RAHUL WADHWA

FUNDAMENTALS OF COMPUTER AND INFORMATION TECHNOLOGY

(With Practicals)

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As per New Syllabus of Boards of Technical Education, Uttar Pradesh

FUNDAMENTALS OF COMPUTER AND INFORMATION TECHNOLOGY

(With Practical)

[For Students Studying in Ist Sememster (Ist Year) of
Computer Science Engineering and Information Technology]

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Preface

You are most welcome to the field of Computer and Information Technology. We feel great pleasure in bringing out the book, "Fundatmentals of Computer and Information Technology" for the students of Polytechnic in Uttar Pradesh and Uttarakhand. The Board of Technical Education has done well in staring various diploma programmes and course in Computere and Information Technology. This book on "Fundatmentals of Computer and Information Technology" has been written in accordance with the latest syllabi, to meet the needs of the students.

Computer has become an integral part of modern era. Every person is supposed to be aware of the application of computers. Every student having the knowledge of software and hardware and computer peripherals will be able to accept any challenge in now days. This book deals with basic knowledge and applications of Computer and Information Technology.

This book tries to explain the various aspects of Computer and Information Technology in a lucid and simple language. I hope it will prove helpful for the readers to grasp the basic concepts of digital electronics in an easy and efficient manner.

The author expresses his gratitude to all those who are helpful directly or indirectly in completion of this work.

Views, suggestions and criticisms from the readers regarding this book are thankfully welcomed.

Regards

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— **Rahul Wadhwa**

TRIALS

No matter what trials come our way,
GOD will see us through each day.
If only we'll put our trust in Him,
The light of His love will never dim.
Don't ever think that He's forgotten you,
It's just, sometimes, we need test or two.
For, we'll never be able to help our brother,
If we're never been tested, one way or another.
Never ask the Lord for an easy road,
But only for strength to carry your load.
For through your sorrows, you will find,
The Lord is with you,
He's loving and kind.
And when your trials have all gone away,
"I've been there, too," is what you can say.
For, there'll be times when someone you meet,
Will praise God to walk in the steps of your feet.

Syllabus

Fundamentals of Computer and Information Technology

RATIONALE:

The diploma holders in Computer Engineering needs to understand computer fundamentals and information technology. They should be able to operate basic software related to computer. Hence this subject is introduced in the curriculum.

LEARNING OUTCOMES:

After undergoing the subject, the students will be able to:

- Understand a computer system that has hardware and software components, which controls and makes them useful.
- Understand the operating system as the interface to the computer system.
- Outline various application of IT
- Differentiate between assembly and high level language.
- Identify various web browser.
- Use the Internet to send mail and surf the World Wide Web

DETAILED CONTENTS

1. **Fundamentals of Computer** (12 Periods)

   Historical Evolution of Computers, Generations of Computers, Classification of Computers — based on Size, Processor, Usefulness of Computers. Applications of Computers, Block Diagram along its Components and Characteristics, Interaction between the CPU, Memory Input/Output Devices, Function of CPU and Major Functional Parts of CPU. State the Relevance of Speed and Word Length for CPU Performance, Recognize the Current Family of CPUs Used in Computers, Types of Memory—RAM ROM, Monitor, Mouse, Keyboard, Disk, Joysticks, Storage Devices, Floppy Disk, CD, DVD, Pen Drive, Trackballs, Printers Types of Printers, Scanner, Modem, Video, Sound Cards, Speakers.

2. **Data Representation** (08 Periods)

   Definition of Information, Difference between Data and Information, Importance of Binary Number System, Various Number Systems, Conversion from Decimal to Binary, Conversion from Binary to Decimal, Binary Number into Hexadecimal Number, Hexadecimal Number into Binary Number System, Memory Addressing and its Importance, ASCII and EBCDIC Coding System.

3. **DOS & Windows Operating Systems** (10 Periods)

   Hardware and Software, Types of Softwares, Introduction and Need of Operating System, Types of Operating System, DOS Operating System, Types of DOS Commands, Operating System as a Resource Manager; BIOS; System Utilities—Editor, Loader, Linker, File Manager. Concept of GUI and CUI Standards. Directories and Files, Wild Cards, Autoexec.bat, Config.sys, Features of Window Desktop, Components of Window, Function of each Component of Window, Method of Starting a Program using Start Button, Understand Maximize, Minimize, Restore Down and Close Button, Uses of File and Folder, Method of Viewing the Contents of Hard Disk Drive using Explore Option, Control Panel, Disk Defragmentation Installation and Uninstallation of the Application Software.

4. Fundamentals of Internet (12 Periods)

Concepts of Computer Network, Client Server Model, Peer to Peer Model, Networking Devices: Switch, Router, Hub, Bridge, Gateway, LAN, MAN, WAN, Topology, Internet, Intranet, Extranet, Internet Service Provider and its Relevance, Role of the Modem in Accessing the Internet, Installation Procedure of a Modem using Control Panel, Purpose of Web Browser Software, URL,URI, URN, WWW, FTP, HTTP, RDC (Remote Desktop Connection), Telnet, Email, Process of Sending and Receiving e-mail, Transmission Modes, IP Address and its Format, MAC Address, DNS, Search Engines, Social Network Sites, Internet Security, Firewall, Cloud Computing and its Services.

LIST OF PRACTICALS

1. Familiarization with Computer System and Its Peripheral Devices.
2. Familiarization with Operating System.
3. Practice of Internal and External Commands of DOS.
4. Working Practice on Windows Operating System: Creating File, Folder, Copying, Moving, Deleting File, Folder.
5. Installing and Uninstalling of New Software using Control Panel.
6. Installation and Uninstallation of New Hardware Drivers using Control Panel.
7. Disk Defragmentation using System Tool.
8. Procedure of Disk Partition and its Operation (Shrinking, Extending, Delete, Format).
9. Installation of Operating Systems.
10. Changing Resolution, Colour, Appearances, and Screensaver Option of the Display.
11. Changing System Date and Time.
12. User Account Creation and its Feature on Windows Operating System.
13. Email Account Creation, Reading, Writing and Sending emails with Attachments.
14. Internet Browsing using Browsers.
15. Using of Search Engine to get Information from Internet.

C

CONTENTS

1 Chapter

FUNDAMENTALS OF COMPUTER

THINK ABOUT IT

It's not about how much you do, but how much love you put into what you do that counts.

— Mother Teresa

1.1 INTRODUCTION

Computer science is the study of computer technology, both hardware and software. However, computer science is a diverse field and hence the required skills are both applicable and in demand across practically every industry in today's technology dependent world. We are living in the midst of a revolution powered by computers. This revolution has invaded all aspects of society.

1.2 WHAT IS COMPUTER?

A computer is an electronic machine that accepts information, stores it, processes it according to the instructions provided by a user and then returns the result.

Computer is an electronic device for performing arithmetic and logical operations.

Computer is a device or a flexible machine to process data and converts it into information.

A Computer is programmed device with a set of instructions to perform specific tasks and generate results at a very high speed.

A Computer is an electronic machine that can solve different problems, process data, stores and retrieves data and performs calculations faster and efficiently than humans.

1.3 DATA, PROCESSING AND INFORMATION

Data: Data is a collection of basic facts and figure without any sequence. When the data is collected as facts and figure, it has no meaning at that time, for example, name of student, names of employees etc.

Processing: Processing is the set of instruction given by the user or the related data to output the meaningful information. The work of processing may be the calculation, comparisons or the decision taken by the computer.

Information: Information is the end point or the final output of any processed work. When the output data has meaning it is called information for example, Gayatri is a data, Lucknow is also a data but Gayatri lives in Lucknow is an information.

Q. What is an IPO cycle?

Ans. IPO stands for input processing output. Computer takes input, process on it and gives output. **Any electronic machine that performs IPO cycle is known as computer.** Devices which transfer data, programs, or signals into a computer systems are called input devices. These devices are used to give raw data to the computer to perform the specific tasks. Firstly, the data, programs, a signals are fed into the input devices in a suitable form, and are then converted by the device into electrical signals from human-readable format that are transmitted to the central processing unit of the computer. The main unit inside the computer is the CPU. This unit is responsible for all events inside the computer. It controls all internal and external devices, performs arithmetic and logic operations. The CPU (Central Processing Unit) is the device that interprets and executes instructions. The two main features of the CPU are It's speed measured in millions of instructions per second and the word size. The word size is the number of bits the CPU can process at a time.

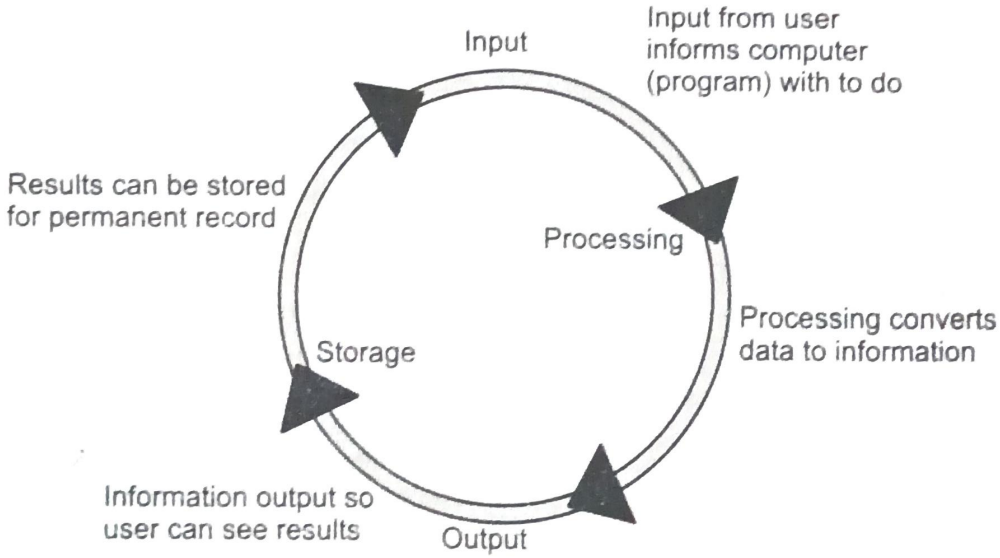

Fig. 1.1 The IPO cycle

1.3.1 Human vs. Computer

Features	Human Being	Computer
Speed of working	Slow	Extremely high
Accuracy	Low	Extremely High
Reliability	Decrease with increase in work	Very High
Ability to think and handle adhoc situation	Can reason heuristically. Solve problems step by step on the basis of past experience.	Now available
Versatility	Can be used for variety of jobs not versatile.	Highly versatile

1.4 HISTORICAL EVOLUTION OF COMPUTERS

The term Computer is derived from a Latin word "computare" which means to calculate, to count, to sum up or to think together. The original definition of the word computer was a person who made calculations. This definition goes back to the 1600s and extends midway through the 20th century, when the term computer began to refer to a machine. The computer is based on the same concept as the abacus, which goes back many years.

Do you know?

- **Computer was born not for entertainment or email but out of a need to solve a serious number-crunching crisis.**
- **By 1880, the U.S. population had grown so large that it took more than seven years to tabulate the U.S. Census results.**
- **The government sought a faster way to get the job done, giving rise to punch-card based computers that took up entire rooms.**

Today, we carry more computing power on our smart phones than was available in these early models. The time line of how computers evolved from their humble beginnings to the machines of today is given below:

- **1822:** English mathematician Charles Babbage conceives of a steam-driven calculating machine that would be able to compute tables of numbers.
- **1837:** Charles Babbage first purposed the Analytical Engine, which was the first computer to use punch cards as memory and a way to program the computer.

  The analytical engine is a machine, first proposed by Charles Babbage in 1837, that is considered to be the concept for the first general mechanical computer. The design featured an Arithmetic Logic Unit (ALU) and permitted basic programmatic flow control. It was programmed using punch cards . It also featured integrated memory. For these reasons, historians consider it to be the first design concept of a general-purpose computer.
- **1943-1944:** Two University of Pennsylvania professors, John Mauchly and J. Presper Eckert, build the Electronic Numerical Integrator and Calculator (ENIAC).
- **1947:** William Shockley, John Bardeen and Walter Brattain of Bell Laboratories invent the transistor. They discovered how to make an electric switch with solid materials and no need for a vacuum.
- **1948:** The world's first stored-program computer was Manchester Baby developed in 1948. The Manchester Baby was a small scale experimental computer developed in Victoria university of Manchester.
- **1949:** The Manchester Mark 1 became operational in April 1949.
- **1950:** Alan Turing publishes his paper Computing Machinery and Intelligence in October. This paper helps create the Turing Test.
- **1953:** Grace Hopper develops the first computer language, which eventually becomes known as COBOL.
- **1954:** The FORTRAN programming language, an acronym for FORmula TRANslation, is developed by a team of programmers at IBM led by John Backus, according to the University of Michigan.

