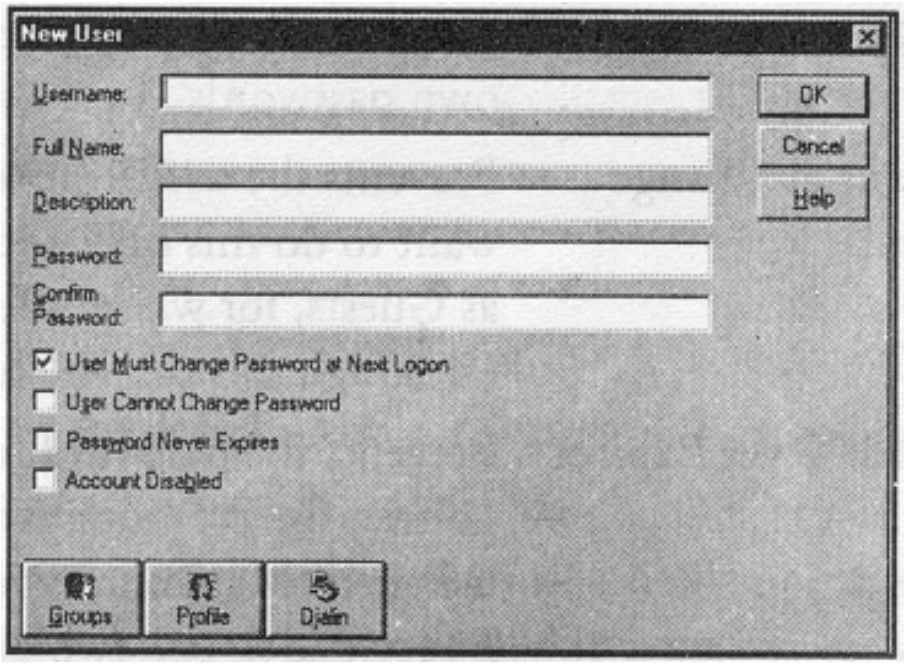
User Manager Rights

Class of User	Rights
Users	Users of this group cannot assign themselves membership in the administrator or power user group in order to give themselevs all rights on the computer. They can create only more users-level group.
Power Users	Create, modify and delete accounts and groups. This includes adding and removing accounts from the power users, guest and users groups.
Administrator	Create, modify and delete accounts and groups, assign password, set audit trails, set systemwide policies and set user rights for each group.

Adding a New Account

To add a new account in Windows NT workstation, follow these steps:

- Choose User >> New User. The New User dialog box appears as shown in the figure.

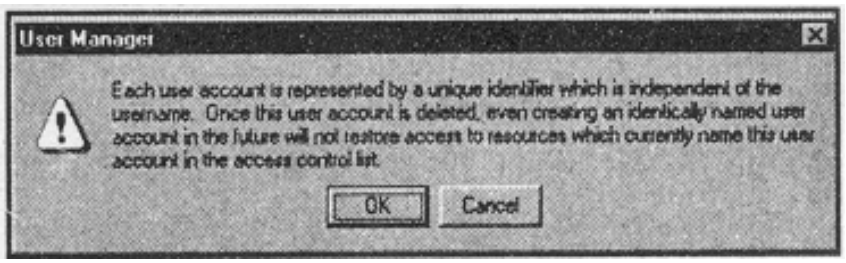


- Fill the Username, Full Name, Password and Confirm Password fields. The Description field is optional. Username can be upto 20 characters long and password can contain up to 14 character and is case-sensitive.
- Fill in the appropriate checkboxes in New User dialog box.
- Specify the group(s) to which user is assigned by clicking on Groups button.
- Create the profile, if necessary, by clicking on Profile button. A profile sets the optional logon script (batch file) that will run when the user logs on and the optional home directory.
- Click OK; the new user then is added to the list of account.

Deleting an Account

To delete an account on the workstation, follow the steps:

- Bring up User Manager from the Administrative Tools group.
- Select the account by clicking it in upper pane.
- Choose User >> Delete. You will get a delete confirmation box as in figure, click OK to delete this user.



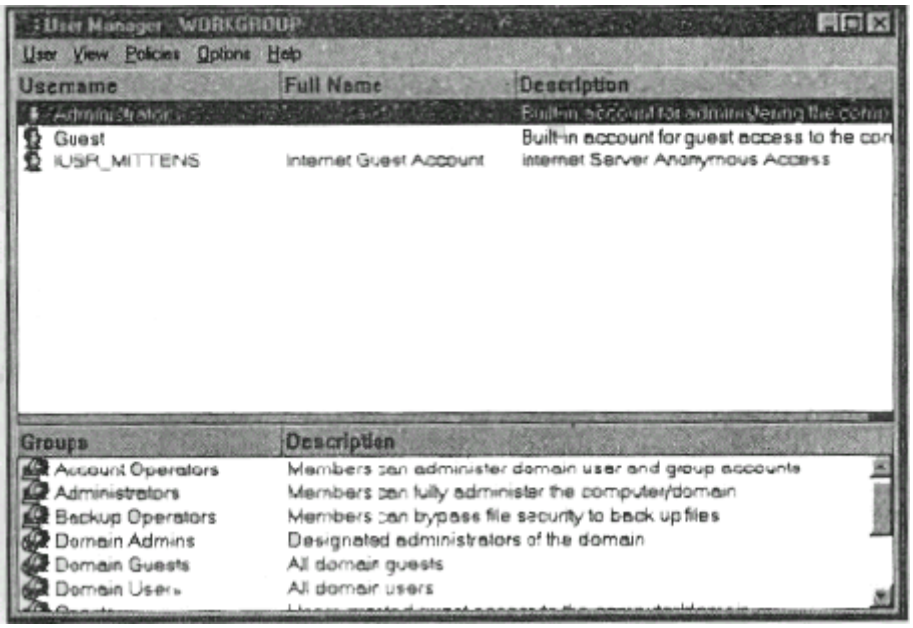
User manager can also be used for modifying account properties, managing account groups and assigning an account to a group. It can also be used to manage security policies.

Student Activity 3

1. Differentiate between domains and workgroups.
2. How will you set up a new domain?
3. How will you create a user?
4. What can you do with user manager?
5. Describe the rights of user manager.
6. How will you add a new account in windows NT workstation?
7. How will you delete an account on the workstation?

User Manager for Domains

User Manager for Domains is one of the Windows NT server administrative tools. As you have seen, the User Manager's primary tool that the administrators use for performing day-to-day administrative tasks is creating users and user groups, maintaining group memberships and changing user passwords when they forget them. User Manager for Domains does all these things just as Windows NT's User Manager but adds several new features to improve system performance and security.



Because NT Server is designed to support large networks, Microsoft decided that multiple administrators should be able to maintain a single domain's user database at the same time through User Manager for Domains. If you are not the only administrator working on domain at a given time, User Manager for Domains periodically refreshes your screen to let you see what other administrators are doing.

Global and Local Groups

NT server supports not only the groups supported in Windows NT, now called local groups, but also global groups. Both global and local groups make administrating your network easier by allowing you to grant rights and permissions to groups of users instead of giving them to each user individually.

Global Groups

The members of a domain's global group are user accounts within the domain. Global groups can't contain other groups but they can have members in common. They can contain only user accounts from within their name domain so they can't have users from other domains as members. These groups are called global because you can grant permissions not only in their own domain but also in any other domain in your network that trusts your domain.

Local Groups

Local groups allow you to include global groups from the domain you're managing or from any other domain that is your trustee. Besides being able to have global groups as members, local groups differ from global groups in two important ways. First, local groups are local to the servers that are members of a domain and are not available for other domains, regardless of any trustee relationship with other domains. Second, local groups can be assigned rights to create new users as well as permissions to access server resources.

Built-in Groups

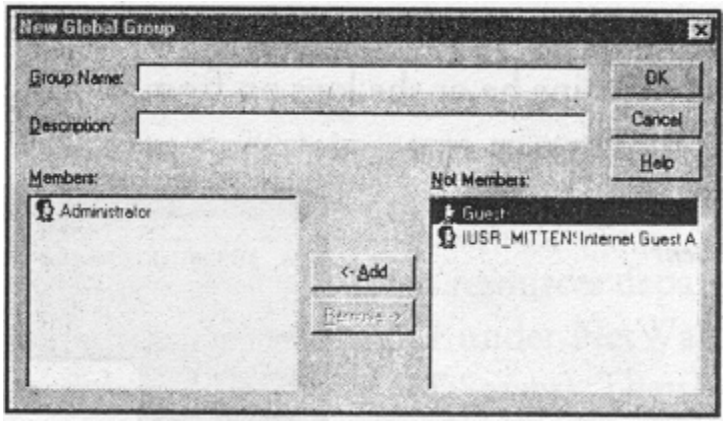
NT Server adds several new predefined groups to the set in Windows NT and this changes how some others act. The Power Users group has been dropped. The built-in groups of Windows NT server are:

1.	Every One	2.	Guests
3.	Users	4.	Domain Users
5.	Backup Operators	6.	Print Operators
7.	Account Operators	8.	Server Operators
9.	Administrators	10.	Domain Admins

Working with the User Menu

When you start working with User Manager for Domains, you will find that user menu alone has several choices as in the figure.

You can create a new global group by choosing New Global Group option from user menu. You will find a dialog box as in the figure below. In the Group Name dialog box enter group name, in Description box enter description and select the users you want to have as members of the group.



Server Manager

NT Servers server manager extends the Control Panel's server and services applets to let you manage not only the server process on the computer but also other servers in your domain. Server manager is also the tool you use to manage members of your domain, both servers and the work stations, adding and deleting members and promoting or demoting domain managers and servers.

As you will start server manager, you will get a Server Manager dialog box. You can see the lists of computers that are members of the domain you're currently logged onto.

One of the Windows NT servers is identified as Window NT 4.0 primary; this is your main domain controller. Other NT servers are identified as Windows NT servers. Windows NT systems in the domain are identified as Windows NT workstations.

Disk Administrator

Disk Administrator is a major administration application in administrative tools group which is visible only to administrators.

With Disk Administrator, you can perform these tasks:

- Display facts about partition sizes and set-up.
- Change drive-letter assignments.
- Create and remove disk partitions of various types.
- Create, enlarge and delete volumes sets.
- Create and delete stripe sets.

Administrative Wizards

These wizards group the common server-management tools into a single place and walk you through the steps required for each task. Windows NT Server 4 includes following wizards:

Add User Account Wizards: Adds new users to a Windows NT Server network.

Group Management Wizards: Creates and manage groups of users.

Managing File and Folder Access Wizard: Shares drives and folders for Macintosh, Microsoft and Novell network clients in one step and specifies security settings.

Add Printer Wizards: Sets up the printers that are connected to your computer or on a network.

Add Remove Programs Wizard: Installs or removes programs from your computer.

Install New Modem Wizard: Sets up or detects modems connected to your computer.

Network Client Administrator Wizard: Installs or updates network client workstations.

Licence Wizard: Makes it easy for administrators to keep track of the software licences they use for severs and clients.

Performance Monitor

It is a Windows NT utility which allows the users to create charts, reports and log files. It also allows to establish warnings called alerts concerning various activities on a computer, shows the performance of the computer, i.e., CPU utilization, etc.

Event Viewer

It is also a Windows NT utility program which lets the system administrator view a log of events triggered by the system or by application.

Student Activity 4

1. Describe user manager for domains.
2. Define global, local and built-in groups.
3. Describe the role of server manager.
4. Describe the role of disk manager.
5. What is Event viewer?

13.12 SUMMARY

- Windows NT is a multiuser, corporate-oriented operating system developed by Microsoft corporation. NT stands for New technology. Windows NT and later versions can break the processes further in threads. Each thread can be defined as an event of a process. A client-server architecture divides the application into two or more separate parts of processes-front-end client and back-end server. Administration in a multiuser operating system like Windows NT consists of three main parts:
    1. File Server Administration
    2. User Administration
    3. Backups
- Windows NT server's most important feature is its domain-based naming and logon system. An NT server domain is a group of NT servers and LAN Manager 2.1 server and all have the same user database along with the workstation they serve. User manager is a primary administrative tool for creating and managing users on a Windows NT workstation. User Manager for Domains is a Windows NT server administrative tool. It has several new features to improve system performance and security than Windows NT's User Manager.

Server manager is a tool you use to manage members of your domain, both servers and workstations, adding and deleting members and promoting and demoting domain managers and servers. Disk administrator is only visible to administrators. Administrative wizards group the common server management tools into a single place.

13.13 KEYWORDS

Windows NT: An operating system useful for any multi user environment.

Client: A system which provides the user with the power to run the data-entry part of the application.

Server: A system that provides data management, administration, system security features and manages information sharing with the rest of the world.

Workgroups: Casual affiliations of servers.

Domains: A more formal and more secure grouping of servers to share common user database.

Global groups: User accounts within the domain.

Local groups: Groups that allow you to include global groups from the domain managed from any other domain.

Built-in groups: Predefined groups windows NT.

Disk administrator: A major administrations application in administrative tools group which is visible only to administrators.

Event viewer: A windows NT utility program which lets the system administrator view a log of events triggered by the system or by application.

13.14 REVIEW QUESTIONS

Fill in the Blanks

1. Administration in terms of multiuser OS like Win NT consists of three main parts – _____, _____ and _____.
2. A _____ is a group of NT server and LAN Manager 2.1 server and all have the same user database along with the workstation they serve.
3. _____ are casual affiliations of servers.
4. The members of a domain's _____ are user account within the domain.
5. _____ allow you to include global groups from the domain you are managing or from any domain that you trust.

Multiple Choice

1. A Windows NT utility, that allows the users to create charts, reports and logfiles
   a. Chart Wizard
   b. Report Manager
   c. Performance Monitor
   d. Event Viewer
2. A Windows NT utility which lets you see a log of events, triggered by the system or by application
   a. Performance Monitor
   b. Error Monitor
   c. Event Viewer
   d. Event Monitor
3. The group dropped from User Manager for Domains is
   a. Back-up Operators
   b. Domain Operators

c. Every one
d. Power User

4. The program that runs and loads Windows NT is
   a. NTLDR
   b. NTOSKERNEL
   c. BOOTNT
   d. BOOTSECT
5. Login process starts by loading
   a. NTLOGONEXE
   b. NTLOGIN.EXE
   c. WIN LOGIN.EXE
   d. WINLOGON.EXE

Descriptive Questions

1. Give the details of booting sequence in Windows NT.
2. Describe Client-Server Architecture.
3. Define NT Server domains. How are they different from workgroups?
4. What do you understand by global and local groups? Give the name of built in groups in Windows NT server.
5. Describe Server Manager and Disk Administrator tools.

Answers to Review Questions

Fill in the Blanks

1. File server administrations, user administration, back-ups
2. NT server domain
3. Work groups
4. Global group
5. Local groups

Multiple Choice

1. (c)
2. (c)
3. (c)
4. (a)
5. (d)

13.15 FURTHER READINGS

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

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

Computers and Communication

UNIT

14

COMMUNICATION CONCEPTS

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Describe mainframes.
- Describe workstations and microcomputers.
- Define clients and servers.
- Define network and its various types.
- Describe various network and its types.
- Understand network protocols.
- Describe various services of internet.
- Define HTML, Java and Java script.

U N I T S T R U C T U R E

14.1 INTRODUCTION

Exchange of information between computers at the maximum possible rate is the need of the current era. As the uses for HTML have expanded dramatically over the past few years. The most common HTML application continues to be pages and sites that can be published on the Internet or on a corporate internet. Network is also a widely spreading field of communication nowadays. The main purpose of network is top provide information to a specific group of users. But with a terrific growth in the need to mutually share information and direct communication networking concepts was extended to a broader concepts, known as Internet.

14.2 MAINFRAMES

The largest type of computer commonly used is **mainframes**. Mainframe computers are used where many people in a large organization need frequent access to the same information, which is usually organized information of one or more large databases.

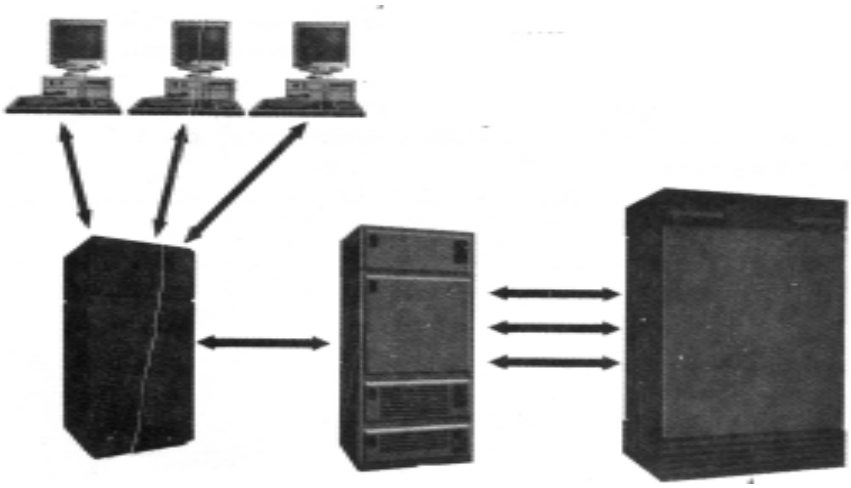


Figure 14.1

After UNIVAC I was sold in 1951, the mainframes caught attention of the computer industry. IBM, the computer giants captured the mainframes market in late 1950's and made their name and money in mainframes market. A mainframe computer system is generally made up of several computers, called terminals (A terminal is a keyboard and a screen wired to mainframe. It does not necessarily have its own CPU or storage it just has input and output devices that functions as the windows of the computer placed elsewhere), in addition to the mainframes, or host processor. The host processor is responsible for controlling rest of the processors, operations and the peripheral devices attached to it. A front-end processor is the one who handles communication to and from all the remote terminals connected to the computer system. At times, a backend **processor** is also used to handle data retrieval operation. Although host computer is capable of doing all the operations by itself but it is still better to have rest two processors to share the load and saving time and increasing speed.