- **1958:** Jack Kilby and Robert Noyce unveil the integrated circuit, known as the computer chip. Kilby was awarded the Nobel Prize in Physics in 2000 for his work.
- **1964:** Douglas Engelbart shows a prototype of the modern computer, with a mouse and a graphical user interface (GUI). This marks the evolution of the computer from a specialized machine for scientists and mathematicians to technology that is more accessible to the general public.
- **1969:** A group of developers at Bell Labs produce UNIX, an operating system that addressed compatibility issues.
- **1970:** The newly formed Intel unveils the Intel 1103, the first Dynamic Access Memory (DRAM) chip.
- In 1981, IBM PC with Intel processors and MSDOS were introduced.
- In 1984, Macintosh Computers were introduced.
- In 1985, Microsoft Windows GUI was introduced.
- In 1989, Intel 486 computers were introduced.
- In 1990, Windows 3.0 operating System for PCs was launched.
- In 1991, the World Wide Web was introduced to the general public.
- In 1991, Linux operating was developed.
- In 1993, Intel's Pentium was introduced.
- In 1995, windows 95 operating system was made released.
- In June, 1996 Windows 4.0 operating system was released.
- On February 17, 2000, Windows 2000 was released.
- Windows XP was released on 25th October, 2001.
- On November 30th, 2006 Windows Vista was released.
- On July 22nd 2009, Windows 7 was introduced.
- On Windows 8, the successor of Windows 7 was released on October 28th, 2012.

Machine	Approximate dates	Features
Abacus	2000–3000 B.C.	First mechanical calculator.
Pascal's Calculator	1645	First adding machine capable of counting, adding and subtracting.
Jacquard's weaving loom	1801	Utilized metal plates with punched holes to control weaving patterns.
Babbage Analytical Engine	1834-1871	Intended to be the first general purpose computer.
Herman Tabulating Machine	1887-1896	Designed a code and device to punch data into card and tabulate collected data. Used in automating the Census of 1980.
Howard Aiken Mark I	1937-1944	Largest electromechanical computer.

Machine	Approximate dates	Features
ENIAC	1943-1950	First electronic computing devices in which program wired into a permanent panel.
John Von Neumann's Stored Program concept	1945-1952	Developed the concept of storing program instructions and data in the memory of the computer.
EDSAC	1946-1952	First computer capable of storing instructions and data in memory.
UNIVAC 1	1951-1954	First computer to get commercially available.

1.5 GENERATIONS OF COMPUTER

As the time passed, the device of more suitable and reliable machine was need which could perform our work more quickly. During this time, in the year 1946, the first successful electronic computer called ENIAC was developed and it was the starting point of the current generation of computer.

First Generation (1940 To 1956)

- ENIAC was the world first successful electronic computer which was develops by the two scientists namely J.P. Eckert and J.W. Mauchy.
- It was the beginning of first generation computer extremely large in size.
- The full form of ENIAC is Electronic Numeric Integrated And Calculator.
- ENIAC was a very huge and big computer and its weight was 30 tones.
- It could store only limited or small amount of information.
- Initially in the first generation computer the concept of vacuum tubes was used.
- A vacuum tube was such an electronic component which had very less work efficiency and so it could not work properly and it required a large cooling system.
- Produced so much heat that they regularly overheated despite large cooling units.

Second Generation (1956 To 1963)

- In this generation, transistors were used as the electronic component instead of vacuum tubes.
- A transistors is much smaller in the size than that of a vacuum tube.
- As the size of electrons components decreased, the size of computer also decreased.
- It became much smaller than that of earlier computer.

Third Generation Computers (1964-1971)

- Integrated circuit development was the hallmark of the third generation of computers.
- Integrated circuits, or semiconductor chips, were large numbers of miniature transistors packed on silicon chips.

- **1958:** Jack Kilby and Robert Noyce unveil the integrated circuit, known as the computer chip. Kilby was awarded the Nobel Prize in Physics in 2000 for his work.
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Third Generation Computers (1964-1971)

- Integrated circuit development was the hallmark of the third generation of computers.
- Integrated circuits, or semiconductor chips, were large numbers of miniature transistors packed on silicon chips.

- There was drastic increased in the speed and efficiency of computers.
- Transistors could be fabricated on tiny silicon chips (semiconductors).
- Users interacted with third generation computers through keyboards and monitors as against punched cards and printouts.
- These were interfaced with an operating system, which allowed the device to run multi process concurrently at one time with a central program that monitored the memory.
- Computers for the first time became accessible to many because they were smaller and cheaper than their predecessors.
- Development of IC gave birth to a new field of microelectronics.
- Main advantage of IC is not only its small size but its superior performance and reliability than the previous circuits.
- First developed by T.S Kilby.
- This generation of computer has huge storage capacity and higher calculating speed.

Fourth Generation Computers (1971 to 2010)

- Millions of transistors fabricated on a single circuit-chip.
- Called monolithic integrated circuit technology.
- Also heralded the invention of the Intel 4004 chip which was the first microprocessor to become commercially available in 1971.
- A microprocessor is a single chip (LSI circuit), which is used in a computer for any arithmetical or logical functions to be performed in any program.
- Led to the dawn of the personal computer industry.
- Creation of even smaller computers including laptops and hand-held devices.
- Graphical user interface invented during this time.
- Computer memory and storage also went through major improvements, with an increase in storage capacity and speed.

Fifth Generation-Present and Beyond: Artificial Intelligence

- Current technological trend in computing devices are based on Quantum computation, molecular, nanotechnology and artificial intelligence, are still in development.
- There are some applications, such as voice recognition, that are already being used today.
- Artificial Intelligence, quantum computation and molecular and nanotechnology will change the view and function of computers in years to come.
- Developing computing device that respond to natural language input and are capable of learning and self organization.
- Fifth generation computing has yet to be truly defined, as there are numerous paths that technology is taking toward the future of computer development.

Generation	Duration	Memory device
First	(1940 to 1956)	Vacuum tubes
Second	(1956 to 1963)	Transistor
Third	(1964-1971)	LSI (Large Scale Integration) IC
Fourth	(1971 to 2010)	VLSI (Very Large Scale Integration) Microprocessor.
Fifth	(2010 onwards)	Biochips (concept of AI)

- In the 1st generation of computers, Computers were built with vacuum tubes.
- Computers were built with Transistors in the 2nd generation of computers.
- In the 3rd generation of computers, Transistors were replaced with Integrated Circuits.
- In the 4th generation of computers, Microprocessors were used to built Computers.

1.6 CLASSIFICATION OF COMPUTERS

Computers differ based on their data processing abilities. They are classified according to purpose, data handling and functionality.

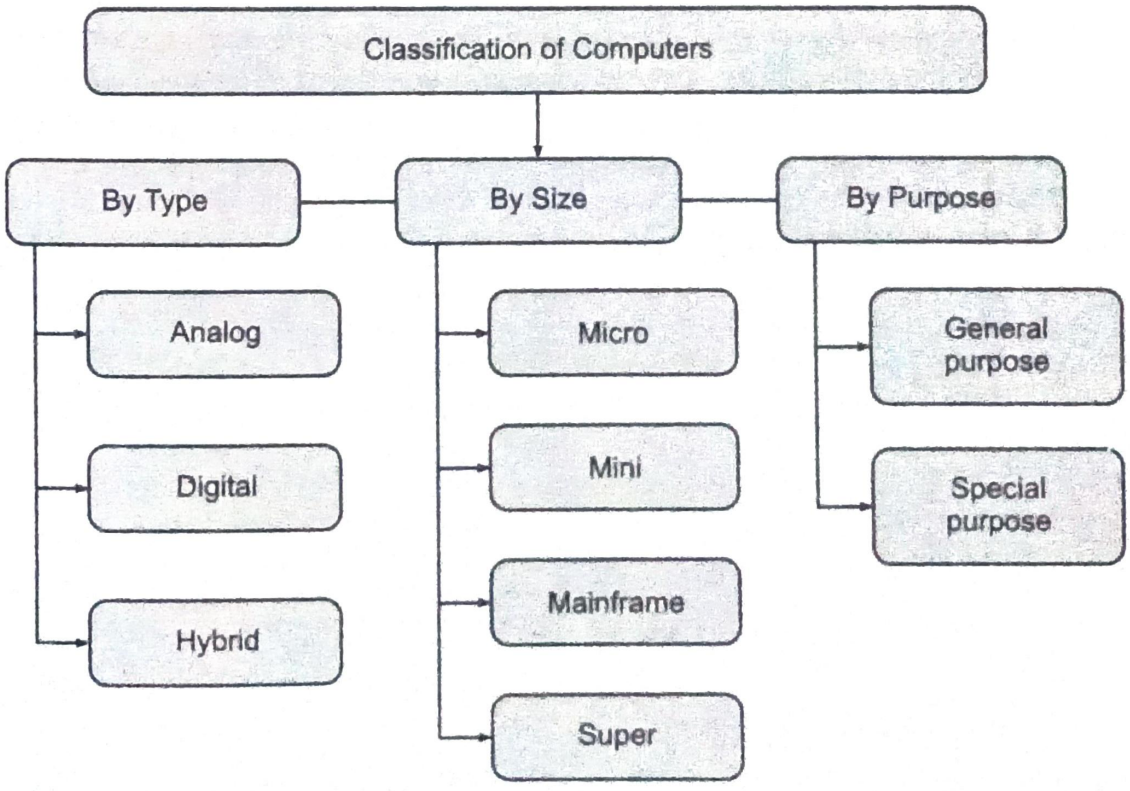


Fig. 1.2

According to purpose, computers are either general purpose or specific purpose. **General purpose computers** are designed to perform a range of tasks. They have the ability to store numerous programs,

but lack in speed and efficiency. Specific purpose computers are designed to handle a specific problem or to perform a particular task. A set of instructions is built into the machine.

Classification based on Area of Applications or by Purpose

Special Purpose Computers

A special purpose computer is designed only to meet the requirements of a particular task or application. The instructions needed to perform a particular task are permanently stored into the internal memory, so that it can perform the given task on a single command. It doesn't posses unnecessary options and is less expensive.

General Purpose Computers

- General Purpose computers are designed to meet the needs of many different applications.
- Instructions needed to perform a particular task are wired permanently into the internal memory.
- When one job is over, instructions for another job can be loaded into the internal memory for processing.
- General purpose machine can be used to prepare pay-bills, manage inventories, print sales report and so on.

According to data handling, computers are analog, digital or hybrid. Analog computers employ electrical parameters, such as voltages, resistances or currents, to represent the quantities being manipulated. Such computers do not deal directly with the numbers i.e. they are not digital. They measure continuous physical magnitudes. Digital computers are those that operate with information, numerical or otherwise, represented in a digital forms. (i.e. binary numbers). Such computers process data into a digital value (in 0s and 1s). They give the results with more accuracy and at a faster rate. Hybrid computers incorporate the measuring feature of an analog computer and counting feature of a digital computer. For computational purposes, these computers use analog components and for storage, digital memories are used.

According to Data Handling or Pperating Principles:

Analog Computer

An analog computer is a form of computer that uses continuous physical phenomena such as electrical, mechanical or hydraulic quantities to model the problem being solved.

Digital Computer

A computer that performs calculations and logical operations with quantities represented as digits, usually in the binary number system.

Hybrid Computer (Analog plus Digital)

A combination of computers those are capable of inputting and outputting in both digital and analog signals. A hybrid computer system setup offers a cost effective method of performing complex simulations.

According to Size

Super Computer

Super computer is the fastest and most powerful type of computer. Supercomputers are very expensive and are employed for specialized applications that require immense amounts of mathematical calculations. For example, weather forecasting requires a supercomputer. Other uses of supercomputers include animated graphics, fluid dynamic calculations, nuclear energy research, and petroleum exploration.

Mainframe Computer

Mainframe Computer is a very large and expensive computer capable of supporting hundreds, or even thousands, of users simultaneously. The difference between a supercomputer and a mainframe is that a supercomputer channels all its power into executing a few programs as fast as possible, whereas a mainframe uses its power to execute many programs concurrently.

Mini Computer

Mini Computer is a midsized computer. In size and power, minicomputers lie between workstations and mainframes. Minicomputer is a multiprocessing system capable of supporting from 5 to about 200 users simultaneously.

Micro Computer or Personal Computer

- **Desktop Computer**: It is a personal computer sufficient to fit on a desk.
- **Laptop Computer**: It is a portable computer complete with an integrated screen and keyboard. It is generally smaller in size than a desktop computer and larger than a notebook computer.
- **Palmtop Computer/Digital Diary /Notebook /PDAs**: It is a hand-sized computer. Palmtops have no keyboard but the screen serves both as an input and output device.

Workstations

It is a terminal or desktop computer in a network.

Classification of Computers

Computers may be classified based on the following:

- Operating principles (based on their construction and working)
- Applications
- Size and capability (or classification into micro, mini, mainframe and supercomputers)
- Number of Microprocessors
- Word length and
- Number of users

Classification Based on Operating Principles

- Digital Computers
- Analog Computers
- Hybrid Computers

Digital Computers

- All quantities are expressed as discrete or numbers.
- Digital computers are useful for evaluating arithmetic expressions and manipulations of data (such as preparation of bills, ledgers, solution of simultaneous equations etc.)

Analog Computers

- An **analog computer** is a form of computer that uses the continuously changeable aspects of physical phenomena such as electrical, mechanical, or hydraulic quantities to model the problem being solved

Hybrid Computers

- computers that exhibit features of analog computers and digital computers
- digital component normally serves as the controller and provides logical operations
- analog component normally serves as a solver of differential equations.

Classification Based on Area of Applications (by purpose)

- Special Purpose Computers
- General Purpose Computers

Special Purpose Computers

A special purpose computer is designed only to meet the requirements of a particular task or application.

The instructions needed to perform a particular task are permanently stored into the internal memory, so that it can perform the given task on a single command doesn't posses unnecessary options and is less expensive.

General Purpose Computers

- General Purpose computers are designed to meet the needs of many different applications instructions needed to perform a particular task are wired permanently into the internal memory. When one job is over, instructions for another job can be loaded into the internal memory for processing general purpose machine can be used to prepare pay-bills, manage inventories, print sales report and so on.

Classification based on size and Capability

Microcomputers (Personal Computer)

A microcomputer is the smallest general purpose processing system. The older pc started 8 bit processor with speed of 3.7 MB and current pc 64 bit processor with speed of 4.66 GB. Examples: **IBM PCs**, **APPLE** computers

Microcomputer can be classified into 2 types: Desktops and Portables

The difference is portables can be used while travelling whereas desktops computers cannot be carried around. The different portable computers are Laptops, Notebooks, Palmtops (hand held), Wearable computers etc.

- **Laptop** is similar to a desktop computers but the size is smaller. They are expensive than desktop. The weight of laptop is around 3 to 5 kg.

- **Notebook** are as powerful as desktop but size of these computers are comparatively smaller than laptop and desktop. They weigh 2 to 3 kg.
- **Palmtop (Hand held) are** also called as personal Digital Assistant (PDA). These computers are small in size. They can be held in hands. It is capable of doing word processing, spreadsheets and hand writing recognition, game playing, faxing and paging.
- **Wearable computer** is very small so that it can be worn on the body. It has smaller processing power. It is used in the field of medicine. For example pace maker to correct the heart beats. Insulin meter to find the levels of insulin in the blood.

Minicomputer

- minicomputer is a medium-sized computer
- more powerful than a microcomputer
- designed to serve multiple users simultaneously (Parallel Processing)
- more expensive than microcomputers
- Examples are Digital Alpha, Sun Ultra

Mainframe computers

- Computers with large storage capacities and very high speed of processing (compared to minicomputers or microcomputers)
- support a large number of terminals for simultaneous use by a number of users like ATM transactions
- also used as central host computers in distributed data processing system.
- Examples are **IBM 370, S/390.**

Supercomputer

- have extremely large storage capacity and computing speeds which are many times faster than other computers
- A supercomputer is measured in terms of tens of millions Instructions per second (mips), an operation is made up of numerous instructions
- mainly used for large scale numerical problems in scientific and engineering disciplines such as Weather analysis.
- Examples is **IBM Deep Blue**

Classification based on Word-Length

In binary number systems, only two digits i.e. 1 or 0 are used to represent any number. A binary digit is called bit. A word is a group of bits which is fixed for a computer. The number of bits in a word (or word length) determines the representation of all characters in these many bits. Word length is in the range from 16-bit to 64-bits for most computers.

Classification based on number of users

- **Single User**: Only one user can use the resource at any time.
- **Multi-User**: single computer shared by a number of users at any time
- **Network**: A number of interconnected autonomous computers shared by a number of users at any time.

1.7 USEFULNESS OF COMPUTERS

Computers are used in so many fields in our daily life. From Engineers to Doctors, Students, Teachers, Government Organization they all use computers to perform specific tasks, for entertainment or just to finish office work. Computers have made our life easier. With greater precision and accuracy and less time taking computers can do a lot in short time while that task can take a lot of time while doing manually. Computers have taken industries and businesses to a whole new level.

People can find any type of information on the internet. Educational and informative websites are available to download books, tutorials etc. to improve their knowledge and learn new things.

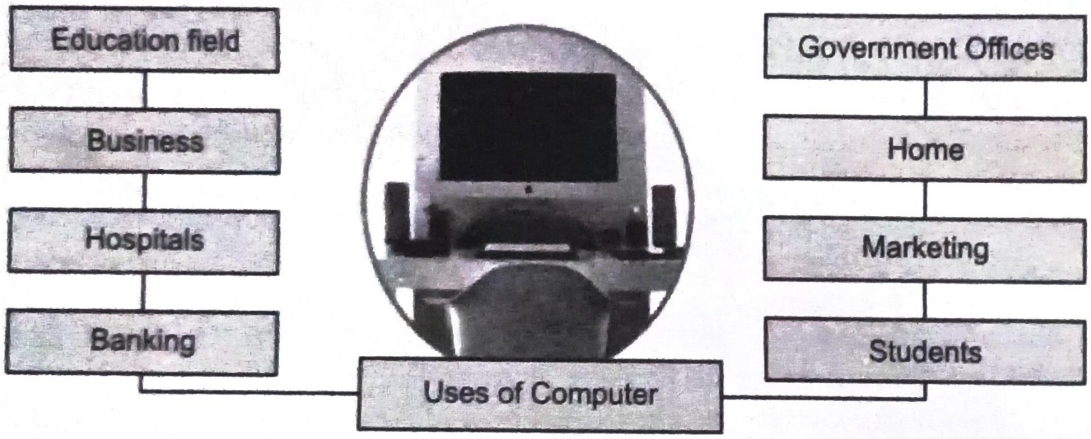


Fig. 1.3 Usefulness of computers

Banking

- Banks are using computers daily to faster and accurate the customer demands.
- Banks are using a computer to deposit customer money in their account.
- Providing ATM to withdraw and cash deposit ATM's for their customer.
- Whenever we deposit, withdraw money we get messages on our mobile number.
- We can see and print our transaction records without visiting banks.
- The whole process of banking is done by computer.

Marketing and E-commerce

- Use of computer with the internet is creating new ways to do the product and services marketing online.
- Digital marketing services, products, websites, and businesses are growing.
- Businesses can use a computer to type marketing content, to publish content marketing article on websites and social media.
- They can sell and market their product on portals or such as Amazon.

Government offices

- Office Automation.
- Consumers are getting a solution with high speed and accuracy because of the uses of computer in official works.

- Applications that speed the process and quality of official works.
- Microsoft Office package, email, video conferencing tools etc. are few applications that speed the work of government offices with accuracy.

Entertainment

- People can find entertainment on the internet.
- Watch movies, listen to songs, and watch videos download different stuff. They can also watch live matches on the internet.

Computer Games

- Different types of games are available.
- Source of entertainment and recreation.
- Developed to improve your mental capability and thinking power.

Chatting & Social Media

- People can chat with friends and family on the internet using different software like Skype etc.
- One can interact with friends over social media websites like Facebook, Twitter & Google Plus.
- Can also share photos and videos with friends.

Working from Home

- People can manage the office work at home.
- Owner of a company can check the work of the employees from home. He can control his office while sitting at home.

Computer Aided Learning (CAL)

- Computer aided learning is the process of using information technology to help teaching and enhance the learning process.
- Use of computer can reduce the time that is spent on preparing teaching material. It can also reduce the administrative load of teaching and research.
- Use of multimedia projector and PowerPoint presentations has improved the quality of teaching.
- Also helped the learning process.

Distance Learning

- Distance learning is a new learning methodology.
- Computer plays the key role in this kind of learning.
- Many institutes are providing distance learning programs.
- Student can attend the lecture at home by connecting to a network.
- Student can also ask questions to the teacher.

Online Examination

- The trend of online examination is becoming popular.
- Different examination like GRE, GMAT and SAT are conducted online all over the world.

- Minimizes the chance of mistakes.
- Enables to announce the result in time.

Marketing

- An organization can use computers for marketing their products.
- Marketing applications provide information about the products to customers. Computer is also used to manage distribution system, advertising and selling activities.
- Companies can know more about their customers and their needs and requirements etc.

Stock Exchange

- Stock Exchange is the most important place for businessmen.
- Stockbrokers perform all trading activities electronically.
- They connect with the computer where brokers match the buyers with sellers. It reduces cost as no paper or special building is required to conduct these activities.

Hospital Management System

- Specialized hospital management softwares are used to automate the day to dav procedures and operations at hospitals.
- These tasks may be Online appointments, payroll admittance and discharge records etc.
- Hospital management systems can store data about patients.
- Computers are used to store data about patients, their diseases & symptoms, the medicines that are prescribed.
- Monitoring systems are installed in medical wards and Intensive care units to monitoring patients continuously.
- These systems can monitor pulse, blood pressure and body temperature and can alert medical staff about any serious situations.
- Specialised devices are used to help impaired patients like hearing aids.

Engineering

- Engineers rely on computers for much of the process. Using computers and specialty computer software, engineers can design, test and make changes to products in minimal time.
- Computer-aided design/computer-aided manufacturing, computer systems used to design and manufacture products.
- Engineering designers can find effective means of collecting, storing, retrieving, processing, communicating, distributing, displaying, plotting and printing large quantities of information.

Thought Question

A digital computer, analog computer and now the use of hybrid computers are growing in our daily life. Computer is doing our work faster and accurately and save our time. But then why people do not have any time today for their family. You can say the computer has changed our lives because today we want to use air purifier inside the home rather than planting new trees outside. Do you agree?

1.8 COMPUTER OPERATIONS OR FUNCTIONS

A computer is a device that can be instructed to carry out sequences of arithmetic or logical operations automatically via computer programming. Modern computers have the ability to follow generalized sets of operations, called programs. These programs enable computers to perform an extremely wide range of tasks.

A computer can process data, pictures, sound and graphics. They can solve highly complicated problems quickly and accurately. Major computer operations or functions are:

- Accepts data or instructions by way of input
- Stores data
- Process data as required by the user
- Gives results in the form of output
- Controls all operations inside a computer.

Input

This is the process of entering data and programs in to the computer system:

- Computer is an electronic machine which takes as inputs raw data and performs some processing giving out processed data.
- Input unit takes data from us to the computer in an organized manner for processing.

Storage

The process of saving data and instructions permanently is known as storage:

- Data has to be fed into the system before the actual processing starts.
- The processing speed of Central Processing Unit (CPU) is so fast that the data has to be provided to CPU with the same speed.
- Data is first stored in the storage unit for faster access and processing.
- Primary storage of the computer system is designed to do the above functionality.
- Provides space for storing data and instructions.
- All data and instructions are stored here before and after processing.
- Intermediate results of processing are also stored here.

Processing

The task of performing operations like arithmetic and logical operations is called processing:

- The Central Processing Unit (CPU) takes data and instructions from the storage unit and makes all sorts of calculations based on the instructions given and the type of data provided.
- It is then sent back to the storage unit.

Output

This is the process of producing results from the data for getting useful information:

- output produced by the computer after processing must also be kept somewhere inside the computer before being given to you in human readable form.
- output is also stored inside the computer for further processing.

Control

The manner how instructions are executed and the above operations are performed.

- Controlling of all operations like input, processing and output are performed by control unit
- takes care of step by step processing of all operations inside the computer.

- Speed is one of the main characteristic of a computer. A computer can perform billions of calculations in a second. The speed of a computer is measured in Mega Hertz (MHz) or Giga Hertz (GHz).
- Computers don't have any intelligence of their own. They follow a set of instructions called program fed into them by user. The user knows what to do and when to perform a specific task. This is just like driving a car. The driver instructs the car when to race, when to brake when to turn etc.
- Computers can perform operations and process data faster but with accurate results and no errors. Results can be wrong only if incorrect data is fed to the computer or a bug may be the cause of an error.
- Storage capacity is another big characteristic of a computer. A computer can store large amount of data. This data can be used at any time and also from any location. The storage capacity of a computer is measured in Mega Byte, Giga Byte, Tera Byte.
- Computers have the ability to communicate, but there needs some sort of connection either Wired or Wireless connection.
- Multitasking is also a computer characteristic. Computers can perform several tasks at a time.

1.9 BLOCK DIAGRAM OF THE COMPUTER

The Computer system consists of central processing unit (CPU), Input Devices, and Output Devices .The Central processing unit (CPU) consists of ALU (Arithmetic Logic Unit) and Control Unit. The set of instruction is presented to the computer in the form of raw data which is entered through input devices such as keyboard or mouse.

1.9.1 Functional Units

Central Processing Unit (CPU)

The ALU and the CU of a computer system are jointly known as the central processing unit. The CPU is the Brain of a computer because without the necessary action taken by the CPU the user cannot get

the desired output. It is just like brain that takes all major decisions, makes all sorts of calculations and directs different parts of the computer functions by activating and controlling the operations.