The mainframe computer has processor that handles input, controls the database and output needs of the terminals attached to it. Each user has access to the contents of database. It is difficult to store such massive amount of data and it would be too slow also. Many modem MFS have multiprocessing capabilities however they are generally limited to 8 or less processor. They are slower than supercomputer and their speed is measured in megaflops and not in gigaflops.

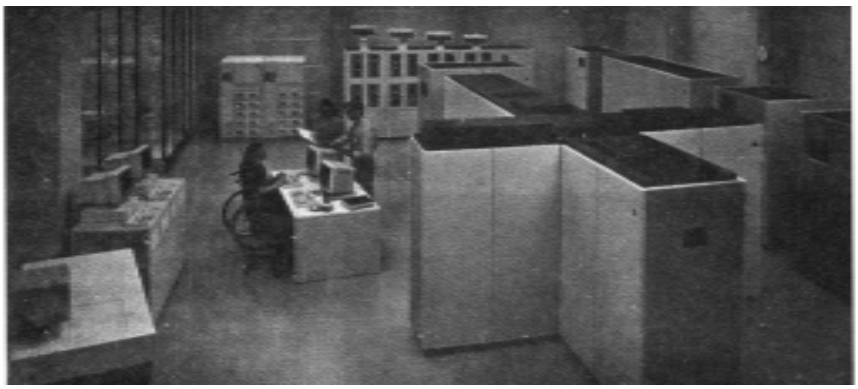


Figure 14.2

Mainframes can cost anything above $35,000. It used to be common for mainframe computers to occupy the entire rooms or even an entire floor of a high rise building. Typically, they were placed inside glass offices with special air conditioning to keep them cool and on raised floors to accommodate all the wiring needed to tie the systems together. This setup is not used anymore. Mainframes today, look more like a file cabinet although they still need the same type of environment.

These computer can support upto several hundred users simultaneously. It supports all of them by keeping number of programs in primary memory and rapidly switching backs and forth between

programs. These operations are so fast that users even do not come to know that it is working on others tasks. This property of processing many tasks concurrently for multiple user's called as "multiprogramming".

No one really knows from where this term mainframe originated from. Earlier IBM documents define the term frame as an integral part of a computers: "the housing …. Hardware supports structures, …. And all the parts and components there in". It was only when computer of various sizes and shapes came into existence, the big computers were referred as mainframes and eventually became one-word mainframes.

14.3 WORKSTATIONS AND MICROCOMPUTERS

When working on minicomputer and mainframes through the terminals, the users can just control the input and output of the computer. Whereas a single user computer gives you the power of controlling the total processing cycle i.e. input and output, processing and storage, you can select your own programs and do not need to be dependent on mainframes or mini's for storage. They are designed to meet the needs of an individual and thus called as Personal Computer also. Terms PC and microcomputers are interchangeable.

When we talk about computers today, we generally mean a PC or a microcomputer. Microcomputers have a great impact on the computer industry. Till 1975, they did not even exist and in 1995 the sale of PC was $16 billion. Microcomputers are the fastest growing segment of computer industry. One of the sources of the PC's popularity is the rate at which improvements are made in the technology. As the technology is growing, microprocessor, memory, chips and storage devices keep getting faster and better and bigger. Today, a typical PC (of the same price as 90 years ago) has 8 times as much RAM, 150 times more storage capacity and a microprocessor that is at least 100 times faster than a PC 10 years earlier. Analysts believe that the pace of this growth will be same for another 20 years.

In 1981, IBM called its first microcomputer the IBMPC. Within few years there were many more companies in the race to design computer compatible to IBMPC. Thus the term IBMPC became the name of the family of computer that included IBM's and IBM compatibles. The vast majority of computers fall in this family except Apple Macintosh. It is another family of microcomputer made by Apple computer. It is appropriate to say that Macintosh is personal computer but not a PC. Presently IBM has about 28 percent of the market where as Apple holds about 8 percent of market share.

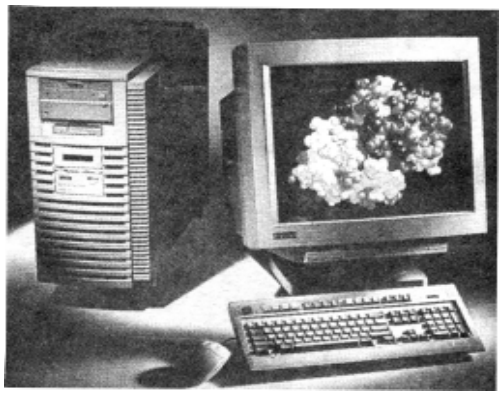


Figure 14.3

Few years ago, Apple computers, IBM and Motorola joined to develop the Power PC chip, which enables Apple computer to run IBM applications and vice versa. Most Apple Macintosh computer and compatible computers are based on this chip.

Single computer can actually fall into category of either microcomputer or workstation. A workstation is a powerful desktop computer designed to meet the computing needs of engineers, architects and other professionals, who need graphic display. Workstations are generally used for CAD (Computer Aided Design) applications. For this type of complex programs the computer needs great processing power and much storage. They are also used as services for LANs (Local

Area Networks). Workstations are sometimes called “Supermicros”. Although they look like desktops but the chip inside is different. Most workstation use RISC (Reduce Instruction Set Computer) microprocessors. RISC processors are used in special purpose applications, where speed is critical Now boundary between workstations and PC is becoming less distinct. Today’s PCs are better than workstations of past. Pentium pro has multiprocessing capabilities. Most microcomputers support multitasking (enabling the user to switch between the tasks). Multitasking saves a lot of time. The user can open another activity when one activity task is being processed, for example till the computer is down loading one thing in the browser, user can open another window for writing a mail (say notepad) or a calculator to perform some calculation. This not only saves time but rescues also.

One style of PC is desktop. These type of computer are small enough to fit on a desk but are too big to carry around. There are number of models in desktops. The cabinets come in flat (horizontal) and vertical (tower model) depending upon the space management of the user.

14.4 CLIENTS AND SERVERS

Like all the Internet services, the Web is based on a client/server system. This means you use a client program (which runs on your computer) to contact a server program (which runs on another computer, somewhere on the Internet). In particular, you use a Web client to communicate with web server. A web server is a computer connected to the Internet that runs a program (which is also called Web server) that takes responsibility for storing, retrieving, and distributing some of the Web's files. A Web client or Web browser is a computer that requests files from the Web. The name Browser is a good one for two reasons. First many people use the Web just for browsing, so the name is descriptive. Second, browsers can access a lot more than web server, and so to call programs "web clients" would be incorrect. Single program — your browser — can act as web clients, gopher clients, ftp clients, Usenet clients and even mail clients.

Student Activity 1

1. What are mainframes?
2. What do you mean by multiprogramming?
3. What are work stations?
4. Define micro computers.
5. Describe client/server system.

14.5 DEFINITION OF NETWORK

A group of computers and associated peripheral devices connected by a communication channel, capable of sharing files and other resources between several users is known as network. A network can range from a peer to peer network connecting a small number of users in an office to LAN connecting many users over permanently installed cables and dial up lines to a Metropolitan Area Network (MAN), or WAN connecting users on several different networks spread over a wide geographic area.

Objectives of Networking

Networking provides us with the facility to share distant resources such as database, processor or software. It provides high reliability by having alternate resources for providing distribution of processing so that load sharing can be achieved.

Networks are used to save money by using a network of computers which is cheaper than using a single mainframe, which costs several times more. A mainframe can be 100 times faster than a personal computer but the cost of mainframe can be thousands time more than that. Networking also provides cheaper expandability in terms of connecting new machines in a network; if we require more nodes, we can attach a new machine very easily at any point of a network communication medium. It provides such a communication medium that persons sitting at geographically separate locations can exchange information, very easily.

14.6 NETWORK PROTOCOLS

A collection of designated practices, policies and procedures often unwritten but agreed upon between its users that facilitates electronic communication between them, are known as network protocols.

Hence, computers are linked into networks, they are the basic building blocks of the information superhighway, and the communication protocols are the rules of the road.

14.7 TYPES OF NETWORKS

Peer to Peer Network

These networks are used for a small range of computers. Where all machines have their own resources and can also have shareable resources for other machines. It means that the resources of machines available for the network are controlled by different computers, so we can call it a network of decentralized resources. This type of network can be developed very easily using Windows'95.

Local Area Network (LAN)

LAN is a group of computers and associated peripheral devices connected by a communication channel, capable of sharing files and other resources between several users. Using LAN, we can get high speed connections among computers but have to sacrifice the ability to cover large distances. LAN can operate between 10 mbps (mega bit per second) to 2gbps. Due to the shorter area coverage, the LAN offers lower delays than WAN and MAN; delays on a LAN can be calculated in miliseconds. For the communication purpose, usually computers on LAN have a network interface device that connects the machine directly to the network medium. Main features of LAN are:

- A common communication medium over which all user terminals can share information, programs and hardware devices.
- A high transmission rate intended to accommodate the needs of both users and equipment.
- A low error rate in data transfer.

Advantages

- Provides a cost-effective multiuser computer environment.
- Easy physical connection of devices to the media.
- Network data transmission rates are independent of the rates used by the attached devices, making it easier for device of one speed to send information to device operating at another speed.
- It provides data integrity.

Metropolitan Area Network (MAN)

MAN is a public, high speed network, operating at 100 mbps or faster, capable of voice and data transmission over a distance of upto 50 Kms. A MAN is smaller than a WAN but larger than a LAN. The metropolitan area network standards are sponsered by IEEE (Institution of Electrical and Electronic Engineers), AT&T (American Telegraphy and Telephony) and The Regional Bell Operating Companies (RBOCs). IEEE 802.6 set of standards are dedicated to MAN.

A MAN is designed with two unidirectional buses, each bus is independent of the other in the transfer of traffic. The topology can be designed as an open bus or a closed bus configuration. MAN may cover an entire city. It may also utilize the Cable Television Networks (CATV) to connect computers together.

Wide Area Network (WAN)

A network that connects users across larger distances, often crossing the geographical boundaries of cities, states or countries is known as Wide Area Network. WANs normally use public telephone network and satellite links for data transmission. Data transmission rates are below 1 mbps (mega bits per second) for WAN. It is normally owned by multiple organizations. The transmission time is more for WAN because of longer distances and different transmission mediums used.

WANs have the following advantages:

- They tend to enhance reliability.
- They are used for remote data collection.
- They allow work groups to be spread across geographical boundaries.

Student Activity 2

1. What is a network?
2. What are the objectives of networking?
3. What are network protocols?
4. Describe the following:
   (a) Peer to peer network
   (b) LAN
   (c) MAN
   (d) WAN
5. What are the advantages of LAN?
6. What are the advantages of WAN?

14.8 SERVICES OF INTERNET

Interpretability (ability of different computer systems to cooperate in solving computational problems together) is the main feature of Internet application programs. Most users access the Internet using the Internet application programs without having any knowledge of TCP/IP networks, structure and the path of data communication. These application programs provide three basic services available on the Internet:

- Electronic Mail (e-mail)
- Telnet
- File Transfer Protocol (FTP)

In order to facilitate provision of these basic services, a number of user friendly tools have been developed. We will discuss the main tools here: Hytelnet, Archie, Gopher, Veronica, WAIS, World Wide Web (WWW).

Electronic Mail

E-mail is one of the basic Internet services – by far the most popular. It enables Internet users to communicate with other users individually or collectively by exchanging messages. Electronic mail (e-mail) has been so successful that many users depend on it for normal business correspondence. Although there are many electronic mail systems that are available, but TCP/IP makes most reliable mail delivery system due to the independence of the computer system architecture and also it does not rely on intermediate computers. By using e-mail, one can exchange messages in a variety of formats:

- Plain text
- Spreadsheet files
- Word processor files
- Image files
- Program files, etc.

Mail programs on the source computer can compose, send, receive and read e-mail messages. Once the message is composed, it travels in the electronic form through several Internet exchange sites before reaching its destination. Messages are held at its destination site until the receiver, to whom it is addressed, reads it, saves it in a file or deletes it. The receiver does not have to be logged in or using the computer continuously for e-mail messages to be delivered.

Telnet

Telnet service enables a user on one computer in the network to access information or run programs on another computer on the network. The service was introduced so that an Internet user on site (local site) could access data, software and other facilities situated at another site (remote site). Access to remote program is possible only when one has the permission (through password, etc.) to use the remote system. For using the remote system, one has to type the command 'Telnet' followed by domain name or the Internet address of the remote site.

Telnet service makes it possible to share services and resources without having to move large amounts of data or programs from one site to another. So we can say that "Telnet is an Internet exploration tool that allows computers to connect to another network and login as a local user of that network system."

File Transfer Protocol (FTP)

FTP is a very useful service which enables the user to retrieve a file quickly from a remote site. The service is most effective when the exact location of the file, file name, directory name and the Internet address of the remote system is known and used to transfer files between hosts, without being registered on the remote system.

The connection with the remote site is set up by giving FTP command followed by domain name of the remote system. Once the connection is established, file transfer can be effected following a set procedure. Several FTP sites permit you to access their anonymous sites. You can use these sites by loging on them as anonymous users. It asks for a password, you may or may not give the password, just by pressing return key you can login on that system.

Other Services

HYTELNET (Hyper Telnet)

Hytelnet is a tool for making more effective use of the telnet service. There are a wide variety of services and resources available on literally thousands of telnet sites scattered throughout the Internet.

This makes it very difficult to quickly locate the right source for information/service that one is looking for. It will be extremely useful to have some kind of directory service which can help in quickly locating the right site.

Hytelnet is such a directory tool for use with the telnet service. It was created by Peter Scott and his associates at the University of Saskatchewan. Hytelnet is developed around an organized list of telnet sites categorized by the type of services provided namely library catalogue, database services, bulletin board, electronic book, or network information. Hytelnet also comes with a glossary of network terms and other information about telnet, hytelnet itself and software available on various library systems.

Archie

Archie is a tool that helps locate a file to be retrieved using FTP. There are millions of files available to any user on the Internet using the anonymous FTP. Archie is invoked by giving the

file name (full or part) to one of the several specialist computers called Archie Servers on the Internet. Archie works as a client program to retrieve public domain files on the user computer.

The Archie Server scans its database (an archive of the file names) and returns the Internet location of the file. The location is the domain name of an anonymous FTP site and the directory that holds the file. It is useful for gathering information and indexing widely distributed information over the Internet. Once it has found the FTP site and the file, the anonymous FTP is used to retrieve the file.

Gopher

Gopher is a menu-based document delivery system. It was created and developed at the University of Minnesota to enable users to browse and retrieve documents in a campus environment. There are around 3800 gopher servers connected on the Internet which are collectively known as gopher space.

Gopher can be used to access various types of information sources like files, documents, address books and images, sounds and services in the form of telnet and phone-book servers. This software is designed to work on any computer system that can be connected to the Internet, viz., workstations, micro computers, mainframes. It is a very simple, menu-driven system and is very easy to operate.

Veronica

Veronica stands for Very Easy Rodent Oriented Netwide Index to Computer Archives. It is just like an indexed database and consists of different titles and Gopher Server items.

It provides keywords and other searching techniques for files by searching the menus of thousands of gopher servers. Once the file is located, it allows to browse through that file.

Wide Area Information Server (WAIS)

WAIS is a specialized software for searching and retrieving text document from databases located anywhere on the Internet. The search is based upon the keyword provided by the user. WAIS identifies documents after checking the most closely related document to the given topic. The search technique is very elementary in nature. You cannot use the 'and/or' type of operations.

When WAIS is used, there is no explicit connection between the user site and the site that holds the database. The linkage is handled by the WAIS system. WAIS ensures that the databases requested are searched. The list of matching items or articles is displayed and the user can select any of the articles from the list to view on the screen, save on a file or send to an Internet address, via e-mail.

World Wide Web (WWW)

World Wide Web is a hypertext networked information system developed at Cern, the European Laboratory for Particle Physics at Geneva, Switzerland. www was developed to provide a single means of access to the wealth of services and resources available on the Internet by using a series of web servers connected through hypertext. Utilizing the features of www you need to only know what you want and need not worry about how to get it.

Instead of having to know and contact the addresses of many different Internet sites and having to learn the details of using different Internet services such as telnet, FTP, WAIS or gopher, one needs to use only one program that provides access to www site. From there you can navigate to other locations on the Internet to search and retrieve information in a variety of forms. The thing which makes the web so exciting is that you can go anywhere on the web without knowing the technique used to do that. Web provides another service called URL (uniform Resource Locator) which defines a universal locator mechanism for data resident anywhere on the Internet.

The program that provides contact to a www site is called Web Browser. Two early web browsers were LYNX and MOSAIC. Now a days, two most popular web browsers are Netscape Navigator and Microsoft Internet Explorer (now an integral part of Windows'98).

LYNX is an entirely text-based web browser. It was designed to work on text-based terminals and it operates in the hypertext environment. Using Lynx, one does not require a very sophisticated or expensive Internet connection : one can work with shell connectivity. The configuration of the user terminal should be at least VT100 or one that can emulate VT100 to use the LYNX browses.

Mosaic

Mosaic was developed by the National Centre for Super Computing (NCSC) at the university of Illinois. Mosaic is a www browser with GUI, designed to operate in Windows environment. Once you have invoked Mosaic, you work within a mosaic window. It is available for Windows, X-Windows and Macintosh environment and available free of cost on Internet. You can download it from ftp.ncsa.uivc.edu.

14.9 HTML

The Hypertext Markup Language is the universal language of the Web. It is used for writing pages for the Web. HTML allows text to include codes that define fonts, layout, embedded graphics, and hypertext links. HTML can be compared to word processing. The text in a word processed file can be formatted in various ways. For example, a heading can be bold and in largest font size than the rest of the document. Also, specific words can be italicized for emphasis.

Thus, HTML is a way to define the formats of text in a web page. HTML is a sub-language of SGML, or Standard Generalized Markup Language. SGML is a system that defines and standardize the structure of an area of text. HTML is standardized and portable. A document that has been prepared using HTML markup "tags" can be viewed using a variety of web browsers, such as Netscape and Lynx. In addition, HTML documents can be viewed on all types of systems, such as Macintosh, PC, and UNIX machines.

14.10 JAVA AND JAVASCRIPT

Java is a language for sending small applications (called applets) over the Web, so that they can be executed by your computer. JavaScript is a language for extending HTML to embed small programs called scripts in Web pages.

Student Activity 3

1. List various activities available on Internet.
2. Describe the following:
   (a) E-mail
   (b) Telnet
   (c) FTP
   (d) HyTelnet
   (e) Archie
   (f) Copier
   (g) Veronica
   (h) WALS
   (i) WWW
   (j) Lynx
   (k) Mosaic
3. Define HTML.
4. What is Java?
5. Define java script.

14.11 SUMMARY

Computers form the backbone of modern information communication systems. An unimaginably large network exists today on which several mainframes and myriads workstations are hooked sending, forwarding and receiving voluminous data/information back and forth day and night.

Most of the communication takes place in client-server fashion in which a client makes a request and one or more servers provide the requested information with or without processing. Communication networks can be various types depending on their extent of influence such as — LAN, MAN, WAN etc. The internet is a universal communication network providing services like e-mail, telnet, newsgroup etc.

14.12 KEYWORDS

Mainframes: Relatively large computer, used by corporations for centralized data processing and maintenance of large databases.

Multiprogramming: The operation of two or more programs running on a single processor (CPU) at the same time.

Workstations: Powerful desktop-sized computer that provides high speed calculations and high-resolution graphics required by engineering applications.

Micro computer: The smallest and least expensive category of general purpose computers.

Client/Server architecture: A form of distributed processing in which several computers share resources and are able to communicate with many other computers; a client is a computer used to access shared network resources, and a server is a machine that is attached to the same network that provides clients with these services.

Network: A connecting system that permits the sharing of resources among different computers.

Protocol: The set of rules and procedures that govern transmission across a network, principally line access and collision avoidance.

Peer to peer network: Network used for a small range of computers where all machines have their resources and can also have shareable resources for other machines.

Local area network: Network that connects communications devices within 2,000 feet so that every user device on the network can communicate with any other.

Metropolitan Area Network: A public, high speed network, operating at 100 mbps or faster, capable of voice and data transmission over a distance of upto 50 kms.

Wide area network (WAN): Networks that cover wide geographic areas and include regional networks such as telephone companies or international networks such as global communications service providers; may be commercial, privately owned, or public.

Electronic mail (e-mail): Application that can electronically manipulate, store, and transmit computer-based messages through telephone wires or wireless networks.

Telnet: Protocol that establishes an error-free link between the two computers and so allows users to be on one computer while doing work on another.

Fill transfer protocol (FTP): Protocol that enables users to access a remote computer and retrieve files from it.

World wide Network: A portion of the internet that uses the transport functions of the Internet, via a client /server architecture, to handle all types of digital information, including text, hypermedia, graphics, and sound.

Hypertext mark up language (HTML): The standard programming language used to create and recognize documents on the world wide web; lets users control visual elements without changing the original information; incorporates dynamic hypertext links to other documents stored on the same or different computers.

Hytelnet (Hyper Telnet): A tool for making more effective use of the telnet service.

Archie: Archie is a tool that helps locate a file to be retrieved using FTP.

VERONICA: VERONICA stands for very easy Rodent Oriented netwide Index to computer Archives. It is just like an indexed database and consists of different titles and Gopher server items.

Wide area information server (WAIS): A specialized software for searching and retrieving text document from databases located anywhere on the internet.

LYNX: An entirely text-based web browser designed to work on text-based terminals and operate in the hypertext environment.

MOSAIC: A while browser with GUI, designed to operate in windows environment.

Java: Java is a language for sending small applications (called applets) over the web, so that they can be executed by your computer.

Javascript: Javascript is a language for extending HTML to embed small programs called scripts in web pages.

14.13 REVIEW QUESTIONS

Descriptive Questions

1. Differentiate between LAN and WAN.
2. What are the advantages of e-mail over conventional mail?
3. What is a Web browser? Name any two Web browsers?
4. Why is networking required?
5. What is a Web Server?
6. Define WWW.
7. Define Telnet. What is Hytelnet?
8. What is LYNX?

1. Fill in the Blanks

1._____Computer can support upto several hundred users simultaneously.

2. Single computer fall into category of either_____or_____.

3. A_____is a computer that requests files from the web.

4. LAN can operate between _____to_____.

5. WANS normally use _____and____for data transmission.

Answers to Review Questions

Fill in the Blanks

1. Mainframe
2. Microcomputer, Workstation
3. Web browser
4. 10 mbps, 2 gbps
5. Public telephone network, satellite links.

14.14 FURTHER READINGS

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

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

Principles of Data Security

UNIT

15

SECURITY, MAINTENANCE AND TROUBLE SHOOTING

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Define security and its various types.
- Define maintenance and its various types.
- Describe various perverse software.
- Describe various computer viruses.
- Describe various preventive measures and treatments of viruses.

U N I T S T R U C T U R E

15.1 INTRODUCTION

The information stored in computer files is more valuable than the computer itself. This is because it is very important and unique. The damage to these files may cause irrecoverable loss to the organization. Nowadays, networks gaining popularity have made the issue of security more critical because messages need to be authenticated and confidential data needs to be protected from unauthorized access. Both internal as well as external factors need to be considered with the security aspect of the computer systems. The computer system needs to be updated and maintained constantly as it may become obsolete very soon if not maintained according to the users changing needs. In case of troubleshooting, proper procedures must be there to resume normal functioning and recover the database.

15.2 SECURITY

Security refers to the protection of data resources from damage and the protection of data against accidental or unintentional disclosure to unauthorized persons or unauthorized modifications or destruction. Security implies the state of being secure from exposure to danger and precautionary measures that are taken to make data safe against adverse conditions. The major security threats perceived by the user and providers of computerized database system include: unauthorized

disclosure of information, unauthorized alteration or destruction of information, unauthorized access of services and denial of service to illegitimate users.

Security also implies providing protection to the system against any sort or loss. The losses can occur in one of the following measures: theft of PC and media, damage due to breakage, environment damage, Inadvertent corruption/loss, usage of inferior media, erasure of files, malicious damage/leakage, unauthorized access, modification measures, computer viruses, data trapping, etc.

Privacy

It refers to the rights of individuals and organizations to determine for themselves when, how and to what extent information about them is to be transmitted to others. Loss of privacy occurs when unauthorized parties get access to the information stored on the computer system. This may lead to significant losses to the owner of information. Revelation of credit card number, a proprietary product design, data on tender forms, or strategic military data can be used by adversaries in numerous undesirable ways.

Protection

The goal of computer security strategy is to protect against the above-mentioned threats. A three level strategy should be adopted to protect against data security lapse: minimize the probability of it happening at all, minimize the damage if it does happen and design suitable methods for recovering from different types of damage.

Authorization

Each database user should be allowed access only to the information essential for completing the tasks that the user is assigned. Most computer-based security policies belong to one of the two basic categories.

- ***Discretionary Access Control (DAC):*** Authorized person (owner of data) only can define the access policies. The creator of the file can specify the access rights to other users. This is a common method in file-oriented systems.
- ***Mandatory Access Control (MAC):*** In this category of authorization, users are classified according to level of authority or clearance for data use and management. Data are classified into security classes according to level of confidentiality. Strict rules are defined regarding which level of user clearance is required for accessing the data of a specific security class, e.g. military documents may be categorized as unclassified, confidential, secret and top secret.

Authentication

Authentication allows access to legitimate system users and denies it to unauthorized parties. This mechanism establishes the authenticity of the user of data. It guarantees that the claimed sender is the actual sender and also that the data has not been touched without permission. This does not provide confidentiality, but nobody can send fake messages.

Passwords

Most common authentication mechanism is based on sharing of a secret code called 'Password' which is assigned to each user by the administrator. All user passwords are stored in the system and system uses these passwords for identification of the user. At the beginning of the log-in process, system requests for password and only when the user supplies the correct password, allowed to access the system. Many systems also allow users to change their password.

File Permissions

Every file has a set of permissions associated with it which determines who can do what with the data stored in the file. These include permission to: read, write, execute, delete, etc. Different permissions are granted to different types of users. The superuser of the system has all the privileges to read or modify any file on the system.

Physical Electronic Access Control

The need to control access rights is especially pronounced in situations where some common utilities, such as editors and compilers, are shared. The common access control mechanisms are: access hierarchies, access lists, capabilities.

Access Hierarchies

In this method, a restricted range of operations are available in the user mode which is a default option for program execution. The supervisor mode is a superset that, in addition to user-mode operations, allows execution of certain higher level instructions which include special I/O functions like halting of the machine, etc. The user programs execute in the user domain and the operating system executes in the supervisor domain. When a user program needs to perform an operation outside its domain, it calls the operating system at the control transfer point. The OS can check the user's authority and grant or deny execution accordingly.

Access Lists

This is another way of recording access rights within a computer system. In principle, it is an exhaustive enumeration of the specific access rights of all entities that have authorized access to a given object. The owner has the exclusive right to define and modify the related access list.

Capability

It is a token or ticket that gives the subject possessing it a permission to access a specific object in the specified manner. It provides a single mechanism to address both primary and secondary memory, access both hardware and software resources, protect objects in both primary and secondary memory. In this, a list of capabilities is associated with each subject. A subject may name and access only those objects for which it possess a valid capability.

Student Activity 1

1. What do you mean by security?
2. What is Privacy?
3. How can you protect a system?
4. What is authorization? Describe its basic categories
5. What do you mean by authentication?
6. Define a password.
7. Describe access hierarchies.
8. What is capability?

15.3 TYPES OF SECURITY

Different types of security is implemented at different levels in a computer system. Broadly, security can be categorized into two types – physical security and hardware security.

Physical Security

Physical Security measures include providing security to the computer system. The various measures are:

- Physically bolt down the PC to a table so that it cannot be casually lifted and taken away.
- Have cupboards for floppies and keep them locked at all times, except when in use.
- Keep a record of all floppies in use, do not permit alien floppies into the organization.
- Ensure that excessive dust or paper scrap does not accumulate near the system.
- Put a thin transparent plastic cover on the keyboard.
- Use CVTs for maintaining voltage fluctuations.

Hardware Security

Keyboard and PC locking devices can be fitted so that the PC cannot be operated unless these locks are opened. Many high-end software packages such as CAD programs use a type of hardware key also called a dangle, without which it cannot be executed. Such programs come with a special electronic "black box" which is attached to the computer's input/output port. When the program is started, the port is checked for the presence of the key; if the key is not present the program aborts. This method allows making back-up copies of the software but prevents running the software on more than one machine.

Software Security

Software security is taken to ensure that data is not corrupted or modified by unauthorized users. For this, use original software for the operating system, compilers or software packages and use correct procedure for shutting down the system so that all files would be properly closed and system does not crash very often. One should separate the user areas in a multiuser environment so that other users may not tamper with the other users data accidentally or intentionally.

Software Locks

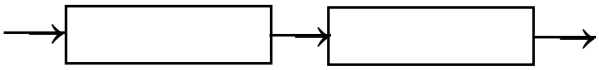
Copy protection is a software "Lock" placed on a computer program by its developer. It prevents the product from being copied and distributed without approval or authorization. Copy protection always involves some unusual use of disk storage space that prevents a computer's operating system from duplicating the disk's contents.

Passwords

A password should be given to access an application so that unauthorized persons cannot access it. The passwords should not be visible on the screen when keyed in.

Cryptography

Another way to strengthen security in computer systems is to encrypt sensitive records and messages in transit and in storage. The basic model of a cryptographic system is:



The original unciphered text is called the plain text or the clear text. It can be encrypted using some encryption method, parameterized by a key, resulting in ciphertext. This may be stored or transmitted via the communication medium such as wires or satellite links. Plain text can be obtained by decrypting the ciphered message using the decryption key. The ciphere text cannot be understood by users unless it is converted back to plain text through the decryption key.

15.4 MAINTENANCE

As the use of computers is becoming more widespread and organizations are becoming increasingly dependent on them for their effective functioning, continuous availability and trouble free operation of hardware and software becomes vital. Maintenance is the function concerned with ensuring continuous availability and trouble-free operation of computer system hardware as well as software.

Types of Maintenance

Maintenance can be classified into two groups:

- Preventive maintenance
- Corrective maintenance

Preventive: Maintenance is carried out periodically, according to a pre-determined schedule, to take care of problems before they affect the system's operation.

***Corrective**:* Maintenance is carried out once the system stops functioning or starts malfunctioning due to some problem.

The nature of maintenance of hardware component is quite different from that applicable for the software component. Thus, the total scope of computer system maintenance can be represented using a 2 × 2 matrix as shown in the diagram.

Type Component	Preventive Maintenance	Corrective Maintenance
Hardware	(1) Provide periodic checking of all hardware system	(2) Troubleshooting when a particular hardware malfunctions
Software	(3) Monitor and make changes to keep the system up to date	(4) Find and fix the software bugs when system gives wrong results or stops working

Besides preventive and corrective maintenance, other two types of maintenance are: adaptive and perfective maintenance.

Generally these are applicable to software. These are the real sources of change in software. It motivates the introduction of evolvability as a fundamental software quality and anticipation of change as a general principle.

Adaptive: Maintenance involves adjusting the application to changes in the environment, e.g. a new release of the hardware or the operating system or a new database system. In adaptive maintenance the need for software changes cannot be attributed to a feature in the software itself, rather the software must change because the environment in which it is embedded changes.

Perfective: Maintenance involves changing the software to improve some of its qualities. Here the changes are due to the need to modify the functions offered by the application, add new functions, improve performance, make it easier to use, etc. Perfective maintenance is generally needed to improve the quality of product in the market or to meet new requirements.

Back-ups

Along with maintenance, routine back-ups of the data files must be maintained. Back-ups are needed to provide security to data in case of loss. Duplicate copy is maintained in movable media generally on magnetic tapes. Back-ups is also a way to preserve data for future use or to transfer data from one user to another. Routine back-up are needed to save the data from theft of parts or entire system, unauthorized access which may lead to loss of data deliberately or inadvertently and virus which can erase or corrupt the data.

Student Activity 2

1. What are the measures included in Physical Security?
2. What do you mean by hardware and software security?
3. Define Cryptography
4. What is maintenance?
5. Differentiate between:
   (a) Preventive and corrective maintenance
   (b) Adaptive and Perfective maintenance
6. Why are back-ups required?

15.5 PERVERSE SOFTWARE

It is a class of software that is deliberately designed to affect adversely the functioning of a computer system. It comes in many shapes and sizes, some of which are discussed below:

- ***Trojan Horse:*** It is a program that seems innocuous but conceals a malicious program within itself. They attach themselves to programs but do not replicate. The most vulnerable

host is a computer network where they take advantage of the access privilege enjoyed by the parent program and cause havoc. The program does not show any symptoms of virus. Some typical programs belonging to this category are: Notroj, Xmas Card Trojan, Run. Me, etc.

- ***Bomb:*** This is also known as 'Logic Bomb' or 'Time Bomb'. An event triggered routine in a program which causes it to crash is defined as a 'Bomb'. Time Bombs are viruses set to activate on a certain date, e.g. Friday the 13th Virus.

- ***Worms:*** They are a self-propagating program that work their way through a system, often causing damages. They do not require a host program to get activated and also do not destroy the data. They make home in the computer memory and slow down the working of the computer. The worm is generally written in a high level language such as 'C'. Example of Worms are: Xerox Parc Worm, Existential Worm, Alarm Clock Worm, Gladiator Worm, Worm Watcher, etc.

15.6 COMPUTER VIRUSES

They are defined as programs inserted into another program which replicate themselves rapidly, destroying the process, legitimate programs and data. It gets activated by its host program. It is transmitted to other systems through floppy transfer. Two types of viruses have been identified. They are 'Parasite' and 'Boot' virus.

- ***Parasite Virus:*** Parasite virus attaches itself to other programs and is activated when the host program is executed. It tries to get attached to more programs so that chances of getting activated increase. It spreads to other computers when the affected programs are copied, e.g. Jerusalem, Data Crime, etc.

- ***Boot Virus:*** Boot virus is specially designed to enter the boot sector of a floppy disc. It works by replacing the first sector on the disc with parts of itself. It hides the rest of itself elsewhere on the disc, with a copy of the first sector. The virus is loaded by the built-in program when the machine is switched on. The virus loads, installs, hides the rest of itself and then loads the original program. On a hard disc, virus can occupy DOS Boot Sector or Master Boot Sector.

15.7 PREVENTIVE MEASURES AND TREATMENT

Use detection utilities, virus scanning programs that determine if an infection exists. Infection prevention program achieves, at least, some measure of protection against viruses penetrating the system. Use of identification and removal utilities identify what type of virus has caused an infection and provide help in removing it. Loading of unknown disks into a system must be avoided unless it is certain that they are virus free. Do not accept a program unless it is certain that it is virus free. Watch for unexplained changes in the way your system functions. Use write-protect tabs extensively and create volume labels to avoid infection of virus to the floppy disks.

Write Protection

Write protect tabs are great disk protectors and should always be used on any disk that does not need data to be written on it, including both the program disks and disks on which archives and back-ups are stored. Sticking the adhesive tape over the notch on minifloppies or moving the tab on the plastic case of micro floppy will save it from subsequent virus attacks. If you get an unexplained write protect error message when any protected disk is in a drive and you are not deliberately trying to access it, then consider this a warning of a possible virus infection. The boot disk for the operating system must be write protected for precautionary measures.