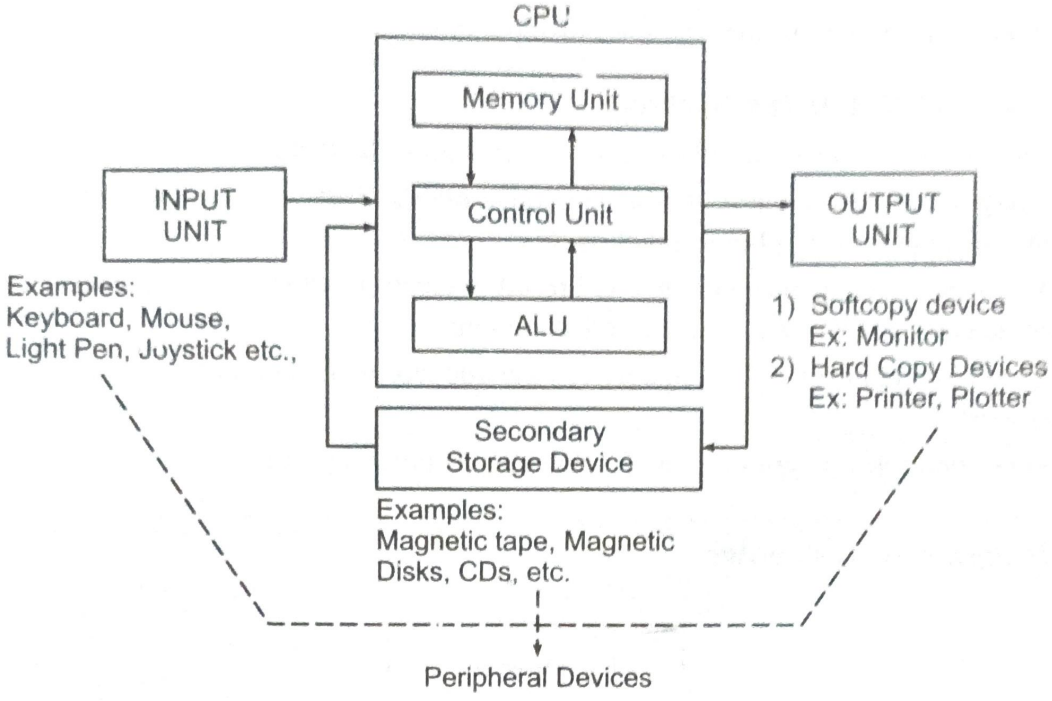


Fig. 1.4 Block diagram of a computer

Arithmetic Logical Unit (ALU)

After you enter data through the input device it is stored in the primary storage unit. The actual processing of the data and instructions are performed by Arithmetic Logical Unit. The operations performed by the ALU are arithmetic operations like addition, subtraction and logic operations like AND, OR, NOT and compare. Data is transferred to ALU from storage unit when required. After processing the output is returned back to storage unit for further processing or getting stored.

Control Unit: Control Unit, acts like the supervisor seeing that things are done in proper fashion. Control Unit is responsible for coordinating various operations using timing signals known as clock pulses. The control unit determines the sequence in which computer programs and instructions are executed. It coordinates the activities of computer's peripheral equipment as they perform the input and output.

Input Devices of Computer System

The data is provided to the computer system or PC with the help of input devices such as keyboard, mouse, scanners etc. This is converted into binary form then it is supplied to computer system for further processing.

- Input Unit performs transferring the data from outside the world into the computer.
- Input Devices accepts or receives the data or instruction from outside the world such as input devices like keyboard and mouse.

- Converts the data or instruction or information into machine readable form for further processing.
- Act like a connection between outside the world and our own computer system.
- Keyboard and mouse are the examples of input devices.

Output Devices of Computer Systems

- The output devices receives all the data or instruction in binary code.
- The output devices converts the binary codes into human readable or intelligible form for better understanding and better functionality.
- They produces the changed or converted result to the user .which is effectively comprehensible by humans for proper and accurate understanding.
- They acts as a connection or link between outside world and computer system or our own PC framework.
- Printers, monitors etc. are the prime examples of output devices.

Block Diagram of Computer

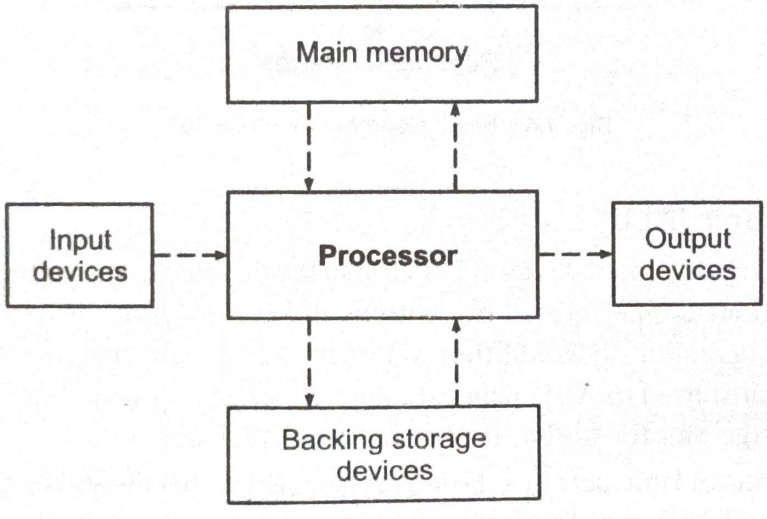


Fig. 1.5

A computer is an electronic device which is used to perform operation on raw data as per instruction given by user. They are:

- It accepts data or instructions through input,
- It stores data,
- It can process required data by the user,
- It gives results as production, and
- It controls all functions inside the computer.

Input unit

Input unit is a unit that accepts any input device. The input device is used to input data into the computer system. It converts inputted data into binary codes. It sends data to main memory of computer.

Central Processing Unit (CPU)

CPU is called the brain of a computer. An electronic circuitry that carries out the instruction given by a computer program CPU can be sub classified into Control unit (CU) and Arithmetic & Logic unit (ALU).

Control unit (CU)

the control unit manages the various components of the computer. It reads instructions from memory and interpretation and changes in a series of signals to activate other parts of the computer. It controls and co-ordinate is input output memory and all other units.

Arithmetic & Logic unit (ALU)

The arithmetic logic unit (ALU), which performs simple arithmetic operation such as ADD, SUBTRACT and logical operations such as AND. OR, NOT etc.

Functions of CPU

It controls all the parts and software and data flow of computer. It performs all operations. It accepts data from input device. It sends information to output device. Executing programs stored in memory. It stores data either temporarily or permanent basis. It performs arithmetical and logical operations.

Output Unit

Output unit is a unit that constituents a number of output device. An output device is used to show the result of processing. It accepts data or information sends from main memory of computer. It converts binary coded information into HLL or inputted languages.

Memory Unit

Memory is used to store data and instructions before and after processing. Memory is also called Primary memory or internal memory. It is used to store data temporary or permanently.

Interaction between the CPU and Memory

CPU as the brain of the computer. The CPU chip retrieves data from the RAM. The chip takes those instructions and begins to move and process data through the motherboard in the correct order to its next designated location. The CPU runs the computer the same way the human brain performs certain tasks that affect your senses, emotions and abilities to physically move and speak. Without the CPU, your computer will not be able to perform any of the functions it's designed for to keep your computer running efficiently.

1.10 RELEVANCE OF SPEED AND WORD LENGTH FOR CPU PERFORMANCE

The factors affecting CPU performance are :

- Multiple cores,
- Cache memory,
- Clock speed,
- Word length,
- Address bus width,
- Data bus width.

Word size refers to the number of bits processed by a computer's CPU in one go (typically 32 bits or 64 bits). Data bus size, instruction size, address size are usually multiples of the word size.

The length of the important registers like Program counter, Accumulator are defined by the word size. 16 bit word size means the register can store 16 ones and zeros in it, and the biggest number is the decimal equivalent of that binary number.

The number of bits in a word (the word size, word width, or word length) is an important characteristic of any specific processor design or computer architecture.

- The 8088 processor has a clock speed of 4.77 MHz and has an 8-bit word length.
- The 80486 has a clock speed of 50 to 80 MHz and has a word length of 32 bits.
- The Pentium 4 as a clock speed of 1.5 gigahertz to 3.2 gigahertz and has a word length of 64 bits.

CPUs with speed and word length

CPU	Clock Speed (MHz)	Word Length (Bits)
8088	4.77	8
80286	6–12	16
80386	25–40	32
80486	50–80	32
Pentium (80586)	96–200	64
Pentium Pro	100–200	64
Pentium II	233–300	64
Pentium III	350 MHz–1.13 GHz	64
Pentium IV	1.5 GHz–3.2 GHz	64

1.11 CURRENT FAMILY OF CPUs USED IN COMPUTERS

x86 Processors (from Intel)

Bits	Family	Clock speed (approx.)	Bus size (bits)	Max RAM	Storage Range	OS
64	Xeon Core i9	4.3 GHz 3.3 GHz	64	3TB 128 GB	500 GB-10 TB	Windows: 10, 8, 7 XP, 2000 NT, 98 95 3.x
	Core i3, i5, i7 Core 2 Duo Pentium 4 Pentium D	3.3 GHz 2.6 GHz 3.8 GHz 3.4 GHz		64 GB		
32	Core Duo Pentium 4 Xeon Celeron Pentium III Pentium II	2.2 GHz 2.8 GHz 3.2 GHz 2.4 GHz 1.2 GHz 450 MHz		4 GB	500 MB–60 GB	Linux Max OS X SCO Unix Solaris DOS DR DOS OS/2 Misc DOS Multiuser
	Pentium Pro	233 MHz		64 GB		
	Pentium	200 MHz		4 GB		
	486 DX 486 SX	100 MHz 40 MHz	32		200–500 MB	
	386 DX 386 SX 386 SL	40 MHz 33 MHz 25 MHz			60–200 MB	
16	286	12 MHz	16	16 MB	20–80 MB	DOS DR DOS Win 3.x OS/2 1.x
	8086	10 MHz		1 MB	10–	DOS

1.12 TYPES OF MEMORY

A memory is just like a human brain. It is used to store data and instruction. Computer memory is the storage space in computer where data is to be processed and instructions required for processing are stored.

- Computer memory is any physical device capable of storing information temporarily or permanently.
- The memory is divided into large number of small parts.
- Each part is called a cell.
- Each location or cell has a unique address which varies from zero to memory size minus one.
- For example if computer has 64k words, then this memory unit has 64 * 1024 = 65536 memory location. The address of these locations varies from 0 to 65535.
- Memory is primarily of two types.
- Internal Memory — cache memory and primary/main memory.
- External Memory — magnetic disk/optical disk etc.

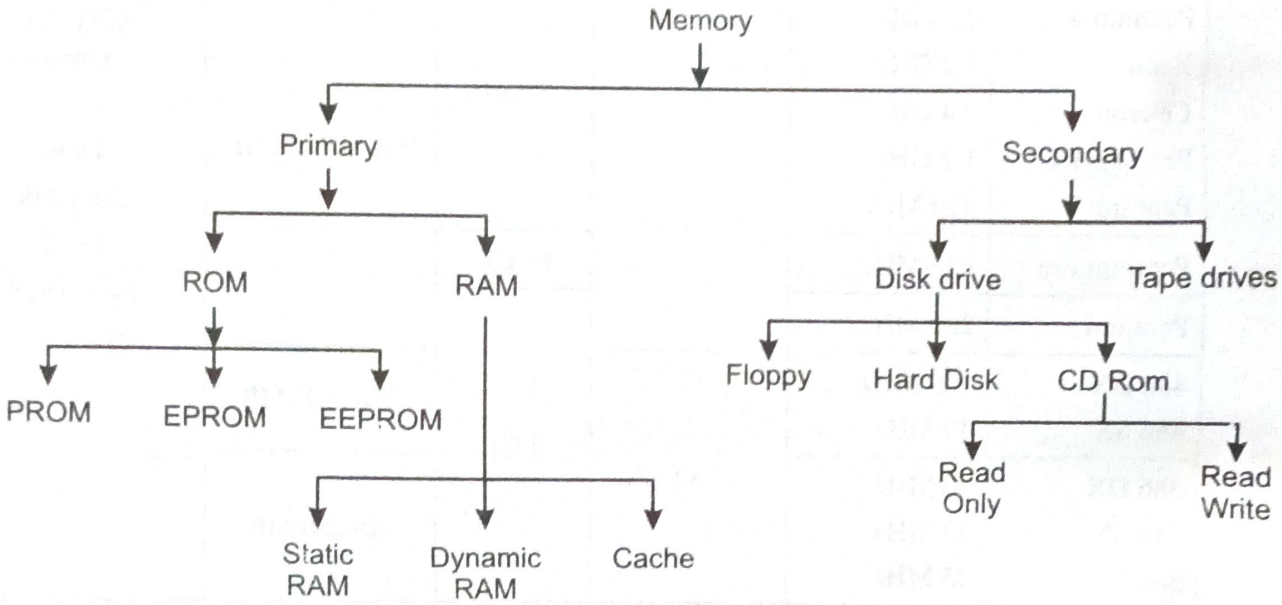


Fig. 1.6 Memory classification

Computer memory is of two basic type – Primary memory/Volatile memory and Secondary memory/ non-volatile memory. Random Access Memory (RAM) is volatile memory and Read Only Memory (ROM) is non-volatile memory.