15.8 VIRUS SCANNERS

Virus detection and control systems are of two types:

- Protection System

- Vaccine Programs

Protection Systems

They keep a watch for viruses and as soon as they detect one, they sound an alarm. Protection systems can be: Boot Monitors, File Monitors, Disk Scanners, and Integrity Checkers.

Boot Monitors

They become memory resident and capture the disk I/O interrupt. They thus pipeline the I/O interrupt routine through their own code and keep a watch over disk I/O to the boot sector and partition table. Whenever any attempt is made to read or write to this area, they sound an alarm and warn the user.

File Monitors

They check if any attempt is being made to write into an .exe or .com file of the system. Whenever an attempt is made, they sound an alarm.

Disk Scanners

They check the hard disk/floppy diskette for viruses. The most famous disk scanning program was developed by Mc Cafee Associates, USA. This program contains a self-test at load time. If it is modified in anyway, a warning will be displayed but the program continues checking for viruses. Another equally famous disk scanner is Virscan developed by IBM. It is a programmable scanner and offers the facility to the user of adding more virus signatures to check for. So when a new virus crops up, its signature can be added to the stored signatures of the program.

To prevent viruses from entering the network and for maximum protection, each workstation should have a signature scanner, a checksum scanner and a memory resident activity monitor. The signature scanner will identify previously identified strings of code signatures known to be viruses and tell if the user has one and exactly which one. Checksum scanners spot unknown viruses. They work on the principle that viruses change the length and content of an executable file by inserting code. Memory resident monitors look for and interrupt viral behaviours such as attempts to format the hard disk drive, etc.

Vaccine Programs

Vaccines are detection products that sound warnings if there have been changes to executable programs. They can be created for specific viruses only as functionally they differ greatly. Developing a vaccine for a virus means studying the virus thoroughly and gathering technical details about its functioning, namely, from where it loads itself wherein memory it stores itself how and what resources of the computers are used and what triggers its destructive routine. Multi-virus vaccine packages have become famous. Most of these scan the disks for viruses by looking for their signatures and then remove the virus. Now many software engineers are working on the idea of developing immunization and inocculation packages against known as well as unknown viruses.

Student Activity 3

1. Write short notes on the following:
   (a) Trojan horse
   (b) Bomb
   (c) Worms
   (d) Parasite virus
   (e) Boot virus
   (f) File monitors
   (g) Boot monitors
2. What is computer virus?
3. What are vaccine programs?
4. What are disk scanners?

15.9 SUMMARY

- Controls have to be implemented at all levels of a computer system. Back-ups are taken periodically to ensure safe recovery in case of a disaster. In a multiuser environment, the network operating system must protect the users from one another. Access rights must be restricted to reliable persons only. The security system must provide protection against fraud and unauthorised access. It should also incorporate safety measures against viruses and methods to recover the data in case of damages caused by it. Without proper maintenance, any computer system would become obsolete. So the computer system must be adjusted to absorb the environment, add changes and satisfy the emerging demands of the users.

15.10 KEYWORDS

Security: The protection of data resources from damage and the protection of data against accidental or uninternational disclosure to unauthorized persons or unauthorized modifications or destruction.

Privacy: The rights of individuals and organizations to determine for themselves when, how and to what extent information about them is to be transmitted to others.

Authentication: Authentication allows access to ligitimate system users and devices it to unauthorized parties.

File permissions: Every file has a set of permissions associated with it which determines who can do what with the data stored in the file.

Access hierarchies: In this method, a restricted range of operations are available in the user mode which is a default option for program execution.

Access lists: Way of recording aces rights within a computer system.

Capability: It is a token or ticket that gives the subject possessing it is permission to access a specific object in the specified manner.

Cryptography: To encrypt sensitive records and messages in transit and in storage.

Maintenance: The function concerned with ensuring continuous availability and trouble free operation of computer system hardware as well as software.

Trojan horse: A program that seems innocuous but conceals a malicious program with itself. They attach themselves to programs but do not replicate.

Bomb: An event triggered routine in a program which causes it to crash.

Worms: A self-propagating program that work their way through a system, often causing damages.

Parasite virus: Virus that attaches itself to other programs and is activated when the host program is executed.

Boot virus: A specially designed virus which enter the boot sector of a floppy disc.

Vaccine programs: Vaccines are detection products that sound warnings if there have been changes to executable programs.

15.11 REVIEW QUESTIONS

Fill in the Blanks

1. Passwords and separate user areas are an example of _____ security.
2. _____ protection of floppy disk is a common way to protect it from virus infection.
3. All the _____ files are made read only so that the virus cannot attach itself to it.
4. To secure messages, plain text is converted into _____ through cryptography.
5. _____ virus resides on the part of the hard drive that the computer reads each time it is started.

Multiple Choice

1. All of the following are examples of physical security except
   a. Limiting access to a computer room

b. Storing tapes and disks in a separate building
c. Requiring passwords to access the system
d. None of the above

2. A computer virus is a
   a. Hardware
   b. Software
   c. Both (a) and (b)
   d. None of the above
3. Back-ups help in
   a. Restoring of the database
   b. Restoring of the system software
   c. Restoring the operation in case of disk crash
   d. All of the above
4. Vaccines
   a. Provide protection against all types of viruses
   b. Provide protection for hardware failures
   c. Protect the computer system from specific type of viruses
   d. None of the above
5. The adjustments made in the computer system according to changes in environment will come under
   a. Adaptive maintenance
   b. Corrective maintenance
   c. Perfective maintenance
   d. None of the above

Descriptive Questions

1. What is the need of security in computer systems?
2. What types of software security is required in a multiuser environment?
3. How many different types of maintenance are there? When do you go for adaptive maintenance?
4. What is a computer virus? How does it differ from a worm?
5. What precautionary measures need to be taken to protect the computer system form different kinds of viruses?

Answer to Review Questions

Fill in the Blanks

1. Software
2. Write
3. Executable
4. Ciphertext
5. Boot Virus

Multiple Choice

1. (c)
2. (b)
3. (d)
4. (c)
5. (a)

15.12 FURTHER READING

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

IT Applications

UNIT

16

SOME IMPORTANT IT APPLICATIONS

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Describe business data processing.
- Describe applications of transaction processing.
- Describe financial information system.
- Describe accounting information system.
- Describe payroll system.
- Describe Inventory management system.
- Define e-commerce and its various categories.
- Describe multi language applications
- Describe remote sensing
- Describe weather forecasting
- Describe applications of computers in different fields.

U N I T S T R U C T U R E

16.1 INTRODUCTION

The impact of IT is all pervasive in modern societies. No sphere of human endeavour is immune to IT applications. Companies and countries are leveraging IT to gain significant competitive advantage in the international trade arena. In this chapter we are going to expose the use of IT in five major areas:

- Business applications
- Medical applications
- Educational applications
- Entertainment and advertising applications

- Multilingual applications

16.2 BUSINESS DATA PROCESSING

Business data processing constitutes the largest segment of computer use. Computers are used for at least three basic organizational tasks:

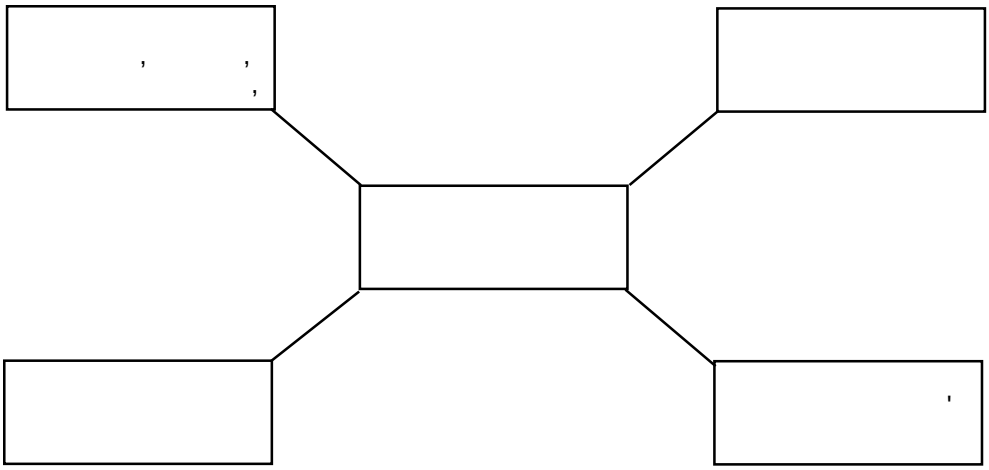
- Management Transaction Processing
- Control Operations
- Decision-making

Computers assist business and commercial organizations in stock control, processing of sales order, sales accounting, sales analysis, market research, forecasting, production planning and similar other business transactions. They are also used by insurance companies and stock-broking firms for updating information; calculating interest, policy rates, bonuses and commissions for preparing policy statements and renewal notices.

Generally, to keep details of all information of the business, a database is maintained. Details of files are referred through the DBMS package that helps to manage the databases. Another useful area of computer application is project management where standard software packages are available for automating all activities in the Project Life Cycle including project initiation, project formulation, project evaluation, project scheduling and resource planning and project monitoring and control.

Transaction Processing Applications

Transaction processing is important for accurate accounting and immediate availability of on-line information. Computers help to effectively and speedily handle large volumes of transactions. Financial institutions and banks, in particular, are making use of computers for processing large volumes of transactions.



Use of Computer in Banking

Processing of cheques at the clearing house (Inter-branch/Inter-bank reconciliation) is done by linking the branches with one or more terminal devices to a large national/regional computer network. Development of Magnetic Ink Character Recognition (MICR) technology has made it possible to sort out cheques rapidly and automatically.

Invoicing

To run any business, maintenance of fundamental source documents is necessary. These source documents are known as invoices. They may include documents related to any fundamental transactions like sales, purchase, sales returns, purchase returns, expenses, gains, etc. Basically, generation and maintenance of these source documents is known as Invoicing.

Examples are:

- When order is placed to a supplier for raw material, a purchase-order-invoice is generated.
- When order is accepted from a customer sales-order invoice is generated.
- When goods are dispatched to the customer, a bill or sales-invoice is generated.

Computers are very helpful in handling a large number of transactions and generating the related invoices.

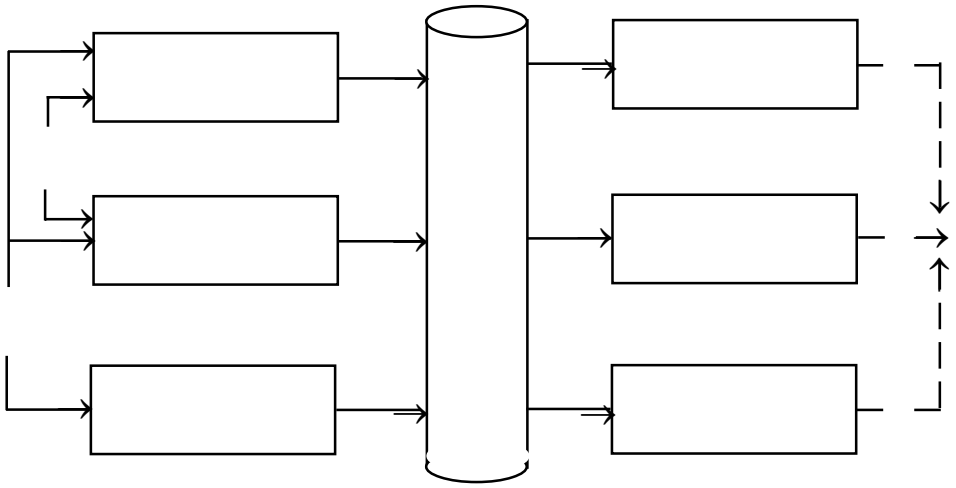
16.3 FINANCIAL INFORMATION SYSTEM

Financial function is concerned with the flow of money through the firm. First it is necessary to acquire enough money to support the manufacturing, marketing and other activities. Then it is necessary to control these funds to make certain they are used in the most effective way.

Financial information system is a subsystem of any business system that provides information to persons and groups, both inside and outside the firm, concerning the firms' financial matters. Information is provided in the form of periodic reports, special reports, etc.

Model of Financial Information System

The system consists of input and output subsystems. Two input subsystems – accounting Information Subsystem and Financial Intelligent Subsystem are there to collect the information. The third one – Internal Audit Subsystem – ensures that the processing of financial data is done properly. The three output systems exert an influence on the firm's money flow. The forecasting subsystem projects the firms' long range activity in an economic environment.



The Funds Management Subsystem manages, the money flow as it occurs seeking to keep it balanced and positive. With the Control Subsystems managers can get effective use from resources of all types that are made available to them.

Student Activity 1

1. List major areas of IT application.
2. What is the Importance of transaction processing?
3. What are Invoices?
4. What is Invoicing? Give atleast two examples of Invoicing.
5. Describe financial Information system.

Accounting Information System (AIS)

It provides input to the executive, marketing and manufacturing information systems.

Importance of Accounting Data

- Accounting data provides a record of everything of monetary importance that happens in the firm.
- A record is made of each transaction describing what happened, when it happened, who participated and how much money was involved.
- Provides "Sales Analysis Report" to marketing manager describing how well products are selling.
- Provides "Maintenance Report" to manufacturing manager showing the costs of running the various production machines.
- Provides an "Aged Accounts Receivable Report" to Credit manager classifying the receivable amounts based on how long they have been owed.
- Accounting Information System (AIS) is the only input component that appears in all of the functional information systems.
- If the firm does not have a good AIS, it cannot expect to have a good MIS, good DSSs and Expert Systems.

Payroll System

It is an important subsystem for any business system. It calculates the regular payslips and additional reports. An Employee Master File and daily transaction files are maintained to keep details of employees and transactions. At the end of the month the "Payslip Statement" for each employee is generated. Additional reports may include Coin-Analysis Report, Leave Report, Allowance and Deduction Report, etc. Generally processing is done in batch processing mode.

Inventory Management System

Inventory means the idle products or stock which a firm maintains for future requirements. Manufacturing management has always been responsible for raw materials and work-in program inventories. Inventory management system deals with management of amount of inventory maintained by the firm.

Inventory Level

The level of a firm's inventory is very important because it represents a substantial investment. Money that is held up in inventory cannot be used elsewhere. The level of a particular item is influenced primarily by the number of units that are ordered from a supplier at one time. The average inventory level can be estimated at half of the order quantity plus the safety stock.

Maintenance Costs

The maintenance cost or carrying cost is usually expressed as an annual percentage of the cost of the item. It includes factors like spoilage, pilferage, taxes, insurance, etc. It varies directly with the inventory level.

Purchasing Costs

Purchasing costs include costs that are incurred when materials are ordered like buyer's time, telephone expenses, secretary time, purchase order form, etc. Generally any firm seeks to minimize its maintenance costs by keeping its inventory level low by ordering small quantities at a time. This is a good objective but it should be taken care that purchase costs should not increase much.

Economic Order Quantity (EOQ)

The EOQ is the technique to determine the quantity to be purchased at one time so as to balance the maintenance and purchasing costs and achieve the lowest total inventory cost. An EOQ is established for each item in raw materials inventory and is included as a data element in the inventory record.

The formula used for determining EOQ for any item in the inventory is as follows:

$$EOQ = \sqrt{\frac{2 \times A \times S}{I.C}}$$

Where A is one time set up and ordering cost associated with each order. S is estimated annual requirement of the item in number of units.I is inventory carrying cost expressed as a fraction of total unit cost.

C is unit cost of the item.

Electronic Commerce

Electronic Commerce (EC or e-commerce) denotes the use of computer networks – intranets, extranets, private networks and the Internet, to execute complete business transactions. Prior to 1997, EC was mainly identified with Electronic Data Interchange (EDI), and older, less flexible technology using proprietory networks which were not very convenient and useful. EC is now implemented on the Internet using a variety of sophisticated, web-based tools. The scope of EC now includes customer interactions of advertising, product selection, contract negotiation and so on all the way through to the product and services delivery and payment settlement.

Due to the differences in the nature of transactions involved, two distinct categories of EC are recognized:

- ***Business-to-Business EC:*** The use of the Internet or private networks to automate business transactions between companies or organizations.
- ***Business-to-Consumer EC:*** The use of the Internet to sell merchandise or provide services to customers in much the same way as a shopkeeper.

The term Electric Business (e-biz) has also been introduced which includes not only EC, but all the web-enabled core business processes, extensive customer integration and connectivity, and strategic transformation of business processes to exploit the full capabilities of emerging IT tools.

Student Activity 2

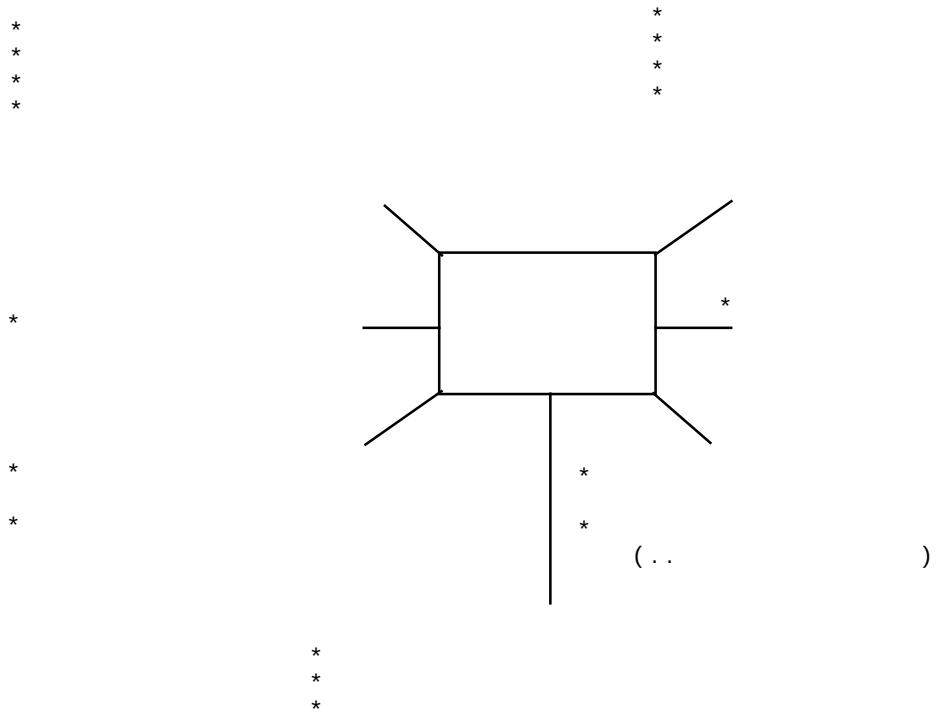
1. What is the importance of accounting data?
2. Define payroll system.
3. Define Inventory management system.
4. What is maintenance cost?
5. What is purchasing cost?
6. Define EOQ.
7. Write a short note on Electronic Commerce.

16.4 MEDICAL APPLICATIONS

Computers are used in medical research, in medical education and in aiding people with limitations because of situational conditions.

Hospital Management System

Computers are increasingly used in hospital administration for tasks such as maintaining inventories of drugs, surgical equipment, payroll, hospital accounting, bed allocation, etc.



Application of Computer in Health Care

In the ICUs, the computer can be used to monitor the condition of several patients simultaneously. It may assist in medical diagnosis. The computer system can act as a vast encyclopedia of medical knowledge, providing the doctor with access to an ever-expanding medical database. It can be used in medical research and medical policy making.

Intelligent Systems

Several intelligent expert systems in various specialized fields have been developed and are now in use. A number of medical diagnose intelligence systems have been developed to diagnose diseases and recommend treatment. An intelligent system called HELP has been developed to diagnose heart diseases. Another intelligent package is PUFF which has been designed to diagnose lung diseases. The intelligent package CADUCEUS is a generalized package that can process and evaluate over 4000 symptoms and other information to diagnose over 600 diseases. The intelligence systems in the medical field, at present, do not replace doctors. They only help doctors to diagnose diseases.

16.5 SCIENTIFIC APPLICATIONS

Applications which involve mathematical, statistical and model processing form a large class of computer usage, often referred to as " Scientific Applications ". For example, computers are being used in the field of genetic research. They can be used for statistical data analysis, for numerical solution of equations and for simulation of complex biological systems on computers.

Investigation into large molecules of biological significance now comprise an active research endeavour. Computers have helped in the unravelling of highly complicated organic molecular structures. This can lead to development of new wonder drugs for treating dreaded diseases like cancer and AIDS.

Computers have found wide application in the field of space technology. They also play a leading role in putting satellites in orbits, monitoring and controlling the proper functioning of space flights, etc.

Weather Forecasting

The weather data collected by worldwide network of space satellites, aeroplanes and ground stations are fed into the computer. Computers store vast quantities of past data which can be analyzed to develop long-term weather patterns.

These help to establish relationships between the variable factors which influence weather and

develop a weather forecasting model. Computer uses this data to run weather forecasting model and make short-term as well as long-term weather forecasts.

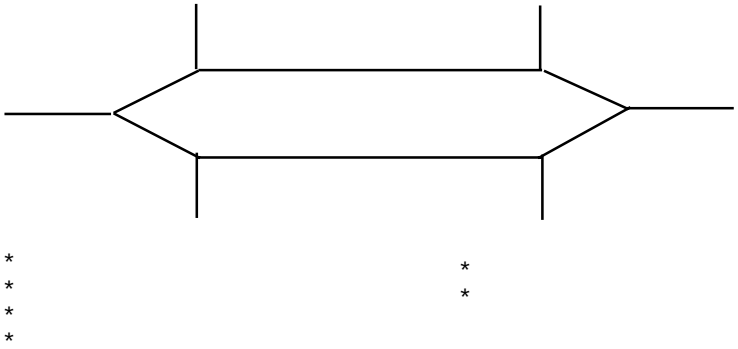
Nuclear Reactors

Due to the reliability and accuracy of computerized systems, lot of critical applications are being monitored and controlled by an intelligent system. In Nuclear reactors, the process of controlling the nuclear reaction is very critical.

Almost every nuclear reactor is controlled by a foolproof intelligent system. It works on certain initial parameters passed to it and the values received through the sensors placed at the site of reaction. The actions to be taken are stored previously. Different conditions trigger these stored actions to control the reactor.

16.6 EDUCATIONAL APPLICATIONS

The learning process can be enriched in many subjects because of the volume and range of information which a computer databank can provide. Learning process can be further facilitated because of the flexible mode (multimedia, etc.) and speed of presentation of learning material. Computers can be used as a resource in teaching and learning at all levels of education.



Computer-Based Tutorial (CBT)

Using the computer to provide intelligent tutoring is gaining in popularity in both high schools and colleges. An intelligent tutoring program can adapt based on student responses to review areas where the student is weak and to skip areas where the student has already mastered the material. CBTs are helpful to students no matter what their level of subject mastery is. Advanced students are not bored by questions that seem repetitive and simplistic. Students having more difficulty with the subject will be asked more questions in order to reinforce concepts. A student will receive immediate feedback from the computer, enabling him or her to see the correct answers while the question is still fresh in the student's mind.

Computer-Aided Instruction (CAI)

When a computer is used as a teaching aid, it is referred to as computer-assisted-instruction or Computer Aided Instruction (CAI). Software for CAI can be prepared by class teachers or can be purchased. The subject material is displayed on the CRT screen. The CAI programs can be prepared in a variety of modes such as tutorial, discovery, problem-solving modelling and drill and practice, etc.

In "tutorial mode", the computer presents new ideas followed by test questions. In "discovery mode", the computer presents information and asks students to draw conclusions. In "problem solving mode", the computer allows students to apply their concepts to solve a problem. In "modelling mode" a process or a system is presented mathematically to make its analysis. In "drill and practice mode" it is assumed that the skill to solve a question is known but repetition is essential to have command over the subject. The interactive feature of CAI make it attractive.

Automatic Examination and Evaluation System

Question papers (objective type) are kept in computer database. In a designed screen, the questions are displayed for a fixed time period. Students are supposed to give the answer in a given place by pressing an option like a, b, c, d. Computer gives some indication that the answer is correct. Final marks are displayed immediately to declare the students result.

16.7 ENTERTAINMENT APPLICATIONS

Multimedia

Multimedia represents the convergence of computers, digital video, digital audio and sound synthesis technologies. It can be referred to as a means of entertainment because of its applications in interactive games and leisure programs. Its popular applications include Video Player, Television Video, Telecommunications, Audio CD Player, CD-ROM Player, etc.

- **Games for Young Children** Games often provide early introduction of computers to young children. Children enjoy using the computer when games are fun and educational. Many computer games build some of the same skills that reading builds like maintaining focus, problem-solving and developing imagination, etc.

- **Advertising Applications** Advertisement is an important activity in the marketing department. In some firms, advertising department exists separately. Advertising departments create ads and other promotional materials and ad campaigns. Various computerized tools are available for marketing, advertising and sales. Organizations trying to get exposure to their products and services are starting to use the Internet in a big way. Various companies pay the web sites to put their details in web pages so that the user of web will come to know about their products and services. Once the companies grow big and the volume of business increases, companies can opt for creating their own web sites.

- **Home Delivery Service** Home shopping is a growing area of internet use. Through Electronic Commerce it has become very easy to order items through the web site and pay electronically. The goods are delivered at home, hence the entire transaction is electronic.

  This can be achieved in the following steps:

  - Visit merchant's web site, select the items, and enter shipping instructions. The merchant's server returns a summary of item, price and transaction ID.

  - Click the pay button which launches the cybercash wallet. Choose a credit card from your wallet and click OK to forward the order and encrypted payment information to the merchant.

  - Merchant receives the packet, strips off the order and forwards the encrypted payment information to cybercash server.

  - Cybercash server receives the packet, takes the transaction behind its firewall, reformats the transaction and forwards it to the merchant's bank over dedicated lines.

  - The merchant's bank forwards the authorization request to the issuing bank via the card association.

  - Cybercash returns the approval to the merchant who then dispatches the goods to the customer.

Student Activity 3

1. Describe the uses of computers in the field of medicine.
2. How is computer useful for scientists?
3. Describe the uses of computers in the field of education.
4. What is CBT and CAI?
5. How are computers useful for entertainment?
6. Describe home delivery service.

16.8 MULTILINGUAL APPLICATIONS

In initial stages of computer development the impetus lay mostly on making computers more and more computationally powerful. English remained the de-facto language for interaction with computers. However, with the rapid penetration of personal computers into peoples' homes the situation changed drastically. Computers became all pervading technology within only a few years crossing all the boundaries – social and geographical. It was only inevitable that the demand for local languages suitable for user of that particular area of residence for computer interaction could no longer be put on hold.

With this intent a number of research projects were initiated worldwide. As a result today language holds no bar as far as computers' applications are concerned. To provide support to non-English language users, multilingual applications and systems are needed. Multilingual application development remains a hot area in the field of computer application development. It forms one of the major concerns in the development of computer applications today.

A multilingual computer application allows different languages their scripts to be entered through keyboards as also is capable of displaying the same on a display device. The computer implementation should allow every word in a language to be written with unique spelling. Additional services like spell checkers, thesaurus and electronic dictionaries should be developed to exercise better control over languages. Web pages being visible to users from wide localities have now invariably incorporated multilingual services.

As an example let us have a look at some of the multilingual support provided with a popular website – ***google.com***. The home page is displayed below.

Note that this website can be interacted in Hindi, Bengali, Telugu, Marathi and Tamil languages apart from English.

In this page you can see what multilingual supports are provided. Specially note that it allows users to search pages written in a selected language, translate text from one language to another, etc.

An effective and accurate keyboard overlay is required so that existing QWERTY keyboards can be used to input multiple language scripts. Normally, a PC uses 8-bit character code with the 7-bit ASCII code as standard for English alphabets. Along with these alphabets only 128 extra characters can be uniquely defined. Therefore, a wider scheme for character representation was needed. Accurate display of complex scripts is possible only on a bitmap graphics display. The composition of the complex script requires considerable analysis and computations. Further, PC's must be equipped with a graphics screen and a powerful microprocessor.

A synopsis of some important coding schemes developed for multilingual applications is listed in what follows.

GIST (Graphics and Intelligence-based Script Technology)

GIST began in 1983 as a DOE sponsored project at IIT, Kanpur. The objective of its formation was to secure the future of every living language of the world on computers. Since 1988, GIST project is located at CDAC (Centre for Development of Advanced Computing), Pune.

GIST provides complete multilingual solutions for Data Processing, Word processing, DeskTop Publishing, Graphics Design, Multimedia and Video Works on a wide range of platforms, e.g. DOS, Unix, Windows, Macintosh and custom hardware.

GIST has developed various language codes for information interchange (ACII), their representation on screen (ISFOC), keyboard layouts for different scripts (INSCRIPT) and spell checker dictionaries for different languages.

AII GIST development have been standardized by CDAC and accepted by BIS (Bureau of Indian Standard) as well as ISO (International Standard Organization).

ACII Codes (Alphabetic Code for Information Interchange)

ACII codes are standard codes devised for each family of scripts. Each ACII code has got its corresponding ACII keyboard.

Various ACII codes are:

- ACII Indian scripts (ISCII code and INSCRIPT keyboard)

  Indian standard code for Information Interchange Code: Assamese, Bengali, Devnagari, Gujrati, Oriya, Kannada, Malayalam, Punjabi, Tamil and Telegu.

- ACII Perso-Arabic: Arabic, Persian, Pushto, Urdu, Sindhi and Kashmire.
- ACII Srilankan (SLSCII Code): Sinhalese and Tamil
- ACII Tibetan / Druk: Tibetan and Bhutanese
- ACII Thai: Thai script

ACII code for a script or script family has the following features:

- It contains the basic alphabets required for composing all the script variants. It excludes all the conjuncts which can be derived from the basic alphabet.
- Numerals and punctuations which can be used from the ASCII set are not repeated in the ACII code.
- It ensures that there is only one unique way for spelling each word. This is necessary for string search and sorting.
- It includes attribute code for reflecting different script and display attributes.

ACII Keyboard Overlay

ACII keyboard overlay for a script or family of scripts is an overlay on the 47 character keys available on the QWERTY keyboard. The characters on the ACII overlay are placed in the normal and shift position of keys. It preserves the position of numerals and punctuations as for the QWERTY keyboard. It provides macro keys for the conjuncts, which generate two or more ACII codes. The distribution of the characters in the overlays are according to their overall frequencies and grouped according to their logical characteristics.

Display and Printing of ACII Codes

Display and printing linear scripts like English involves the placing of basic characters one after another. However, ACII codes within a word are mapped onto display through an intelligent algorithm. The algorithm uses a basic set of shapes required for composing the script and displays it on a bitmap screen.

Transliteration

ACII codes constituting a word are composed by a script specific algorithm. The same word could be composed and displayed differently as required for different scripts of a family. This change of mode of display within a family of scripts is referred to as transliteration. For universal legibility, a word can be displayed using English letters with appropriate diacritic marks for unambiguation. It is called Roman Script. Transliteration features in a system using ACII codes are:

- Transliteration is always available between members of a script family based on practical requirements.
- Transliteration is always available to Roman script.

Multilingual Application Development in India

In the early 1980s, an "Integrated Devanagiri Terminal" supporting an alphabetic keyboard and code was developed using a 8086 microprocessor. In 1986, "Graphics and Indian Script Terminal" supporting a common phonetic overlay and code for all the Indian scripts was developed using Motorola MC 68000 microprocessor. In 1988, GIST terminal was developed into a GIST add-on card which allowed all the existing character-oriented packages to be used along with Indian scripts. In 1991, ISCII code and INSCRIPT keyboard standards developed by GIST Technology became a part of BIS standards. (IS 13194:1991).

Multilingual Application Products

Hardware

- ***GIST Card:*** It is an add-on card for IBM PC. It allows existing character-oriented softwares to be used along with any of the ACII code scripts. It also gives the ability to do word processing in different scripts and transliteration between scripts of the same family.
- ***GIST Terminal:*** It is VT100/200/300 compatible and allows the GIST scripts to be used on multiuser computer systems with O/S like UNIX, XENIX, VMS, etc.
- ***GIST Printer Spooler:*** It supports both 'serial and parallel' ports. It prints multilingual characters using the graphics mode of a Dot Matrix Printer. It off loads the host computer from script printing burden.
- ***CGIST and PAL Overlay Card:*** It is a plug-in card for IBM-PC that generates a high resolution (960x572) PAL display for TV monitors. Pal Overlay Card allows the display generated by the CGIST card to be overlaid on an external video.

Software

- ***ALP (APEX Language Processor):*** It is multilingual word processor allowing typing of all Indian scripts through the common INSCRIPT keyboard overlay. It is WS compatible.
- ***ISM (ISFOC Script Manager):*** It allows Indian scripts to be typed using the INSCRIPT keyboard overlay within applications running under Windows.
- ***LEAP (Language Environment for Aesthetic Publishing):*** It is a complete DTP package under Windows. It is integrated with ISM, Spellcaster and includes thesaurus, dictionary and grammar checker for various Indian languages.
- ***TransName:*** It allows conversion of a database containing names in English to any of the Indian scripts. It requires GIST card.
- ***Caption Editor:*** It allows creation of colour captions for video display (requires CGIST card) which integrates Indian script and graphics.
- ***ISM for Video and Graphics:*** It is an interface for Indian scripts for graphics design, animation and video software such as AUTODESK's 3D Studio, AT&T, TOPAZ, etc.

Video Works System

- ***LIPS (Language Independent Program Subtitling):*** It is used for including subtitles in a cassette in a variety of languages simultaneously. The viewer can use a standard VCP and a subtitle decoder as LIPS receiver to view the videotape with subtitles of his choice of language. It consists of a LIPS creation station and LIPS receiver.
- ***LIPSIS (Language Independent Program Subtitles Infused in Speech):*** It provides a platform for creating dubbed audio in an interactive way. The software allows putting off the dialogues automatically in a sequence with reference to the original soundtrack. LIPSIS receiver decodes the signals and the user can select the soundtrack of his/her choice.
- ***MOVE (Multilingual On-line Video Editor):*** It is a software used for multi script caption generation and teleprompting. It is useful for TV studios and broadcast station.
- Multilingual Dubbing Station
- Multilingual Teleprompter

Student Activity 4

1. Describe the requirements of computer for multilingual support.
2. What is GIST?
3. Define ACIT

4. What is transliteration? Describe its features.
5. Describe four multilingual application products.
6. Write a short note on the following:
   (a) LIPS
   (b) LIPSIS
   (c) MOVE

16.9 REMOTE SENSING

For all of us earthen mortals the earth with its vital atmosphere and our celestial neighbors are immensely important. Some of these objects are comprehensible to our raw senses. However, a majority of such objects are simply beyond our direct senses. Scope of our senses is pathetically limited. Remote sensing has widened our sensual prowess to a considerably significant limit.

Remote sensing is a vast area of scientific applications in which an object of interest is observed, controlled and manipulated without a direct contact of our primary sensory organs.

Remote Sensing has emerged as a technology that is now instrumental in surveillance. We can now keep a vigil on objects of our interest which were hitherto beyond our reach. Objects near the Earth's surface and atmosphere, the planets, and the entire Universe are being observed, measured, and interpreted from such vantage points as the terrestrial surface, earth-orbit, and outer space.

Interestingly, remote sensing began on the ground. Later with the advent of machines that could fly humans and their precision instruments into air and space, remote sensing has gone further.

Generally a remote sensing system consists of cameras, scanners, radiometers, detectors, radar, sonar and the like. These instruments help us in acquiring information about Earth, the planets, the stars, and ultimately the whole universe. Such instruments can be planted on high altitudes, on the satellites in space and even beyond that. Unmanned vehicles can transport such devices into areas beyond human reach.