1.12.1 Random Access Memory (RAM)

- Also called as read write memory or the main memory or the primary memory.
- Programs and data that the CPU requires during execution of a program are stored in this memory.
- Volatile memory as the data loses when the power is turned off.
- Classified into SRAM (Static Random Access Memory) and DRAM (Dynamic Random Access Memory).

1.12.2 Read Only Memory (ROM)

- Stores crucial information essential to operate the system, like the program essential to boot the computer.
- Not volatile.
- Always retains its data.
- Used in embedded systems or where the programming needs no change.
- Used in calculators and peripheral devices.
- ROM is further classified into MROM, PROM, EPROM, and EEPROM.

1.12.3 Types of Read Only Memory (ROM)

- **PROM (Programmable read-only memory)** – can be programmed by user. Once programmed, the data and instructions in it cannot be changed.
- **EPROM (Erasable Programmable read only memory)** – can be reprogrammed. To erase data from it, it is exposed to ultra violet light. To reprogram it, all the previous data has to be erased.
- **EEPROM (Electrically erasable programmable read only memory)** – The data can be erased by applying electric field, no need of ultra violet light. We can erase only portions of the chip.

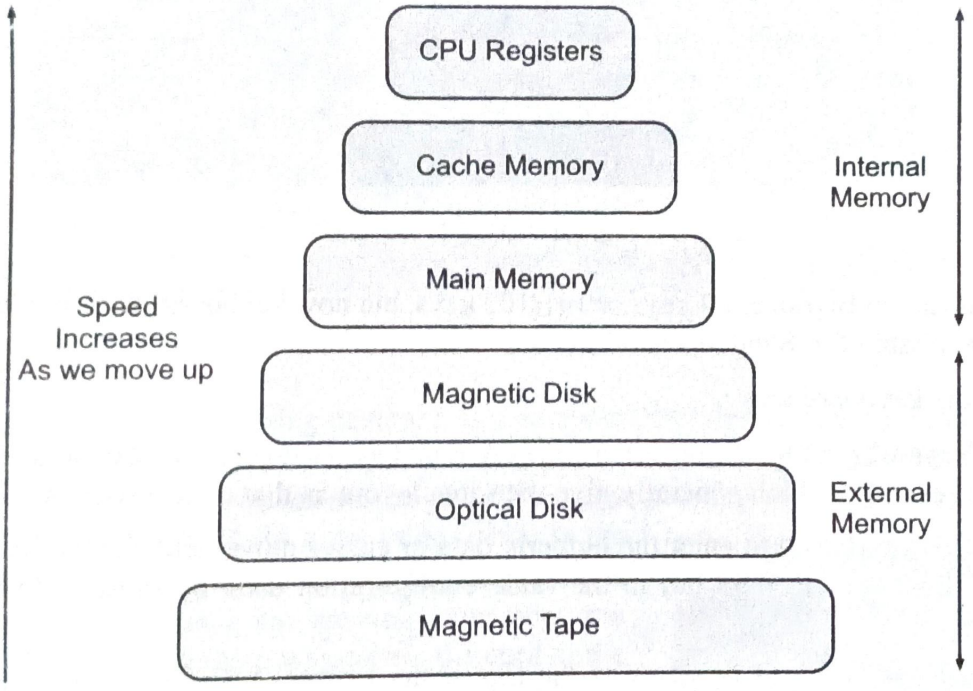


Fig. 1.7 Memory Hierarchy

Characteristics of Memory Hierarchy are following when we go from top to bottom.

- Capacity in terms of storage increases.
- Cost per bit of storage decreases.
- Frequency of access of the memory by the CPU decreases.
- Access time by the CPU increases.

1.13 INPUT DEVICES

An input device is a hardware or peripheral device used to send data to a computer. An input device allows users to communicate and feed instructions and data to computers for processing, display, storage and/or transmission. Input devices are peripherals used to provide data and control signals to a computer. Input devices allow us to enter raw data for processing.

To interact with your computer, you need input devices. The most common are a keyboard and a mouse, but there are other devices for more specialized tasks.

1.13.1 Keyboard

- Keyboard is the most common input device which helps to input data to the computer.
- Layout of the keyboard is like that of traditional typewriter, with some additional keys provided for performing additional functions.

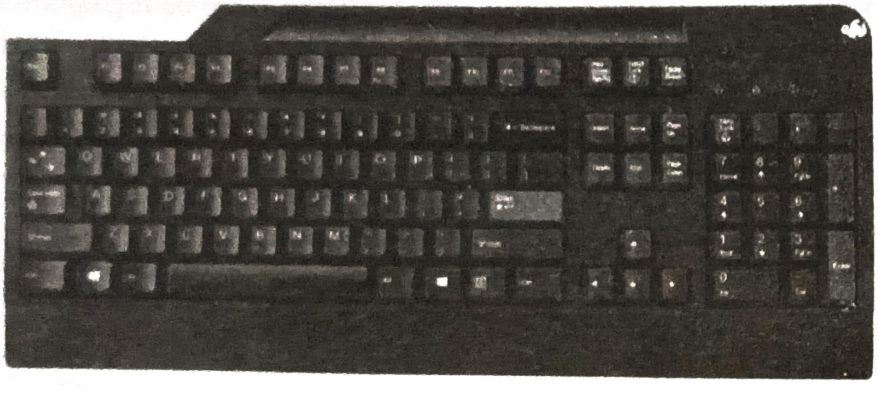


Fig. 1.8 QUERTY keyboard

- Keyboards are of two sizes 84 keys or 101/102 keys, but now keyboards with 104 keys or 108 keys are also available for Windows and Internet.

The keys on the keyboard are:

- **Typing Keys which** include the letter keys (A-Z and a-z (with caps lock on and off respectively)) and digit keys (09) which generally give the same layout as that of typewriters.
- **Numeric Keypad** used to enter the numeric data or cursor movement. Generally, it consists of a set of 17 keys that are laid out in the same configuration used by most adding machines and calculators.
- **Function Keys** arranged in a row at the top of the keyboard. Each function key has a unique meaning and is used for some specific purpose. There are twelve function keys.
- **Control keys** provide cursor and screen control. It includes four directional arrow keys. Control keys also include Home, End, Insert, Delete, Page Up, Page Down, Control (Ctrl), Alternate (Alt), Escape (Esc).
- **Special Purpose Keys** such as Enter, Shift, Caps Lock, Num Lock, Space bar, Tab, and Print Screen.

- Keyboard is used to enter text information into the computer.
- Keyboard can also be used to type commands directing the computer to perform certain actions.
- Commands are typically chosen from an on-screen menu using a mouse, but there are often keyboard shortcuts for giving these same commands.
- In addition to the keys of the main keyboard used for typing text, keyboards usually also have a numeric keypad for entering numerical data efficiently, a bank of editing keys used in text editing operations and a row of function keys along the top to easily invoke certain program functions.
- Laptop computers, which don't have room for large keyboards, often include a function key so that other keys can perform double duty such as having a numeric keypad function embedded within the main keyboard keys.
- Most keyboards attach to the PC via a PS/2 connector or USB port. Figure 1.9 shows QUERTY keyboard.

Fig. 1.9 QUERTY keyboard

1.13.2 Mouse

Mouse is the most popular pointing device. It is a cursor-control device having a small palm size box with a round ball at its base, which senses the movement of the mouse and sends corresponding signals to the CPU when the mouse buttons are pressed. The mouse pointing device sits on your work surface and is moved with your hand. In older mice, a ball in the bottom of the mouse rolls on the surface as you move the mouse, and internal rollers sense the ball movement and transmit the information to the computer via the cord of the mouse. The optical mice does not use a rolling ball, but instead uses a light and a small optical sensor to detect the motion of the mouse by tracking a tiny image of the desk surface. Optical mice avoid the problem of a dirty mouse ball, which causes regular mice to roll unsmoothly if the mouse ball and internal rollers are not cleaned frequently.

Fig. 1.10 Mouse

It has two buttons called the left and the right button and a wheel is present between the buttons.

- Mouse can be used to control the position of the cursor on the screen, but it cannot be used to enter text into the computer.
- Mouse is the most popular pointing device.
- a cursor-control device having a small palm size box with a round ball at its base, which senses the movement of the mouse and sends corresponding signals to the CPU when the mouse buttons are pressed.
- sits on your work surface and is moved with your hand.
- a ball in the bottom of the mouse rolls on the surface as you move the mouse, and internal rollers sense the ball movement and transmit the information to the computer via the cord of the mouse.
- **optical mouse** does not use a rolling ball, but instead uses a light and a small optical sensor to detect the motion of the mouse by tracking a tiny image of the desk surface avoid the problem of a dirty mouse ball, which causes regular mice to roll unsmoothly if the mouse ball and internal rollers are not cleaned frequently.
- **Cordless** or **wireless mouse** communicates with the computer via radio waves using *BlueTooth* hardware and protocols that a cord is not needed. Also includes one or more buttons to allow users to interact with the GUI.

Advantages

- Easy to use
- Economic
- Moves the cursor faster than the arrow keys of the keyboard.

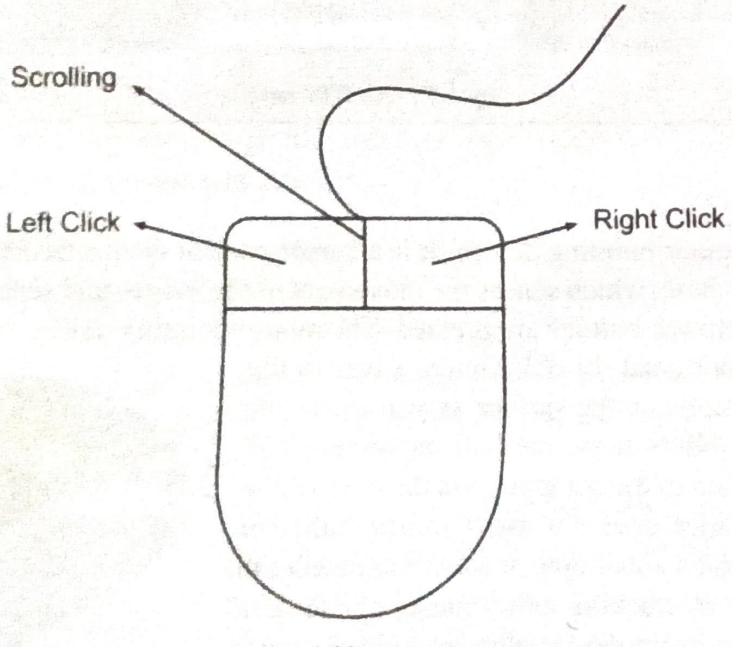


Fig. 1.11 mouse

Do you know

Most laptop computers today have a touch pad pointing device. You move the on-screen cursor by sliding your finger along the surface of the touch pad. The buttons are located below the pad, but most touch pads allow you to perform mouse clicks by tapping on the pad itself.

- Touch pads take up much less room to use.
- There are no moving parts to get dirty and result in jumpy cursor control.
- A flat control surface used to move the cursor and perform other functions on a computer. Touchpads are commonly found on laptops and replace the functionality of a mouse.
- Designed to be controlled with your finger.
- By sliding your fingertip along the surface, you can move the cursor on the screen.
- Similar to a mouse, touchpads can detect acceleration as well as linear motion.
- This allows you to have refined control with slow movements and quickly move the cursor across the screen using a fast motion.

Fig. 1.12 Touch pad

1.13.3 Joystick

Joystick is also a pointing device, which is used to move the cursor position on a monitor screen. It is a stick having a spherical ball at its both lower and upper ends. The lower spherical ball moves in a socket. The joystick can be moved in all four directions.

Joystick is used in Computer Aided Designing (CAD) and playing computer games.

Fig. 1.13 Joystick

- A joystick is an input device that can be used for controlling the movement of the cursor or a pointer in a computer device.
- Pointer movement is controlled by maneuvering a lever on the joystick.
- Mostly used for gaming applications.
- Graphics applications.
- Can be helpful as an input device for people with movement disabilities.
- Used when there is a need to perform a direct pointing or when a precise function is needed.
- Different types of joysticks are displacement joysticks, hand-operated joysticks, finger-operated joysticks, thumb operated joysticks, hand operated isometric joysticks etc.
- Similar to the mouse in movement and usage, joysticks also include buttons, sometimes known as triggers.
- Difference between the mouse and the joystick is largely based on the fact that the cursor continues the movement in the direction of the joystick unless it is kept upright, whereas the mouse prevents the cursor from further movement until it is moved.
- Provides fast interactions, which are much needed in gaming applications.
- Provides a much-needed gaming experience, which is better in quality compared to that provided by other input devices.
- Simple design.
- Easy to learn and use.
- Inexpensive.
- Not as easy to handle when selecting options from a screen.