Skylab was the first operational system launched into space for collecting information about Earth. The first remote sensing artificial satellite Landsat was planted in a near orbit for mapping natural and cultural resources on land and ocean surfaces. In the year 1978 Seasat was placed in the orbit equipped with a radar imaging system. Since then a large variety of specialized sensors such as Coastal Zone Color Scanner (CZCS), Heat Capacity Mapping Mission (HCMM), Advanced Very High Resolution Radiometer (AVHRR) have been augmenting remote sensing programmes.

Shuttle Imaging Radar or SIR-A, the first non-military radar system was projected into the sky in the year 1982. This act inspired various countries to follow the suit. Consequently, Landsat was soon privatized and was thrown open for a widespread commercial use of remote sensing.

Remote sensing satellites are varied and many. Some of them are listed below segregated into three categories according to their primary applications.

- Primarily Land Observers
- Landsat (1973)
- Seasat (1978)
- HCMM (1978)
- RESURS (Russia, 1985)
- IRS (India, 1986)
- ERS (1991)
- JERS (Japan. 1992)
- Radarsat (Canada, 1995)

- ADEOS (Japan, 1996)
- Terra (1999)
- Proba/Chris (2001)
- Primarily Meteorological Observers
- TIROS (1960)
- Nimbus (1964)
- ESSA (1966)
- ATS(Geostationary) (1966)
- DMSP series I (1966)
- Kosmos (Russia, 1968)
- ITOS series (1970)
- SMS(Geostationary) (1975)
- GOES(Geostationary) series (1975)
- NOAA (1976)
- DMSP series 2 (1976)
- GMS (Himawari, Geostationary) series (Japan, 1977)
- Meteosat(Geostationary) series (Europe, 1978)
- TIROS-N series (1978)
- Bhaskara(Geostationary) (India, 1979)
- NOAA (1982)
- Insat (1983)
- ERBS (1984)
- MOS (Japan, 1987)
- UARS (1991)
- TRMM (U.S./Japan, 1997)
- Envisat (European Space Agency, 2002)
- Aqua (2002)
- Oceanographical
- Seasat (1978)
- Nimbus 7 (1978)
- Topex-Poseidon (1992)
- SeaWiFS (1997)

Remote sensing in most crude form is combination of four activities:

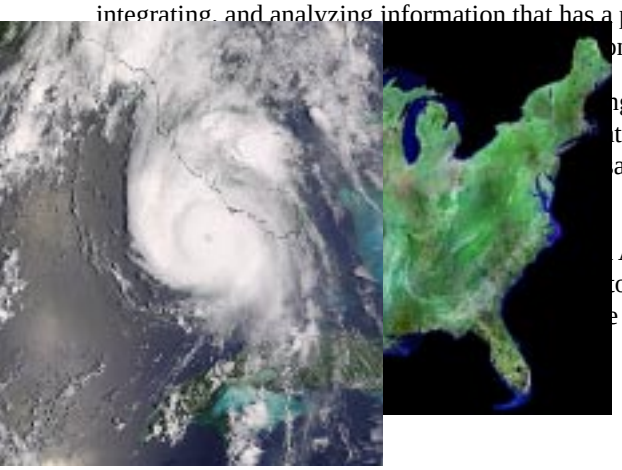
- Image capturing
- Image processing

- Image interpretation
- Simulation

Computers are integral to the remote sensing systems in all the above activities. The instruments that capture images of the objects of interest are controlled by embedded computers; the images captured by these instruments are processed by powerful supercomputers; the results are analyzed and manipulated by yet another supercomputer; the models developed to study the subject are experimented with and simulated on supercomputers. Given below is one remote sensing image captured from the space of the United States of America (courtesy NASA).

The applications mentioned above are only a small subset of a large list of other applications of remote sensing. Many others are still being added everyday.

In the beginning these applications were isolated from each other. However, computer technology has provided an exceptional means for integrating timely remote sensing data with other spatial types of data using Geographic Information Systems (GIS). GIS systems are capable of storing, integrating, and analyzing information that has a practical value in many fields concerned with onmental control, and site development.



ng natural disasters in advance. Satellite imagery te when a storm, or other weather aberrations, aster monitoring is one of the most important

August 14, 2004, killing 19 and causing more tored using remote sensing. Satellites captured e one shown below.

This is a MODIS image of Charley as it hit the Florida coast. The recent Tsunami could have been averted if prompt system were in place though remote sensing did provide the requisite warnings there were no evacuation plan with the civil administrations in the affected areas.

Similarly, a solar eclipse was captured by a polar satellite (shown below).

One of the most practical applications of remote sensing is the GPS based assisted satellite navigation systems. Such systems are very effective in guiding a traveler from the origin to destination. Such systems are equipped with mobile units having giant hard disks pre-loaded with maps for the concerned geographical area. An embedded computer with highly powered processor controls the entire operation. A bluetooth hands-free device is provided so that the users' hands are free while interactive with the system. These systems have features like itinerary planning and advanced route avoidance.

Another interesting application available to a common Internet user is the GoogleEarth.com. Google Earth is virtual globe program. It can be downloaded free of cost from www.earth.google.com. Satellite images are superimposed on aerial photography and GIS over a 3D globe to provide real-time images of any place on the surface of the earth. Given below is one such image of a part of Delhi.

The involvement of computers into remote sensing holds tremendous promises in the days to come.

16.10 WEATHER FORECASTING

Predicting the behavior of the weather has always been both fascinating and challenging to mankind since the time immemorial mostly because mastering weather would eventually make man master of his existence. Earth's atmosphere is where all the climatic and weather related activities take place. The atmosphere itself is such a large mass of fluid that it is impossible to control it. Since, our existence depends on the atmosphere so much that its control is much desirable. If weather could be forecasted accurately it could prove to be a real boon to the human life.

Scientists and experts all over the world have continuously tried to understand the phenomenon of weather. For weather prediction an unimaginably large amount of atmospheric data has been collected from time to time. Several atmospheric models have been developed and tested for their correctness. Despite that we have been able to predict the weather fairly accurately.

In the beginning weather prediction depended on personal experiences and was supposed to be

black magic. This is more because of the limitations of human beings on the amount of data storage and assimilation what to talk about their processing.

The computer technology has however changed the situation in man's favor. Now it is possible to procure real time data, store them, process them, interpret them and finally use them to develop realistic atmospheric models. Thus, computer is today an integral part of the weather prediction mechanism.

The atmosphere is a fluid. The basic idea of numerical weather prediction is to sample the state of the fluid at a given time and use the equations of fluid dynamics to estimate the state of the fluid at some time in the future.

Atmospheric models are a collection of computer programs that output meteorological information for future times. There exist a large number of weather forecasting agencies world over each delving on their individual models. Though none of these models are accurate individually, a number of them can be used together for the purpose of useful weather predictions.

An atmospheric model typically involves meteorological variables superimposed on a 3-D model of the globe. Similar to global models local and regional models have also been developed.

Models are developed using observational data, mostly collected by weather satellites. A powerful computer then processes this data. Data is The data is then sent to the model to create a forecast. Models usually take the form of a collection of equations involving meteorological variables. The equations once perfected with the observed data are stepped forward in time through the complete forecast length.

Some of the important global weather forecasting models are listed below:

- Global Forecast System (GFS)whose prediction output is freely available
- NOGAPS developed by the US Navy
- GEM Global Environmental Multiscale developed by the Meteorological Service of Canada (MSC)
- ECMWF developed by the European Centre for Medium Range Weather Forecasts
- UKMET developed by the UK Met Office
- GME developed by the German Weather Service

Given below is the list of some regional weather models.

- Weather Research and Forecasting (WRF) model
- North American Mesoscale (NAM)
- Advanced Research WRF (AR-WRF) developed primarily at the U.S. National Center for Atmospheric Research
- High Resolution Limited Area Model (HIRLAM)

Some of the recent activities in weather forecast are listed hereunder.

- The SKIRON modeling system
- The RAMS modeling system
- The Mercury modeling systems
- Poseidon system
- Nhreas forecasting system
- ASRC Weather and air quality forecasting system
- Mediterranean Air Quality Forecasting System

16.9 SUMMARY

- Business Data Processing constitutes the largest segment of computer use. Computerized systems are extensively used in transaction processing and accounting systems. Electronic Commerce (EC) has been a buz word nowadays. Two distinct categories of EC are business-to-business and business-to-consumer. Computers have entered not only in business organizations but they are doing wonders even in scientific and education systems. Moreover computers have brought a new revolution in the field of entertainment and advertisement. Multilingual applications are still the subject of research and development. India supports lots of regional languages and CDAC has already come up with many Multilingual appllications like GIST and ACII codes.

16.10 KEYWORDS

Invoices: To run any business, maintenance of fundamentals source documents is necessary. These sources documents are known as invoices.

Financial Information System: A subsystem of any business system that provides information to persons and groups, both inside and outside the firm, concerning the firms, financial matters.

Payroll system: An important subsystem for any business system to calculate the regular payslips and additional reports.u

Inventory: The idle products or stock which a firm maintains for future requirements.

Inventory Management System: System that deals with management of amount of inventory maintained by the firm.

Purchasing Cost: Costs that are incurred when material are ordered like buyer's time, telephone expenses, secretary time, purchase order form, etc.

Economic Order Quantity: The techniques to determine the quantity to be purchased at one time so as to balance the maintenance and purchasing costs and achieve the lowest total inventory cost.

Computer Aided Instruction (CAI): When a computer is used as a teaching aid, it is referred to as computer assisted-instructions or computer Aided Instruction(CAI).

Computer Based Tutorial (CBT): Using the computer to provide intelligent tutoring is gaining in popularity in both high schools and colleges.

ACII Codes (Alphabetic Code for Information Interchange): Standard codes devised for each family of scripts.

GIST Card: It is an add-on card for IBM PC. It allows existing character-oriented software to be used along with any of the ACIT code scripts.

GIST Terminal: It is VT 100/200/300 compatible and allows the GIST scripts to be used on multiuser computer systems with O/s like UNIX, XENIX, VMS etc.

Move (Multilingual on-line Video Editor): It is software used for multi script caption generation and teleprompting.

16.11 REVIEW QUESTIONS

Fill in the Blanks

1. Through _____ it has become very easy to order the items through web site and pay electronically.
2. Applications involving mathematical, statistical and model processing are called _____.
3. Inventory means _____ which a firm maintains for future requirements.
4. Accounting data provides a record of _____ importance that happens in the firm.
5. _____ is a software used for multiscript caption generation and teleprompting.

Multiple Choice

1. Organizations use computers for
   a. Transaction Processing
   b. Management Control Operations
   c. Decision-Making
   d. All of the above
2. Payroll System maintains
   a. Employee Master File
   b. Purchase Transaction Fil
   c. Sale Transaction Fil
   d. None of the above
3. MIS stands for
   a. Manual Information System
   b. Management Integration Systems
   c. Management Information System
   d. None of the above
4. PUFF is a package used
   a. in personnel administration
   b. in inventory system
   c. to diagnose lung disease
   d. None of the above
5. Entertainment applications do not include
   a. Audio and Video CD Player
   b. Games and animation packages
   c. Computer based tutorials
   d. None of the above

Descriptive Questions

1. Briefly explain the Financial Information System. How are computers useful in Accounts?
2. What is EOQ? How does it help in inventory management?
3. How can computer be utilized in our education system?
4. What is transliteration? Discuss multilingual application development in India.

Answers to Review Questions

Fill in the Blanks

1. Computers
2. Scientific applications
3. Stock
4. Monetary
5. MOVE

Multiple Choice

1. (d) 2. (a) 3. (c) 4. (c) 5. (c)

16.12 FURTHER READINGS

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

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

UNIT

17

SOME IMPORTANT NATIONAL PROJECTS

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Describe Railway Reservation System.
- Describe NICNet.
- Describe ERNET.
- Describe INDONET.
- Describe PARAM.
- Understand Smart City concept.
- Describe NIB.

U N I T S T R U C T U R E

17.1 INTRODUCTION

ffective deployment of IT for economic growth requires strong IT, particularly communication, infrastructure backed by an equally strong Research and Development effort. In this effort government as well private sector organizations must collaborate and contribute. With a view to make India an IT superpower, Government of India has launched a large number of initiatives both to create world-class IT infrastructure as well as a network of R&D organizations. Most state governments have also formulated state IT policies. Private sector organizations have shown remarkable dynamism after liberalization of economy. In this chapter, we describe a number of important national projects having direct bearing on use of IT for economic growth.

Information technology has tremendous potential for accelerating the national development effort. Recognizing this fact, central government, has initiated a number of IT projects to create infrastructure for rapid economic development. In this chapter, we are going to discuss some of the major IT projects in the country.

17.2 RAILWAY RESERVATION SYSTEM

Indian Railways have introduced computerized ticket reservation system at many important stations. The computer stores all necessary information in connection with ticket reservation such as the train number, stations enroute, distance, number of seats available on each train and in each class, fare, etc.

The person sitting at the counter has ready access to information whether seats on a particular date in a particular train are available or not. If seats are available, the computer prints the ticket and the details of the person getting reservation are recorded. The computer also prints the reservation charts. It also gives information regarding train timings, train fares, etc., on enquiry.

17.3 NICNET

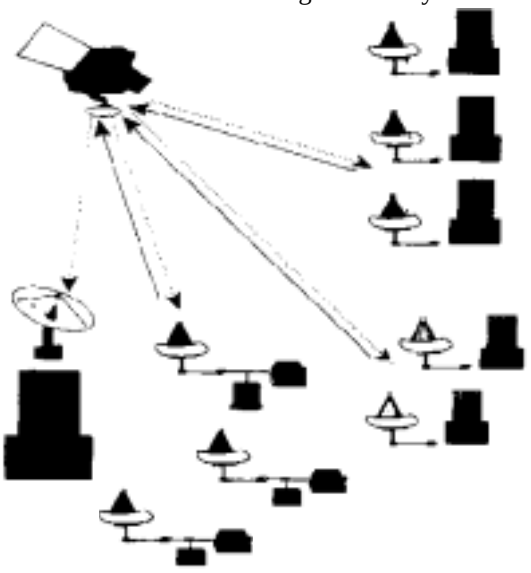
In order to exploit the vast opportunities offered by IT which will improve the planning process and accelerate implementation of socio-economic programmes, central government has created a nodal organization – National Informatics Centre (NIC), attached to the ministry of Information Technology.

The mandate of NIC is to introduce computer-based MIS, paperless office concept, electronic-mail services and telemetric services in the central, state and district government departments. NIC has established a satellite-based computer communication network called NICNET, linking all district headquarters, state capitals and national capital. It has also facilitated creation of and access to essential databases for effective administration at the district, state and national levels.

NICNET Infrastructure

NICNET Infrastructure comprises:

- Very large computers (NEC - 51000) at the NIC headquarters (New Delhi) and regional centres (Pune, Bhubaneshwar, and Hyderabad).
- Super minicomputers (ND-550 or equivalent) at state capitals for providing informatics services to the state governments.
- Super PC-AT computer systems at each district headquarter to provide information support to the district administration.
- Mother earth station at NIC headquarters, Delhi, and a micro earth station at each of the NIC state units and district informatics centres for exchange of information via satellite (INTELSAT).
- The state, regional, and national centres have facility to share loads and also serve as back-up to one another. The network has high reliability and round the clock availability.

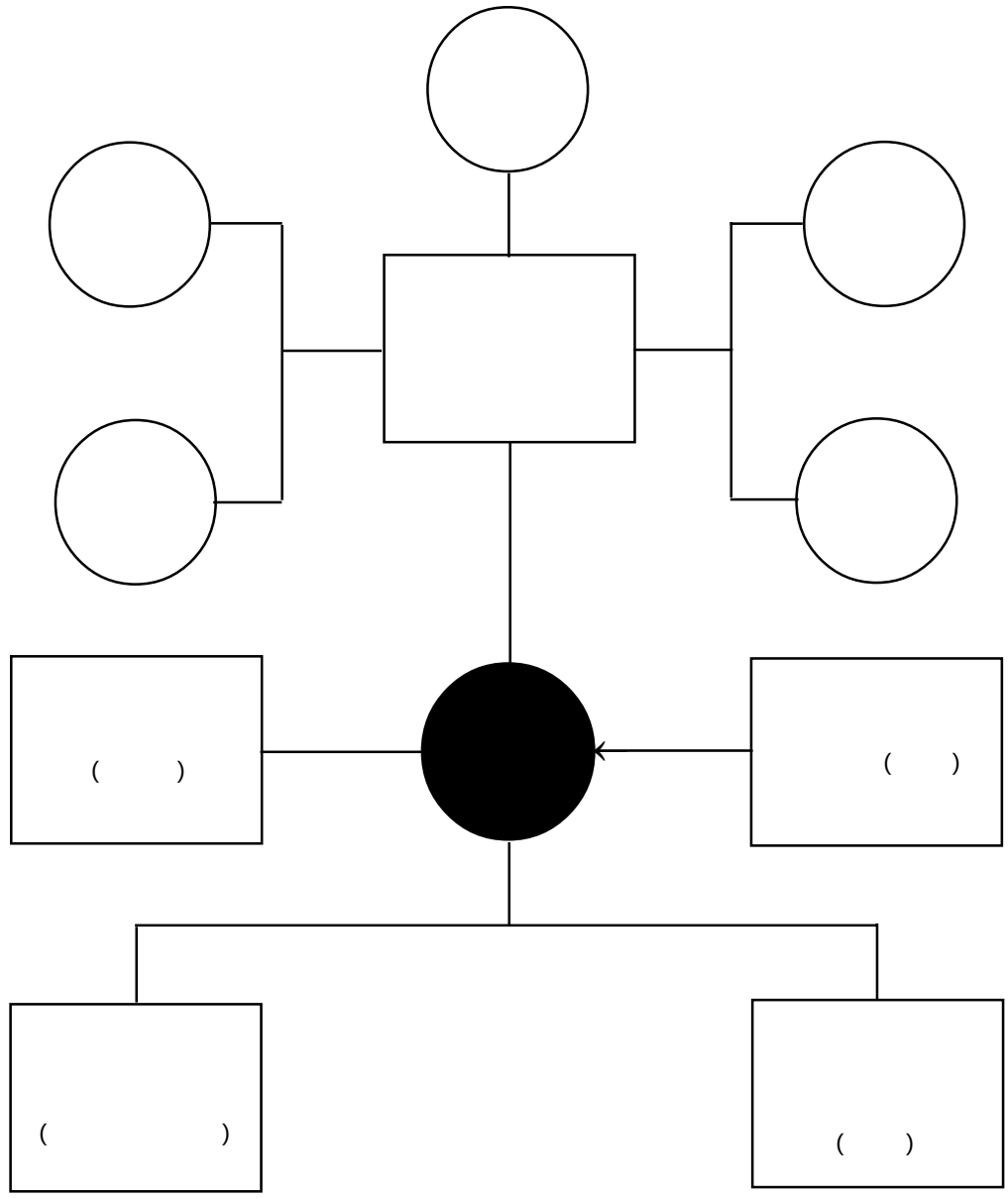


NICNET Infrastructure

NICNET Information Flow

Each District Informatics Centre (DIC) has facilities to process information for monitoring socio-economic development activities within the district. Each DIC has communication link with the State Informatics Centre (SIC) for flow of information between districts and the state headquarters. The information exchange between districts can be through SIC only.

The SIC provides information support primarily to all state government departments but also to district administration. The regional centres provide technical support to the SIC in the respective regions. They provide access to specialized peripherals and high processing power for state level modelling and simulating studies. The national centre at NIC headquarters provides information support to various central government departments.



Functional Components of DISNIC

17.4 ERNET

It stands for the educational and research NETwork of the Department of Electronics. ERNET was set up with the following objectives:

- It started off as United Nations Development Program (UNDP) project.

- Other academic and research institutions like IIT Kanpur, Kharagpur and IISc Bangalore are also involved in managing the project.
- It was initially meant to provide Internet services to educational institutions only; it has also provided connections to commercial institutes at concessional rates.
- In a major move to spread Internet culture at the grass-roots level, the government, in association with ERNET, plans to use VSAT technology to provide schools with access to WEB.
- Presently ERNET has about 80,000 users.
- ERNET has now been spun off as an independent society under Department of Electronics (DOE).

17.5 INDONET

It is a public data network in India installed in 1986 by CMC Ltd. It links up with cities of Calcutta, Mumbai, Delhi, Chennai through P&T's dedicated trunk links. It offers the users the opportunity to utilize the processing power of large computers located in different metropolitan cities. Users can conveniently avail of numerous software packages and databases from their own premises anywhere in India by means of leased lines.

Student Activity 1

1. Describe railway reservation system.
2. What is NIC net? Describe its infrastructure.
3. Describe NICNET Information flow.
4. What is ERNET? What are its major objectives?
5. What is INDONET?

17.6 PARAM

The Indian Government, established the Centre for Development of Advanced Computing (CDAC) in 1988. In July 1991, an ambitious project was completed which resulted in the development of a super computer called PARAM. Now PARAM is available in various models – PARAM-8000, PARAM-8600 and PARAM-9000, PARAM-10000. PARAM-9000 has a capacity of 2000 megaflops which can be increased to 50,000 megaflops. PARAM 10000 is a 100 gigaflops capacity supercomputer. It is being used in several scientific and research institutions belonging to space, atomic energy and meteorological departments.

17.7 SMART CITY CONCEPT

Pune is going to become the country's first networked city under C-DAC's National Information Infrastructure (NII) project. The project entails connecting every home, school, college, hospital and enterprise by building a massive NII to improve the quality of life in the city.

The NII project will create virtual classrooms with facilities for distance learning, provide multilingual access device and enable residents to operate bank accounts, make bill payments, access libraries, make reservations and receive medical reports on-line from home.

The NII project has been planned in accordance with the emerging Global Information Infratructure (GII) initiative under which similar projects have already taken off in the USA, Japan, Korea, Malaysia, and Singapore.

17.8 NATIONAL INTERNET BACKBONE (NIB)

NIB is a broad-based access network that provides nodes for Internet net access throughout the country. It is supposed to act as a transmission media to carry Internet traffic, both government

and private, to the nearest international gateway. The objective of the backbone is to provide convenient and easily accessible Internet Access Points (IAPs) for all Internet Service Providers (ISPs) so that they can connect their Points of Presence (PoP) to the Internet easily. Presently 549 IAP stations are to be established throughout the country.

The total operation of NIB consists of a multitier structure of aggregation and connectivity at three different levels. The first tier comprises 14 metropolitan and major cities (Type A) connected by high-capacity links to gateways, out of which six will be international gateways. The second tier (Type B) consists of 31 medium-sized towns and will be connected to the first tier by medium capacity links. In all 376 district headquarters comprise the third tier (Type C) and these are to be connected through the second tier only in the final phase.

The network architecture for these stations is top-of-the-line with "Mesh Topology" connecting 8 international gateways. The carrier class equipment which includes Remote Access Servers (RAS), routers, LAN switches and application server with network management system offer a high degree of reliability and redundancy. NIB will support Internet access through PSTN and ISDN dialup, leased lines and X.25.

Indian Information Technology Act-2000

The rapid proliferation of Information Technology (IT), Internet, and e-commerce have not only changed the methods of conducting business transactions but also raised a number of legal issues. As more and more activities are conducted electronically, it becomes imperative that electronic evidence of such activities is legally acceptable to demonstrate the legal rights and obligations that flow from them. Thus, there is an urgent need for a legal framwork to both support such commercial transactions and also prevent new types of crimes which may arise in electronic/digital era.

In May 2000, both the houses of the Indian Parliament passed the Information Technology Bill 2000. The bill received the assent of the President of India on June 9, 2000 and has now become the Information Technology Act 2000. The relevant rules for implementing the Act were notified on October 17, 2000 and thus the Act stands implemented from this date.

The Act, through its 94 clauses and associated implementation rules, provides a much-needed legal framework for facilitating electronic transactions. It accomplishes this by both, amending several existing laws as well as enacting new ones, including those designed to deal with cyber crimes.

The Act seeks to empower various government departments to accept filing, creating and retention of official documents in the digital format. It also provides legal framework for the authentication and origin of electronic records/communications through digital signature. Thus the Act tries to promote legal and business infrastructure necessary to implement e-commerce and spur the use of internet-based communication, i.e. e-mail, etc.

Information source: lexadvisor.com/Acts/Infotech/Rules.htm
www.mit.gov.in

Student Activity 2

1. What is PARAM?
2. Describe Smart City Concept.
3. What is NIB?
4. Write a short note on Indian Information Technology Act-2000.

17.9 SUMMARY

- The Government of India considers IT as an agent of transformation of every facet of human life which will bring about a knowledge-based society in the 21st century. It has launched a drive to accelerate the settng up of a world-class information infrastructure with an extensive spread of fiber optic networks, satellite communication for interconnecting National Information Infrastructure and Global Information Infrastructure. NIC has established a satellite-based computer network called NICNET in this regard.

17.10 KEYWORDS

NICNET: In order to exploit the vast opportunities offered by IT which will improve the planning process and accelerate implementation of socio-economic programmes, central government has created a nodal organization—National Informatics Centre (NIC), attached to the ministry of Information Technology.

ERNET: It stands for the educational and Research NET work of the Department of Electronics.

INDONET: It is a public data network in India installed in 1986 by CMC Ltd. which offers the users the opportunity to utilize the processing power of large computer located in different metropolitan cities.

PARAM: In July 1991, an ambitious project was completed which resulted in the development of a super computer called PARAM.

National Internet Backbone (NIB): NIB is a broad-based access network that provides nodes for Internet net access throughout the country

17.11 REVIEW QUESTIONS

Fill in the Blanks

1. Indian Railways has introduced computerized_____.
2. The mandate of NIC is to introduce_____,_____, _____, and____ in Central, state and district government.
3. _____was initially meant to provide Internet services to educational institutions only.
4. The Indian Supercomputer is named as_____.
5. The _____project will create virtual classrooms.

Descriptive Questions

1. What steps have been taken by the Government of India to make the country an IT superpower?
2. What do you understand by Smartcity concepts?
3. Write short notes on the following:
   a. NICNET
   b. NIB
   c. ER-NET
   d. PARAM

Answers to Review Questions

Fill in the Blanks

1. Ticket reservation system
2. Computer-based MIS, paperless office concept, e-mail services, telemetric services.
3. ERNET
4. PARAM
5. NII

17.12 FURTHER READINGS

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

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

UNIT

18

INTRODUCTION TO OOPS

L E A R N I N G O B J E C T I V E S

After studying this unit, you should be able to:

- Describe the need of object-oriented programming.
- Describe procedure-oriented programming.
- Define class and objects.
- Describe features of OOP.
- Describe various class relationships.
- Describe base class and derived class.
- Define data abstraction, inheritance and polymorphism.

U N I T S T R U C T U R E

18.1 INTRODUCTION

The term object-oriented programming (OOP) is widely used, but experts cannot seem to agree on its exact definition. However, most experts agree that OOP involves defining abstract data types (ADT) representing complex real-world or abstract objects and organizing your program around the collection of ADTs with an eye toward exploiting their common features. Use of object-oriented techniques does not impart anything to a finished software product that the user can see. However, as a programmer while implementing the software, you can gain significant advantages by using object-oriented methods, especially in large software projects. Because OOP enables you to remain close to the conceptual, higher-level model of the real world problem you are trying to solve, you can manage the complexity better than with approaches that force you to map the problem to fit the features of the language.

18.2 NEED OF OBJECT-ORIENTED PROGRAMMING

The term object-oriented programming (OOP) is widely used, but experts cannot seem to agree on its exact definition. However, most experts agree that OOP involves defining abstract data types (ADT) representing complex real-world or abstract objects and organizing your program around the collection of ADTs with an eye toward exploiting their common features. The term data

abstraction refers to the process of defining ADTs; inheritance and polymorphism refer to the mechanisms that enable your to take advantage of the common characteristics of the ADTs - the objects in OOP. This chapter further explores these terms later.

Before you jump into OOP, take note of two points. First, OOP is only a method of designing and implementing software. Use of object-oriented techniques does not impart anything to a finished software product that the user can see. However, as a programmer while implementing the software, you can gain significant advantages by using object-oriented methods, especially in large software projects. Because OOP enables you to remain close to the conceptual, higher-level model of the real world problem you are trying to solve, you can manage the complexity better than with approaches that force you to map the problem to fit the features of the language. You can take advantage of the modularity of objects and implement the program in relatively independent units that are easier to maintain and extend. You can also share code among objects through inheritance.

The second point is that OOP has nothing to do with any programming language, although a programming language that supports OOP makes it easier to implement the object-oriented techniques. As you will see shortly, with some discipline, you can use objects in C programs.

Procedure-Oriented Programming

Before you get into OOP, take a look at conventional procedure-oriented programming in a language such as C. Using the procedure-oriented approach, you view a problem as a sequence of things to do. You organize the related data items into C structs and write the necessary functions (procedures) to manipulate the data and, in the process, complete the sequence of tasks that solve your problem. Although the data may be organized into structures, the primary focus is on the functions. Each C function transforms data in some way. For example, you may have a function that calculates the average value of a set of numbers, another that computes the square root, and one that prints a string. You do not have to look far to find examples of this kind of programming – C function libraries are implemented this way. Each function in a library performs a well-defined operation on its input arguments and returns the transformed data as a return value. Arguments may be pointers to data that the function directly alters or the function may have the effect of displaying graphics on a video monitor.

In any realistic software project, post implementation changes are all but inevitable. Also, the real nature of the human creative process is inherently evolutionary. Because we learn as we go along, our usual approach to a new programming task is to go through an iterative process of analyzing the problem, implementing it and then refining the design. In other words, we develop prototypes or working models of the software. Grady Booch calls this the strategy of "analyze a little, design a little." He qualifies this by stating that it does not mean that you should design by trial and error. Instead, Booch advocates a design process that proceeds with a series of prototypes, each modeling an important aspect of the system and each selected with an eye towards arriving at the complete functionality as the collection of prototypes glows.

The emerging object-oriented design (OOD) techniques reflect the evolutionary aspect of software development. The steps of analysis, design and implementation are still necessary, but the separation between them is blurred. Also, the approach in each phase is more closely tied to the objects in the real world problem being solved. The remainder of this chapter briefly discusses several ways of using object-oriented techniques in the software development process.

18.3 A LOOK AT PROCEDURE-ORIENTED PROGRAMMING

Conventional programming using high level languages such as COBOL, FORTRAN and C is commonly known as procedure-oriented programming. In the procedure-oriented approach, the problem is viewed as a sequence of things to be done, such as reading, calculating and printing. A number of functions are written to accomplish these tasks. The primary focus is on functions. A typical program structure for procedural programming is shown in Figure 18.1. The technique of hierarchical decomposition has been used to specify the tasks to be completed in order to solve a problem.

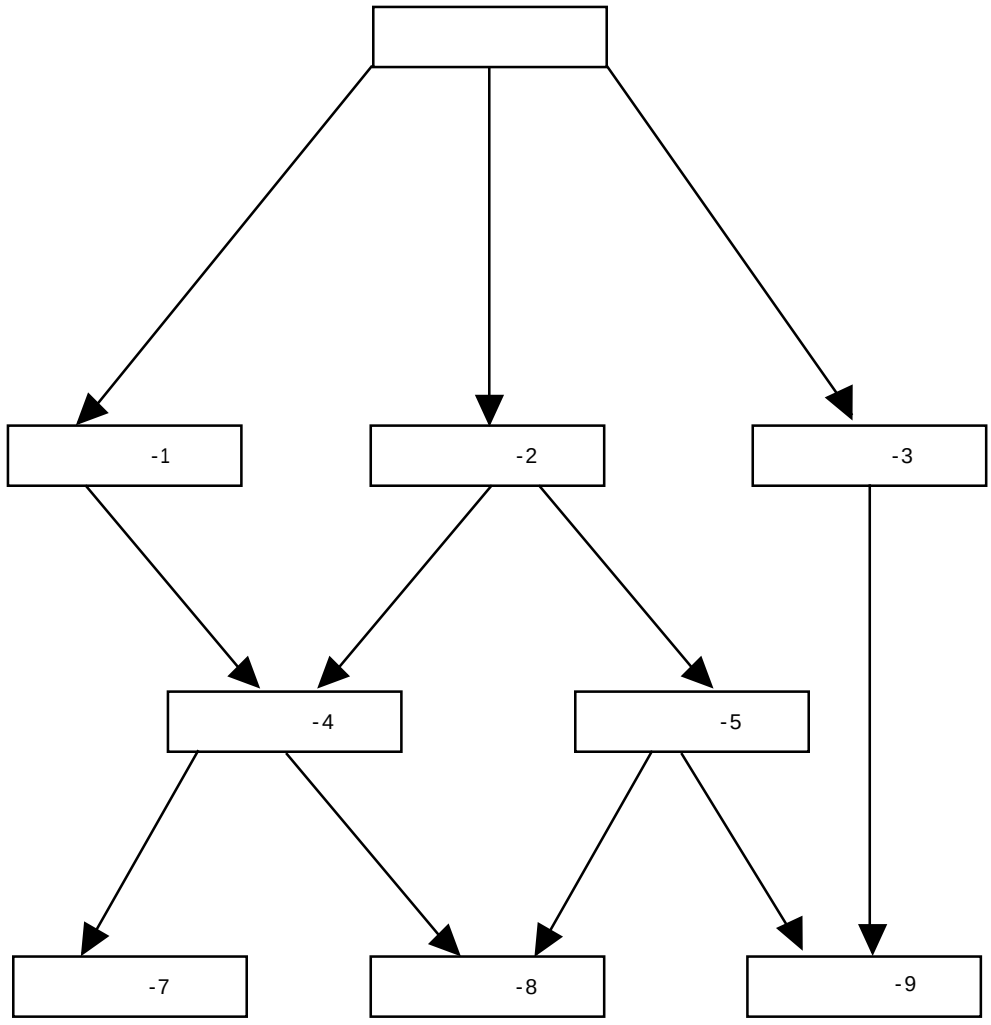


Figure 18.1: Typical Structure of Procedure-oriented Programs

Procedure-oriented programming basically consists of writing a list of instructions for the computer to following and organizing these instructions into groups known as functions. We normally use a flowchart to organize these actions and represent the flow of control from one action to another.

While we concentrate on the development of functions, very little attention is given to the data that are being used by various functions. What happens to the data? How are they affected by the functions that work on them?

In a multi-function program, many important data items are placed as global so that they may be accessed by all the functions. Each function may have its own local data. Figure 19.2 shows the relationship of data and functions in a procedure-oriented program.