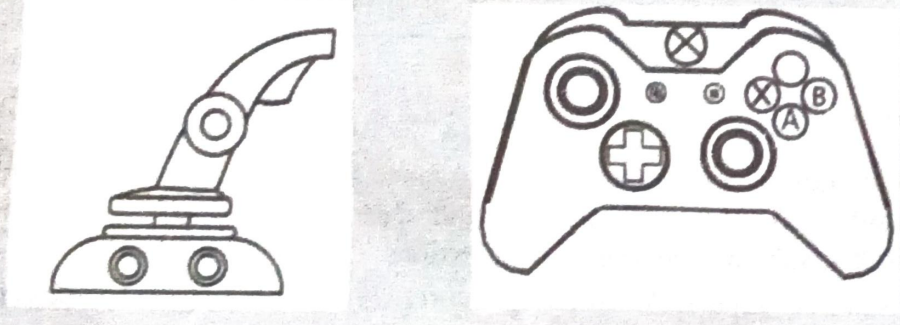


Fig. 1.14

1.13.4 Light Pen

Light pen is a pointing device similar to a pen.

- *Used to select a displayed menu item or draw pictures on the monitor screen.*
- *Consists of a photocell and an optical system placed in a small tube.*
- When the tip of a light pen is moved over the monitor screen and the pen button is pressed, its photocell sensing element detects the screen location and sends the corresponding signal to the CPU.

Fig. 1.15

1.13.5 Track Ball

A trackball is a pointing device consisting of a ball held by a socket containing sensors to detect a rotation of the ball about two axes like an upside-down mouse with an exposed protruding ball. A trackball is an input device used to enter motion data into computers or other electronic devices. It serves the same purpose as a mouse, but is designed with a moveable ball on the top, which can be rolled in any direction. Instead of moving the whole device, you simply roll the moveable ball on top of the trackball unit with your hand to generate motion input.

Fig. 1.16

Trackballs designed for computers generally serve as mouse replacements and are primarily used to move the cursor on the screen. Like mice, computer trackball devices also include buttons, which can serve as left-click and right-click buttons, and may also be used to enter other commands.

Track ball

- An input device used in notebook or laptop computers, instead of a mouse.
- A ball which is half inserted and by moving fingers on the ball, the pointer can be moved.
- Since the whole device is not moved, a track ball requires less space than a mouse.
- Comes in various shapes like a ball, a button, or a square.
- Small footprint, fingertip control which may offer more accuracy.
- Improved ergonomics since there is less strain on the wrist.
- Some people find trackballs harder to use than mice, since they feel less natural and may require practice to get used to.
- Hence, still vast majority of computers include a mouse, rather than a trackball, as the default input device.

1.13.6 Scanner

A scanner can be used to input printed images such as photographs or pages of text directly into the computer. Scanner is an input device, which works more like a photocopy machine. It is used when some information is available on paper and it is to be transferred to the hard disk of the computer for further manipulation. Scanner works by shining a light at the image being scanned and measuring how much light is reflected back using an optical sensor. The amount of light that is reflected back tells the computer how light or dark the image is at each point.

The light and optical sensor reads information about one line of the image at a time. They must be moved down the picture to input the whole image. There are two different types of scanner :

- **Flatbed Scanner:** You place the image on top of the scanner. The scanner moves the light and sensor itself and scans the whole image automatically.
- **Handheld Scanner:** You must manually push the light/sensor along the image.

Fig. 1.17

- A scanner is a device that captures images from photographic prints, posters, magazine pages, and similar sources for computer editing and display.
- Scanners come in hand-held, feed-in, and flatbed types and for scanning black-and-white only, or color.
- Very high resolution scanners are used for scanning for high-resolution printing, but lower resolution scanners are adequate for capturing images for computer display.
- Scanners usually come with software, such as Adobe's Photoshop product
- Scanner captures images from the source which are then converted into a digital form that can be stored on the disk
- These images can be edited before they are printed.
- Flatbed scanners are better as they can scan larger images and are more accurate than handheld scanner
- Shandheld scanners are cheaper and more portable

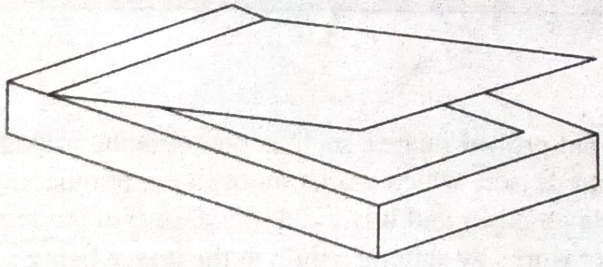


Fig. 1.18

1.13.7 Digitizer

Digitizer is an input device which converts analog information into digital form. *Digitizer* is an electronic tool which converts or digitalized hand drawn images into data which computer can access. Digitizer can convert a signal from the television or camera into a series of numbers that could be stored in a computer. They can be used by the computer to create a picture of whatever the camera had been

pointed at. Digitizers convert analog or physical input into digital images. This makes them related to both scanners and mice, although current digitizers serve completely different roles.

- Digitizer or graphics tablet is a tool used to convert hand-drawn images into a format suitable for computer processing.
- Images are usually drawn onto a flat surface with a stylus and then appear on a computer monitor or screen
- Can also be used as an input device, receiving information represented in drawings and sending output to a CAD application and PC-based software like AutoCAD.
- Converts graphics and pictorial data into binary inputs
- Used for fine works of drawing and image manipulation applications.
- Like a thin plastic film attached to the screen
- Sensitive to your finger movements, and sends information about the position and movements of your fingers to the motherboard.
- Information you enter with your fingers is analog information, and it is converted by the digitizer into digital, or computer-readable, data.

Fig. 1.19

1.13.8 Microphone

Microphone is an input device to input sound that is then stored in a digital form. It is a device that captures audio by converting sound waves into an electrical signal. This signal can be amplified as an analog signal or may be converted to a digital signal, which can be processed by a computer or other digital audio device. The microphone is used for various applications such as adding sound to a multimedia presentation or for mixing music.

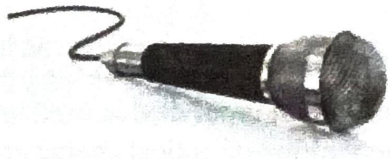


Fig. 1.20

- Microphone is an input device to input sound that is then stored in a **digital** form.
- Microphone is used for various applications such as adding sound to a multimedia presentation or for mixing music.
- Device used in sound-reproduction systems for converting sound into electrical energy, usually by means of a ribbon or diaphragm set into motion by the sound waves.
- The vibrations are converted into the equivalent audio frequency electric currents

1.13.9 Magnetic Ink Card Reader (MICR)

Magnetic Ink Character Recognition is a character recognition system that uses special ink and characters. When a document that contains this ink needs to be read, it passes through a machine, which magnetizes the ink and then translates the magnetic information into characters.. MICR input device is generally used in banks as there are large number of cheques to be processed every day. The bank's code number

and cheque number are printed on the cheques with a special type of ink that contains particles of magnetic material that are machine readable.

Fig. 1.21

- MICR technology is used by banks. Numbers and characters found on the bottom of checks usually containing the check number, sort number, and account number are printed using Magnetic Ink. To print Magnetic Ink need, you need a laser printer that accepts MICR toner.
- This reading process is called Magnetic Ink Character Recognition (MICR).
- MICR provides a secure, high-speed method of scanning and processing information.
- The main advantages of MICR is that it is fast and less error prone.

1.13.10 Optical Character Reader (OCR)

OCR is an input device used to read a printed text. Optical character recognition or optical character reader is the mechanical or electronic conversion of images of typed, handwritten or printed text into machine-encoded text, whether from a scanned document, a photo of a document, a scene-photo or from subtitle text superimposed on an image. OCR scans the text optically, character by character, converts them into a machine readable code, and stores the text on the system memory.

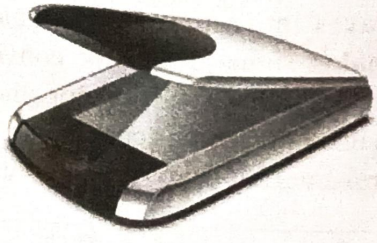


Fig. 1.22

- Optical Character Recognition, or OCR, is a technology that enables you to convert different types of documents, such as scanned paper documents, PDF files or images captured by a digital camera into editable and searchable data.
- OCR (optical character recognition) is the recognition of printed or written text characters by a computer.
- Involves photo scanning of the text character-by-character, analysis of the scanned-in image, and then translation of the character image into character codes, such as ASCII, commonly used in data processing.

- In OCR processing, the scanned-in image or bitmap is analyzed for light and dark areas in order to identify each alphabetic letter or numeric digit.
- When a character is recognized, it is converted into an ASCII code. Special circuit boards and computer chips designed expressly for OCR are used to speed up the recognition process.
- OCR is being used by libraries to digitize and preserve their holdings
- OCR is also used to process checks and credit card slips and sort the mail.
- Billions of magazines and letters are sorted every day by OCR machines, considerably speeding up mail delivery.

1.13.11 Bar Code Readers

A bar code reader or bar code scanner is an electronic device that can read and output printed barcodes to a computer. It is a device used for reading bar coded data which is data in the form of light and dark lines. Bar coded data is generally used in labelling goods, numbering the books, etc. It may be a handheld scanner or may be embedded in a stationary scanner. Bar Code Reader scans a bar code image, converts it into an alphanumeric value, which is then fed to the computer that the bar code reader is connected to.

Fig. 1.23 Bar code reader

Fig. 1.24 Bar code

- Barcode readers are electronic devices for reading printed barcodes.
- Optical machine-readable representations of data relating to the object to which they are attached.
- Barcode readers consist of a light source, a lens and a light sensor that translates optical impulses into electrical ones.
- Contain decoder circuitry.
- Analyzes the barcode's image data provided by the sensor and sends the barcode's content to the scanner's output port.
- Important tool for warehouse management and operation.
- Provides a real-time overview of products stored in the warehouse, plus additional information, if need be.

- While original barcodes showed data by varying the widths and spacings of parallel lines, they would evolve into a number of geometric patterns in two dimensions, still called barcodes. The principle of electronic-based record-keeping has remained the same throughout, however

1.13.12 Optical Mark Reader (OMR)

OMR is a special type of optical scanner used to recognize the type of mark made by pen or pencil. This popular recognition technology is used for collecting data from "fill-in-the-bubble" forms such as educational tests, surveys, assessments, evaluations, and many other multiple choice forms. It is used where one out of a few alternatives is to be selected and marked. It is specially used for checking the answer sheets of examinations having multiple choice questions.

OMR device uses a dedicated scanner that focuses a beam of light onto the concerned area. Since black spots reflect lesser light than white areas, the scanner detects them. Then, a digital blue print of the paper is prepared by different computing algorithms.

Nowadays, we also use Digital Image Processing techniques for OMR. In that case an image of the page is taken, algorithms are run to extract the required contrasts and finally computed further.

Advantages of OMR

- Fast
- Accurate
- Cost effective
- Easy to implement and support
- Optical Mark reading is a method of entering data into a computer system.

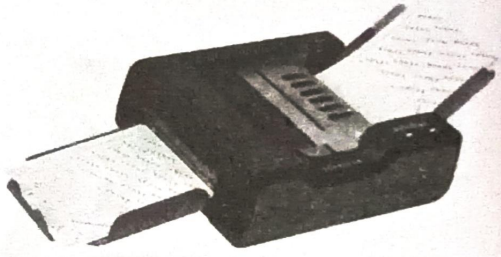


Fig. 1.25

- Optical Mark Readers reads pencil or pen marks made in predefined positions on paper forms as responses to questions or tick list prompts.
- OMR data entry system contains the information to convert the presence or absence of marks into a computer data file.
- The OMR technology could be used if data is to be collected from a large number of sources simultaneously, a large volume of data must be collected and processed in a short period of time, information mainly comprises the selection of categories or "tick box" answers to multiple-choice questions.

1.14 OUTPUT DEVICES

An output device is any device used to send data from a computer to another device or user. Most computer data output that is meant for humans is in the form of audio or video. Thus, most output devices used by humans are in these categories. Examples include monitors, projectors, speakers, headphones and printers.

1.14.1 Display

The display is how you see the output of the computer. The display is the external monitor on a desktop or the attached monitor on a laptop. Although displays used to be made with cathode-ray tubes (CRT), flat-screen panels have replaced that technology. Flat-screen liquid-crystal display (LCD) monitors are lighter and have better display quality than older CRT monitors.

Monitors OR Visual Display Units (VDUs) are the main output device of a computer. It forms images from tiny dots, called pixels that are arranged in a rectangular form. The sharpness of the image depends upon the number of pixels.

There are two kinds of viewing screen used for monitors.

- Cathode-Ray Tube (CRT)
- Flat-Panel Display

1.14.2 Cathode-Ray Tube (CRT) Monitor

A cathode ray tube (CRT) is a specialized vacuum tube in which images are produced when an electron beam strikes a phosphorescent surface. Most desktop computer displays make use of CRTs. The CRT in a computer display is similar to the picture tube in a television receiver.

The CRT display is made up of small picture elements called pixels. A pixel is the smallest unit of a digital image or graphic that can be displayed and represented on a digital display device. A pixel is the basic logical unit in digital graphics. A pixel is also known as a picture element. The smaller the pixels, the better the image clarity or resolution. It takes many illuminated pixels to form a whole character.