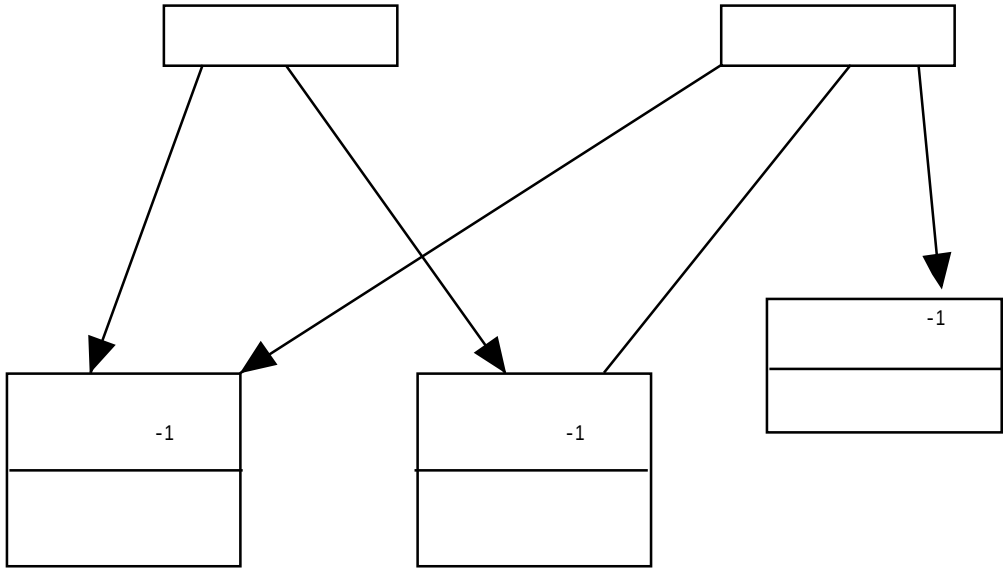


Figure 18.2: Relationship of Data and Functions in Procedural Programming

Global data are more vulnerable to an inadvertent change by a function. In a large program it is very difficult to identify what data is used by which function. In case we need to revise an external data structure, we should also revise all functions that access the data. This provides an opportunity for bugs to creep in.

Another serious drawback with the procedural approach is that it does not model real world problems very well. This is because functions are action-oriented and do not really correspond to the elements of the problem.

Some characteristics exhibited by procedure-oriented programming are:

- Emphasis is on doing things (algorithms).
- Large programs are divided into smaller programs known as functions.
- Most of the functions share global data.
- Data move openly around the system from function to function.
- Functions transforms data from one form to another.
- Employs top-down approach in program design.

18.4 CLASS AND OBJECTS

Object-Oriented Programs (OOPs) attempt to emulate real world in software system. The real world consists of objects, categorized in classes. For example, you're using an object categorized as a book to learn about programming. OOP describes a software system in terms of real world objects.

Consider a 14 inch television, an object. It has certain attributes: a 14 inch screen and controls for adjusting a volume, brightness and color. It also has certain behaviors: it shows moving pictures and allows a viewer to change channels. Finally, it has an identity: a serial number that distinguishes it from other televisions.

How was the TV made? The management of the TV company decided that it should have certain attributes and behave in a certain way. These decisions were documented as blueprint, which was used to make TV. The blueprint in OOP is called class. All objects belong to some class that defines their attributes and behaviors. An object is an instance of a class. In OOP, classes have attributes represented by data members. For example, a TV has an attribute called size, which may have value 14 inches and a state (on/off).

The attributes distinguish an object of the class. Classes have behaviors, which are represented as methods. The methods define how an object acts or reacts.

The features of OOP are listed below:

1. ***Real world:*** The real world consists of objects like books, tables, chairs and TV. The same concept has been introduced into programming, bringing it closer to real life.
2. ***Information encapsulation (Hiding):*** Objects provide the benefit of information hiding. Electrical wiring in a TV should not be tampered with and should be hidden from the user. OOP allows you to encapsulate data that you do not want users of the object to access. Typically attributes of a class are encapsulated.
3. ***Abstraction:*** It allows us to focus only on those parts of an object that concern us. To continue the example given above, a person operating the TV does not need to know the intricacies of how it works. The person just need to know how to switch it on, change channels and adjust the volume. All the details that are unnecessary to the user are encapsulated, leaving only a simple interface to interact with. Providing only the users what they need to know is an abstraction. Abstraction lets us ignore the irrelevant details and concentrate on the essentials.
4. ***Inheritance:*** A TV has certain common attributes and functionality. For example, you expect a TV to have a screen. Companies add more features to the basic functionality of TVs to create their own brand or class of TVs. This means they've added new functionality to the existing class without creating a new one from the scratch. For example, a color TV has been derived from TV class. The child class, color TV, inherits the properties of the parent class, TV. Similarly, programmers can reuse code rather than rewrite it. You can use the existing features of the class and add more functionality to it. This is known as inheritance. Using inheritance you can extend the scope of classes and at the same time, reduce the amount of code to be written. Through inheritance you can provide the reusability of code.

Student Activity 1

1. What is the need of object-oriented programming?
2. Describe procedure oriented programming.
3. What are the characteristics of procedure oriented programming?
4. What are the features of OOP.

18.5 THE CONCEPT OF A CLASS

The user defined data type, class, distinguishes C++ from traditional procedural language. A class is a new data type that is created to solve a particular kind of problem. Once a class is created anyone can use it, without knowing the specifics of how it works or even how a class is built.

18.6 THE CLASS KEYWORD

The class keyword is used to declare a class. The braces are used to indicate the start and end of a class body. Member variables and member functions are declared inside the class body. A semicolon is used to end the declaration.

Example

```
# include <iostream.h>
class car
{
        ...
};
int main()
{
car ford;
...     return (0);
}
```

18.7 CLASS RELATIONSHIP

Design and Construction

You need to be an expert carpenter to design a wooden bridge, but you need to known the fundamentals of wooden construction and the properties of the wood and the carpenters who will construct the bridge. Similarly, to design a piece of software successfully, you need fairly detailed knowledge of the chosen programming language. A good bridge designer considers and respects the properties of the material and resources. Similarly, a good programmer builds on the strengths of the implementation language.

Types of Relationships

1. **A "kind of" relationship** Taking the example of a human being and an elephant, both are "kind of" mammals. Mammals have attributes - eyes and limbs. They also have behavior, walking. As human beings and elephants are "kind of" mammals, they share the attributes and behaviors of mammals. Human beings and elephants are subsets of mammal class. The following Figure 18.3 depicts the relationship between the mammal and human beings.

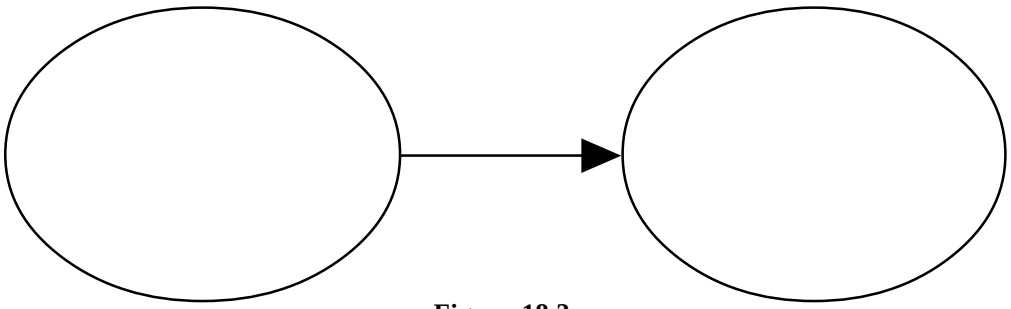


Figure 18.3

2. ***"Is a" relationship:*** The previous example depicts the relationship between human beings and mammals. Let's take an instance of a human being and therefore a mammal. The following figure depicts "is a" relationship:

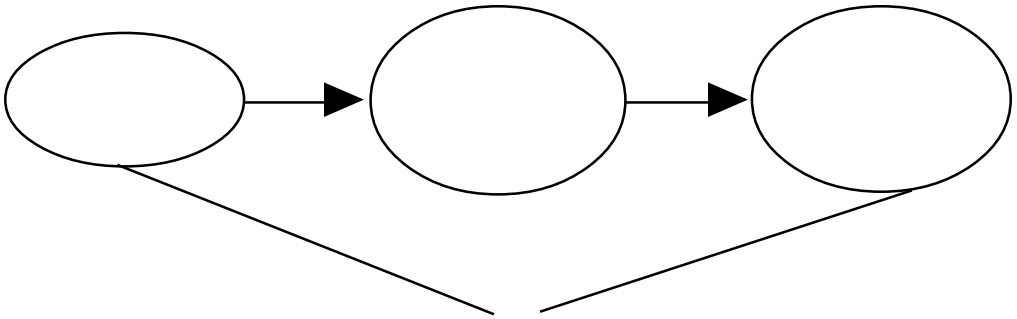


Figure 18.4

3. ***"Has a" relationship/part of relationship:*** A human being has a heart. This represents "has a" relationship. The same relationship can be represented as: A heart is a part of human being. The following figure depicts the relationship between a human being and heart.

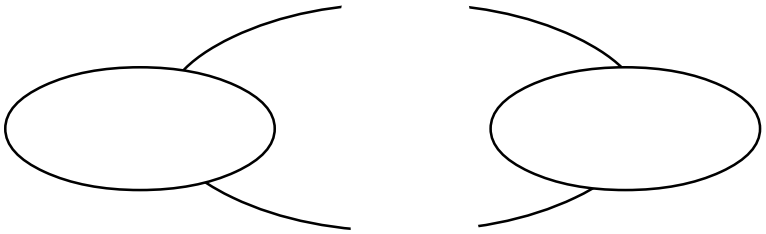


Figure 18.5

Base Class and Derived Class (Super class and Sub class)

Let us take the example of air tickets. Air tickets can be of two types – confirmed and request. Both these ticket have a lot of common attributes, for example, flight number, date, time and destination. However, a confirmed ticket would also have a seat number, while a request ticket would have status.

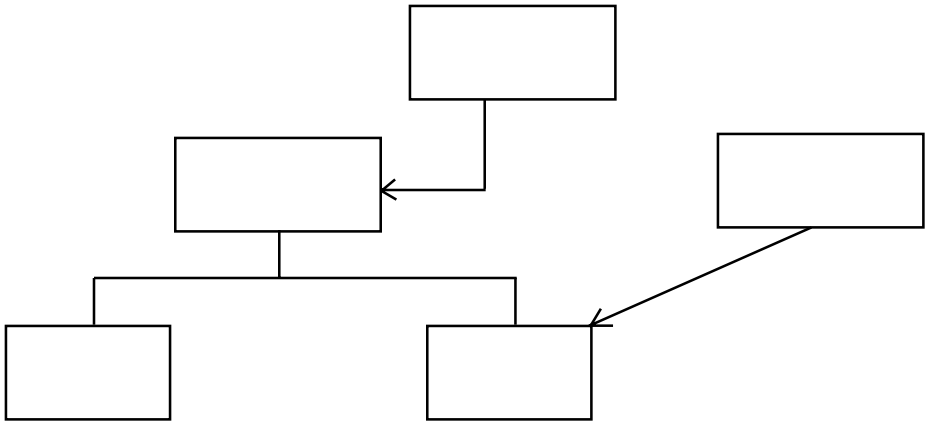


Figure 18.6

In the example above, we have incorporated the structure and behavior that is common to the two classes to form a superclass. The superclass represents generalized properties and the subclass represents specialization, in which attributes and behavior from the super class are added, modified or hidden.

A super class is a class from which another class inherit properties. A super class shares its properties with its child classes. A sub class is a class that inherits attributes and methods from super class.

18.8 DATA ABSTRACTION

To understand data abstraction, consider the file I/O routines in the C run-time library. These routines enable you to view the file as a stream of bytes and to perform various operations on this stream by calling the file I/O routines. For example, you can call fopen to open a file, fclose to close it, fgetc to read a character from it and fputc to write a character to it. This abstract model of a file is implemented by defining a data type named FILE to hold all relevant information about a file. The C constructs struct and typedef are used to define FILE. You will find the definition of FILE in the header file stdio.h. You can think of this definition of FILE, together with the functions that operate on it, as a new data type just like C's int or char.

To use the FILE data type, you do not have to know the C data structure that defines it. In fact, the underlying data structure of FILE can vary from one system to another. Yet, the C file I/O routines work in the same manner on all systems. This is possible because you never access the members of the FILE data structure directly. Instead, you rely on functions and macros that essentially hide the inner details of FILE. This is known as data hiding.

Data abstraction is the process of defining a data type, often called an abstract data type (ADT), together with the principle of data hiding. The definition of an ADT involves specifying the internal representation of the ADT's data as well as the functions to be used by others to manipulate the ADT. Data hiding ensures that the internal structure of the ADT can be altered without any fear of breaking the programs that call the functions provided for operations on that ADT. Thus, C's FILE data type is an example of an ADT.

Inheritance

Data abstraction does not cover an important characteristic of objects. Real world objects do not exist in isolation. Each object is related to one or more other objects. In fact, you can often

describe a new kind of object by pointing out how the new object's characteristics and behavior differ from that of a class of objects that already exists. This is what you do when you describe an object with a sentence such as: B is just like A, except that B has..., and B does... Here you are defining objects of type B in terms of those of type A.

This notion of defining a new object in terms of an old one is an integral part of OOP. The term inheritance is used for this concept, because you can think of one class of objects inheriting the data and behavior from another class. Inheritance imposes a hierarchical relationship among classes in which a child class inherits from its parent. In C++ terminology, the parent class is known as the base class, the child is the derived class.

Multiple Inheritance

A real world object often exhibits characteristics that it inherits from more than one type of object. For instance, on the basis of eating habits, an animal maybe classified as a carnivore; other ways of classification place it in a specific family, such as the bear family. When modeling a corporation, you may want to describe a technical manager as someone who is an engineer as well as a manager. An example from the programming world is a full-screen text editor. It displays a block of text on the screen and also stores the text in an internal buffer so that you can perform operations such as insert a character and delete a character. Thus, you may want to say that a text editor inherits its behavior from two classes: a text buffer class and a text display class that, for instance, rt~nages an 80-character by 25-line text display area.

These examples illustrate multiple inheritance – the idea that a class can be derived from more than one base class. Many object-oriented programming languages do not support multiple inheritance, but C++ does.

Polymorphism

In a literal sense, polymorphism means the quality of having more than one form. In the context of OOP, polymorphism refers to the fact that a single operation can have different behavior in different objects. In other words, different objects read differently to the same message. For example, consider the operation of addition. For two numbers, addition should generate the sum. In a programming language that supports OOP, you should be able to express the operation of addition by a single operator, say, +. When this is possible, you can use the expression x+y to denote the sum of x and y, for many different types of x and y – integers, floating-point numbers, and complex numbers, to name a few. You can even define the + operation for two strings to mean the concatenation of the string.

Similarly, suppose a number of geometrical shapes respond to the message, draw. Each object reacts to this message by displaying its shape on a display screen. Obviously, the actual mechanism for displaying the object differs from one shape to another, but all shapes perform this task in response to the same message.

Polymorphism helps by enabling you to simplify the syntax of performing the same operation on a collection of objects. For example, by exploiting polymorphism, you can compute the area of each geometrical shape in an array of shapes with a simple loop like this:

```
        /* Assume "shapes" is an array of shapes (rectangles, circles,
          * and son on) and "compute_area) is a function that computes
          * the area of a shape
          */
for     (i = 0; i < number_of_shapes; i++)
        area_of_shape = shapes[i].compute_area();
```

This is possible because regardless of the exact geometrical shape, each object supports the compute_area function and computes the area in a way appropriate for that shape. effort. Recognizing this fact, central government, has initiated a number of IT projects to create infrastructure for rapid economic development. In this chapter, we are going to discuss some of the major IT projects in the country.

Student Activity 2

1. What is a class?
2. Describe the following class relationships, give atleast are example to explain them.
   (a) 'Kind of' relationship
   (b) 'Is a' relationship
   (c) 'Has a' relationship
3. What is a base class and a derived class?
4. Write short notes on the following:
   (a) Data Abstraction
   (b) Inheritance
   (c) Polymorphism

18.9 SUMMARY

Object oriented programs attempt to emulate real world in software system. The real world consists of objects, categorized in classes. The attributes distinguish an object of the class. Classes have behaviours, which are represented as methods. The methods define how an object acts or reacts.

Objects provide the benefit of information hiding abstraction and inheritance. A class is a new data type that is created to solve a particular kind of problem. Once a class is created anyone can use it, without knowing the specifics of how it works or even how a class is built.

To design a piece of software successfully, you need fairly detailed knowledge of the chosen programming language. A good programmer builds on the strength of the implementation language.

The superclass represents generalized properties and the subclass represents specialization, in which attributes and behaviour from the super class are added, modified or hidden.

OOP is a method of designing and implementing software. Since OOP enables you to remain close to the conceptual, higher-level model of the real world problems, you can manage the complexity better than with approaches that force you to map the problem to fit the features of the language. Some essential concepts that make a programming approach object-oriented are objects, classes, data abstraction, encapsulation, polymorphism, Inheritance, dynamic binding and message passing.

18.10 KEYWORDS

Object: In the object-oriented model a combination of a small amount of data and instructions about what to do with that data when the object is selected or activated.

***Object* Oriented Programming (OOP) Language:** Programming language that encapsulates a small amount of data along with instructions about how to manipulate that data; inheritance and reusability features provide functional benefits.

Class: A class represents a set of related objects.

Data abstraction: The act of representing essential features without including the background details or exploitation.

Data encapsulation: The wrapping up of data and functions in a single unit (class).

Inheritance: The process by which objects of same class acquire the properties of object of another class.

Polymorphism: The ability to take more on form.

Super-class: A class from which another class inherit properties.

Sub-class: A class that inherits attributes and methods from super class.

18.11 REVIEW QUESTIONS

Fill in the Blanks

1. OOP is a method of _____and_____software.
2. Using _____approach, you view a problem as a sequence of things to do.
3. In procedure-oriented programming, most of the functions share _____data.
4. _____allows us to focus only on those parts of an object that concern us.
5. Through_____reusability of code is provided.

Descriptive Questions

1. What is the difference between OOPs and procedural programming?
2. Give some main features of OOPs.
3. Explain the concept of inheritance with example.
4. What do you understand by polymorphism?
5. Distinguish between an object and a class.
6. Differentiate between data hiding and encapsulation.
7. Name some languages that support object-oriented paradigm.

Answers to Review Questions

Fill in the Blanks

1. Designing, Implementing
2. Procedure-oriented approach
3. Global
4. Abstraction
5. Inheritance

18.12 FURTHER READING

E. Balaguruswami, *Object-oriented Programming with C++*, Tata McGraw Hill.