Fig. 1.26

1.14.3 Limitations of CRT

- Large in Size
- High power consumption

- CRT works by heating a cathode which causes electrons to flow.
- Accelerating and focusing anodes turn the electrons into a fine beam that is directed to the phosphors by magnetic fields that are generated by steering coils.
- Viewing end of a color CRT tube is coated with red, green and blue phosphor dots, and separate electron guns bombard their respective colors a line at a time in a prescribed sequence.
- Resulting color displayed on screen is derived by the intensity of the electron beams as they strike the red, green and blue phosphors and cause them to glow at each pixel location.

1.14.4 Flat-Panel Display Monitor

A flat panel display is a television, monitor or other display appliance that uses a thin panel design instead of a traditional cathode ray tube (CRT) design. These screens are much lighter and thinner, and can be much more portable than traditional televisions and monitors. The flat-panel display have reduced volume, weight and power requirement in comparison to the CRT. Current uses of flat-panel displays include calculators, video games, monitors, laptop computer, and graphics display.

Fig. 1.27

The flat-panel display is divided into two categories i.e. Emissive Displays which include Emissive displays are devices that convert electrical energy into light. For example, plasma panel and LED (Light-Emitting Diodes) and Non-Emissive Displays which include Non-emissive displays use optical effects to convert sunlight or light from some other source into graphics patterns. For example, LCDs (Liquid Crystal Displays).

- A thin **display screen** for a computer, tablet, smart phone or TV.
- Each pixel acts as a switch, they don't emit any light.
- Instead there is a white back lighting.
- This light passes through the liquid crystal then through colour filter.
- The liquid crystal solution is trapped between two polarised glasses.
- Each sub-pixel is controlled electrically and thus more or less light is allowed to pass through the crystal, then through the polarised glass on to the display surface.
- Controlled red, green, and blue shades are thus emitted.

Advantages

- Very low power consumption.
- Low driving voltage (5-20 volts).
- Very thin display.
- Low cost.
- High contrast ratio.
- Readable in direct sunlight.
- Available from many commercial sources.
- Full-color display capability.
- Fast writing speed.

Limitations

- Narrow viewing angle or cone.
- Limited contrast.
- Slow writing speed.
- Nearly defect-free panels difficult to manufacture.
- High capital equipment investment.
- Low transmissivity of color filters requires strong backlight.

1.14.5 Printer

Printer is an output device, which is used to print information on paper. A *printer* is a device that accepts text and graphic output from a computer and transfers the information to paper, usually to standard size sheets of paper. A printer is a device that prints output to a page. Printers come in color or black and white. Inkjet and laser printers are the most common home devices. Most businesses have laser printers since the quality is better and the output is faster. Printers can be connected to the computer or networked using a print server. Note that a copy of any document stored in computer is called a soft copy. When we take its print on a paper, it is called a hard copy or a print-out.

Types of Printers

- Impact Printers
- Non-Impact Printers

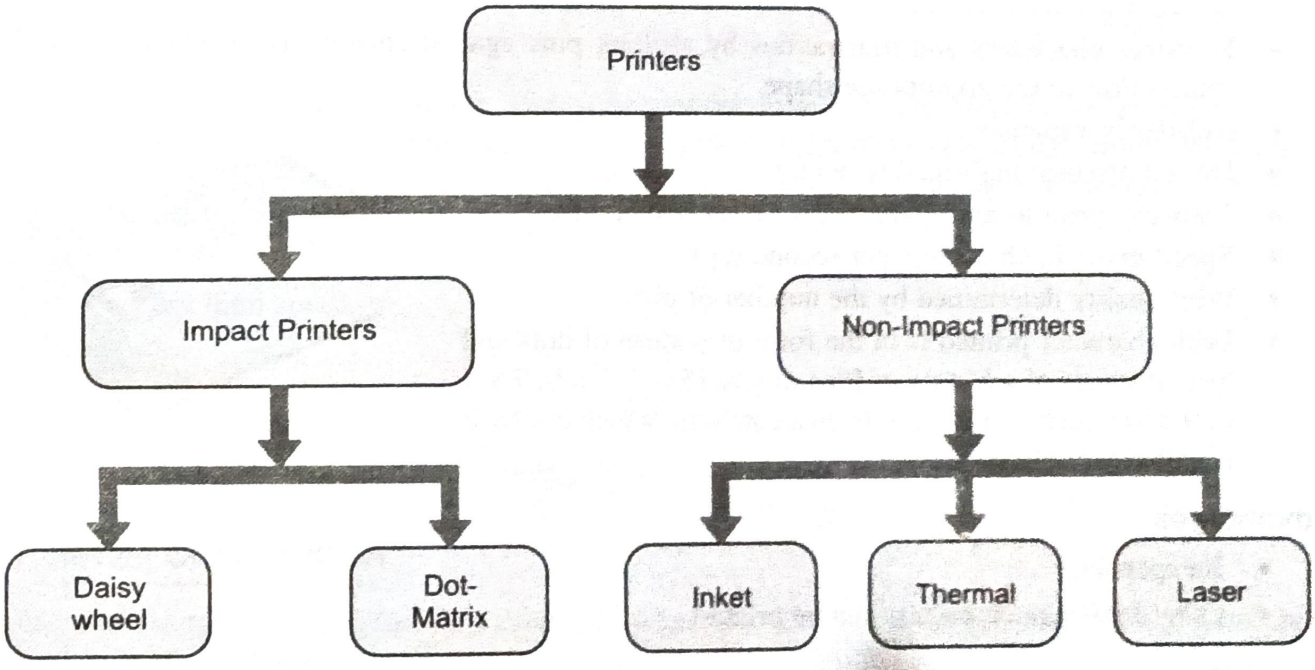


Fig. 1.28

1.14.6 Impact Printers

Impact printers print the characters by striking them on the ribbon, which is then pressed on the paper.

Characteristics

- Very low consumable costs.
- Very noisy.
- Useful for bulk printing due to low cost.
- There is physical contact with the paper to produce an image.

These printers are of two types:

- Character printers
- Line printers

1.14.7 Character Printers

Character printers are the printers which print one character at a time.

These are further divided into two types:

- Dot Matrix Printer (DMP)
- Daisy Wheel

1.14.8 Dot Matrix Printer

- Produces characters and illustrations by striking pins against an ink ribbon to print closely spaced dots in the appropriate shape.
- Relatively expensive.
- Do not produce high-quality output.
- They can print to multipage prints i.e. carbon copies.
- Speed given in characters per second (cps).
- Print quality determined by the number of pins.
- Each character printed is in the form of pattern of dots and head consists of a Matrix of Pins of size (5×7, 7×9, 9×7 or 9×9) which come out to form a character which is why it is called Dot Matrix Printer.

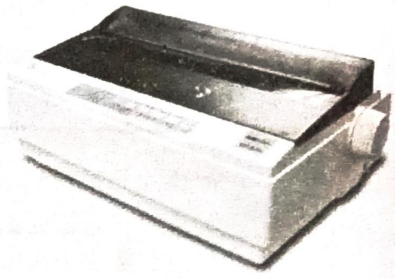


Fig. 1.29

Advantages

- Inexpensive
- Other language characters can be printed

Limitations

- Slow Speed
- Poor Quality

1.14.9 Daisy Wheel

- Head is lying on a wheel and pins corresponding to characters are like petals of Daisy flower.
- Used for word-processing in offices used that require a few letters to be sent here and there with very nice quality.

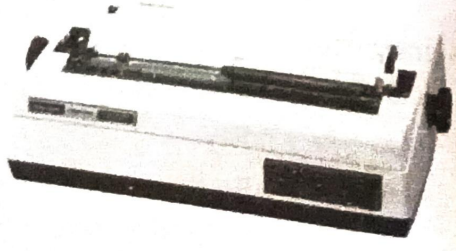


Fig. 1.30

Advantages

- Reliable
- Better quality
- Fonts of characters can be easily changed

Limitations

- Slow
- Noisy
- Expensive

1.14.10 Line Printers

Line printers are the printers which print one line at a time.

Fig. 1.31

Types

- Drum Printer
- Chain Printer

1.14.11 Drum Printer

This printer is like a drum in shape. The surface of the drum is divided into a number of tracks. Total tracks are equal to the size of the paper, i.e. for a paper width of 132 characters, drum will have 132 tracks. A character set is embossed on the track. Drum printers are faster in speed than their counterparts.

Advantages

- Very high speed

Limitations

- Very expensive
- Characters fonts cannot be changed

1.14.12 Chain Printer

An obsolete type of solid-font line printer in which the font was etched or engraved on small plates linked together to form a chain.

Advantages

- Character fonts can easily be changed.
- Different languages can be used with the same printer.

Limitations

- Noisy

1.14.13 Non-impact Printers

A printer that prints without banging a ribbon onto paper is called a non impact printer. Laser, LED, inkjet, solid ink, thermal wax transfer and dye sublimation printers are examples of non-impact printers. Non-impact printers print the characters without using the ribbon. Impact printers have physical contact; non-impact printers (NIPs) do not. These printers print a complete page at a time, thus they are also called as Page Printers. Non impact printers are generally much quieter than impact printers since they

don't physically strike the page. For example, inkjet printers spray tiny drops of ink onto the page, while laser printers use a cylindrical drum that rolls electrically charged ink onto the paper. Both of these methods are non-impact and provide an efficient printing process that produces little sound. The low impact nature of inkjet and laser printers also means they are less likely to need maintenance or repairs than earlier impact printers.

These printers are of two types:

- Laser Printers
- Inkjet Printers

Characteristics of Non-impact Printers

- Faster than impact printers.
- They are not noisy.
- High quality.
- Supports many fonts and different character size.

1.14.14 Laser Printers

These are non-impact page printers. They use laser lights to produce the dots needed to form the characters to be printed on a page. It makes a laser beam scan back and forth across a drum inside the printer, building up a pattern of static electricity. The static electricity attracts onto the page a kind of powdered ink called toner. Finally, a fuser unit bonds the toner to the paper.

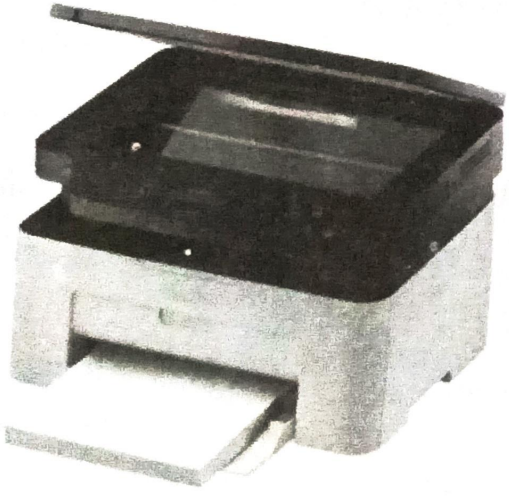


Fig. 1.32

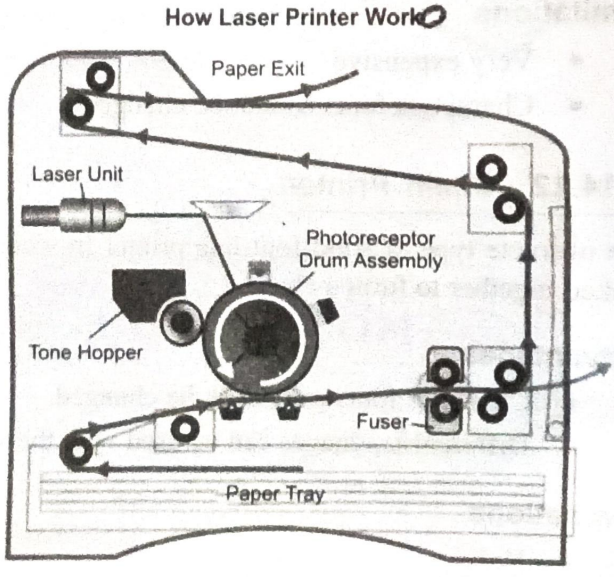


Fig. 1.33

Advantages

- Very high speed.
- Very high quality output.
- Good graphics quality.
- Supports many fonts and different character size.

Limitations

- Expensive.
- Cannot be used to produce multiple copies of a document in a single printing.

1.14.15 Inkjet Printers

An inkjet printer is a computer peripheral that produces hard copy by spraying ink onto paper. Inkjet printers are also non-impact character printers. They print characters by spraying small drops of ink onto paper. Inkjet printers produce high quality output with presentable features. They make less noise because no hammering is done and these have many styles of printing modes available. Color printing is also possible. In the inkjet printing mechanism, the print head has several tiny nozzles, also called jets. As the paper moves past the print head, the nozzles spray ink onto it, forming the characters and images.

Fig. 1.34

Advantages

- High quality printing.
- More reliable.

Limitations

- Expensive as the cost per page is high.
- Slow as compared to laser printer.

- Early printers, such as dot matrix and daisywheel printers were called impact printers, since they operated by striking an ink ribbon against the paper.
- Most modern printers, including inkjet and laser printers, don't include an ink ribbon and are considered to be non-impact printers.
- Impact printers have physical contact; **non-impact printers** (NIPs) do not.
- Non-impact printers are faster and quieter than impact printers.
- Non-impact printers form characters and images without direct physical contact between the printing mechanism and the paper.
- For example, inkjet printers spray tiny drops of ink onto the page, while laser printers have a cylindrical drum that rolls electrically charged ink onto the paper.
- Non-impact printers use a cartridge filled with toner or liquid ink, which allows them to produce fine-quality images quickly and quietly.
- Inkjet printers also form images with tiny dots; they simply spray small charged droplets of ink from four nozzles through holes in a matrix at high speed onto paper.
- Consists of a print cartridge filled with liquid ink and small nozzles in the form of a matrix.
- inkjet printers they are slower than laser printers.

- Advancement on inkjet technology is the bubble-jet printer, which uses a type of small heating element which pushes specially formulated ink through print heads with 128 miniature nozzles.
- With thermal printers, output characters are formed by a special heating element placed with special heat-sensitive waxy paper, forming darkened dots when the element reaches a critical temperature.
- Thermal printers are usually quite expensive as compared to other non-impact printers, but produce extremely high quality printouts.

Impact printers	Non impact printers
Prints characters or images by striking print hammer or wheel against an inked ribbon. Example: DMP, Display Wheel printers.	Prints characters and images without striking the papers. Example: inkjet and laser printers.
Slow	Fast
Printing quality is lower.	Printing quality is higher.
Normally uses continuous paper sheet.	Normally uses individual paper sheet.
Generates noise during printing.	Does not generate noise during printing.
Uses inked ribbon for printing.	Uses toner or cartridge for painting.
Less expensive.	Expensive.

1.14.16 Plotters

A plotter is a computer vector graphic printer that gives a hard copy of the output based on instructions from the system. Plotters are widely used to print designs of things such as cars, ships and buildings on a piece of paper using a pen. A plotter is a computer hardware device much like a printer that is used for printing vector graphics. Instead of toner, plotters use a pen, pencil, marker, or another writing tool to draw multiple, continuous lines onto paper rather than a series of dots like a traditional printer.

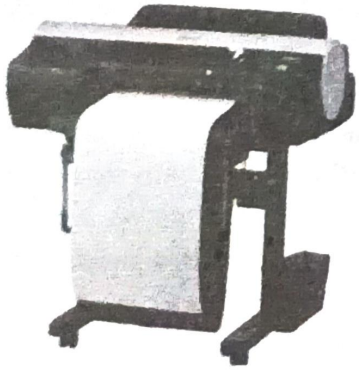


Fig. 1.35

- A device that draws pictures on paper based on commands from a computer.
- Plotters differ from printers in that they draw lines using a pen.
- As a result, they can produce continuous lines, whereas printers can only simulate lines by printing a closely spaced series of dots. Multicolor plotters use different-colored pens to draw different colors.
- More expensive than printers.
- Used in engineering applications where precision is mandatory.

Advantages

- Drawings are of the same quality as if an expert drew them.
- Larger sizes of paper can be used than would be found on most printers.

Limitations

- Plotters are slower that printers, drawing each separately.
- Then are often more expensive to but than printers.
- Not suitable for text.

1.14.17 Speakers

Speakers are one of the most common output devices used with computer systems. Some speakers are designed to work specifically with computers, while others can be hooked up to any type of sound system. Speakers are attached to computers for the output of sound. Sound cards are required in the computer for speakers to function. Speakers range from simple, two-speaker output devices to surround-sound multi-channel units. A computer speaker is a hardware device that connects to a computer to generate sound. The signal used to produce the sound that comes from a computer *speaker* is created by the computer's sound card.

Fig. 1.36

- A speaker is a device which converts an electrical audio signal into a corresponding sound.
- Speakers are typically housed in an enclosure which plays an important role in the quality of the sound.
- Speakers are popular output devices used with computer systems.
- They receive audio input from the computer's sound card and produce audio output in the form of sound waves.
- Most computer speakers are active speakers, meaning they have an internal amplifier which allows you to increase the volume, or amplitude, of the sound.
- Speakers usually come in pairs, which allows them to produce stereo sound from two separate audio channels.

1.14.18 Storage Device

Any media, permanently attached or transportable, capable of storing electronic information.

Examples

- Hard drive
- CD-ROM
- DVD-ROM
- Flash media
- Thumb drive
- Memory stick
- IPOD
- Digital camera
- Removable hard drive
- Back-up tape
- PDA (Palm Windows Mobile, etc.)
- Blackberry
- Cell phone

1.14.19 Floppy Diskette

The floppy disk is a secondary storage device which is used for storing the data in a permanent manner. The floppy is made up of rigid mylar plastic and also contains a magnetic black disk inside the plastic cover. The floppy disk also stores all the data into the form of tracks and sectors and the floppy disk provides both reading and writing the data into the disk. We can read and write the data from the disk. The floppy disk is also called as reusable disk means the floppy disk provides us the facility to read and writes the data into disk as and when necessary and also many times.

1.14.20 Optical Disks

An optical disk is any computer disk that uses optical storage techniques and technology to read and write data. It is a computer storage disk that stores data digitally and uses laser beams transmitted from a laser head mounted on an optical disk drive An optical disk is primarily used as a portable and secondary storage device. It can store more data than the previous generation of magnetic storage media, and has a relatively longer lifespan. Compact disks (CD), digital versatile/video disks (DVD) and Blu-ray disks are currently the most commonly used forms of optical disks. These disks are generally used to:

- *Distribute software*
- *Store large amounts of data such as music, images and videos*
- *Transfer data to different computers or devices*
- *Back up data*

DVD or Digital Versatile Disc

DVD or digital versatile disc is a type of optical disc used for data storage and as a platform multimedia. Its most prominent commercial application is for playing back recorded motion pictu and television programs, though read-only, recordable, and even erasable and rewritable versions be used on personal computers to store large quantities of almost any kind of data. A DVD is a type optical media used for storing digital data. It is the same size as a CD, but has a larger storage capacity Some DVDs are formatted specifically for video playback, while others may contain different types of data, such as software programs and computer files. DVDs are also used to distribute software programs. Writable DVDs also provide a way to store a large number of files and back up data. The writable DVD formats include DVD-R, DVD+R, DVD-RW, DVD+RW, and DVD-RAM. A standard DVD can hold 4.7 GB of data, but variations of the original DVD format have greater capacities. For example, a dual-layer DVD (which has two layers of data on a single side of the disc) can store 8.5 GB of data. A dual-sided DVD can store 9.4 GB of data (4.7 × 2). A dual-layer, dual-sided DVD can store 17.1 GB of data

Pen Drive

A pen drive, or a USB flash drive, is a portable data-storage device. Micro, lightweight and handy, a pen drive can be easily carried from place to place by students, professionals, academicians and independent tech consultants. Currently available pen drives with storage capacities ranging from 8 GB and 32 GB can be used to store graphics-heavy documents, photos, music files and video clips.

The pen drives are used in a wide range in the world they have easily replaced CD's, Floppy Disk due to its huge data storing capacity and faster data transferring speed.

Pen drives are connected to USB i.e. Universal Serial Bus Port which is available on computer motherboards they are used without any additional power supply they receive the power directly from the USB port itself and hence are playing dominant role in the PC world.

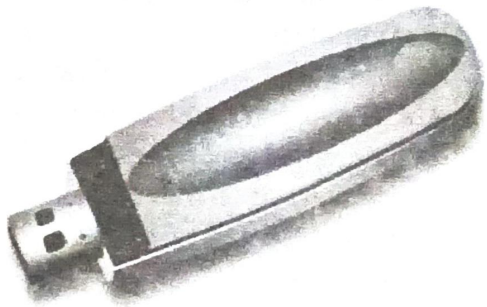


Fig. 1.37

Advantages

- Huge data storing capacity from 64 MB to 128 GB.
- Consist of a compact design which make them portable.
- Used as bootable medium.
- Faster data transferring rate
- Can hold or store data almost permanent memory and also called as secondary storage devices.
- Can be kept in pocket for easy transportation.
- Damaged due to scratches like CDs and DVDs.

Limitations

- So small that they can be misplaced.
- Primary source for spreading Computer viruses
- Can easily infect other computer if comes in contact if not taken proper precautions such as Scanning with good Anitvirus.
- Don't have high storage capacity like hard disk

- Pen Drive, commonly known as USB flash drive, is a portable device which means it can be easily transferred from one location to another due to its compact design it looks like a pen shape and therefore it is named as pen drive.
- A pen drive plugged into a USB port can be used as an interfacing device to transfer files, documents and photos to a PC.
- Select files can be transferred from a pen drive to any workstation.
- Lightweight and micro characteristics of a pen drive make it possible to carry it from place to place.
- Important information, medical records and photos can be backed up on them due to encryption features.
- Academicians can easily transport large files and lectures on a pen drive and access them anywhere.
- Companies and businesses use pen drives as effective tools to promote sales literature and other marketing-communication content

1.13.21 ASCII and EBCDIC Codes

ASCII (American Standard Code for Information Interchange) is the most common format for textfiles in computers and on the Internet. In an ASCII file, each alphabetic, numeric, or special character is represented with a 7-bit binary number (a string of seven 0s or 1s). 128 possible characters are defined. ASCII character encoding provides a standard way to represent characters using numeric codes. These include upper and lower-case English letters, numbers, and punctuation symbols. ASCII uses 7 bits to represent each character. For example, a capital "S" is represented by the number 83 and a lowercase "s" is represented by 115. Other keyboard keys are also mapped to standard ASCII values.

EBCDIC (Extended Binary Coded Decimal Interchange Code) is a binary code for alphabetic and numeric characters that IBM developed for its larger operating systems. In EBCDIC code, each alphabetic or numeric character is represented with an 8-bit binary number. 256 possible alphabets, numerals, and special characters) are defined. The difference between the two is that the EBCDIC uses 8 bits per character while the original ASCII standard only uses 7. ASCII uses a linear ordering of letters while EBCDIC does not.

The details of these codes is given in chapter 6.

1.13.22 Prospects in Computer Science

The disciplines encompassed by a computer science are incredibly vast, and student must know how to effectively navigate amongst this sea of sub-disciplines and specializations. A few possible areas of specialization available to students pursuing computer science are:

- Operating Systems
- Computer Game Development
- Robotics
- Computer Graphics
- Memory Systems

- Computational Physics
- Artificial Intelligence
- Microprogramming
- Bioinformatics
- Applied Mathematics
- Digital Image/ Sound
- Web Development
- Design Databases
- Parallel Programming
- IOS Development
- Mobile Development Cryptography
- Software Development
- Data Management
- Networks And Administration
- Computer Architecture Networks
- Simulation And Modelling

Important Points to remember

- A computer is a man made electronic machine which stores, reads and processes data to produce meaningful information as output.
- Computers cannot work on their own. They do what we want them to do, when we give them the right command.
- A collection of raw figures or facts is called data. Data can be numeric, alphabetic or alphanumeric. A processed data is called information, It is organized, meaningful and useful and helps in decision making. The input-process-output is called IPO cycle.
- The main characteristics of computer are speed, accuracy, reliability, high storage capacity, automation, diligence and versatility.
- Computers are used for entertainment, recreation, eduction. Banking, Railways and Airways reservations and ticketing systems, Medical Science, Business, Defence, Designing, Scientific researches. Administration, Publications, Communications Engineering etc.
- The main functions of a computer are data collection, data storage, data processing, and data output.
- The electronic computer has been around for over a half century but its ancestor abacus has been around for over 4000 years back. However, in the last 40 years. Computer has changed our life styles.
- Programming language is the medium used by user to give instructions to a computer. The programs are written in English-like statement, and this is called high level language. However, computer can understand only binary language in the form of 1's and 0's. This is called machine language. A software (program) that converts high level language to machine level language is called compiler. Interpreter also does the same thing but the difference lies in the compiler does the translation of whole program in one step while Interpreter

does the translation line by line. Another language in form of Pnemonics is called assembly language. An assembler is a software (program) that converts assembly language to machine language.

EXERCISES

1. What is a computer? How is it important for us?
2. What is data and information? What is an IPO cycle?
3. Throw light on the historical evolution of computers.
4. Explain the various generations of computers.
5. Explain the classification of computers based on size and processor.
6. What are the various applications of computers?
7. Draw the block Diagram along its components and characteristics.
8. Explain the Interaction between the CPU and Memory.
9. Explain about Input and output devices of the computer.
10. What is the function of CPU? What are the major functional parts of CPU?
11. State the relevance of speed and word length for CPU Performance.
12. Recognize the current family of CPUs used in Computers.
13. What are the various types of Memory? Explain RAM and ROM and their types.
14. What do you mean by peripheral devices of a computer? Explain the following in relevance with computer peripheral devices: Monitor, Mouse, Keyboard, Disk, trackballs and joysticks.
15. What is a storage device? Explain about floppy disk, CD, DVD and Pen drive.
16. Explain Printers, types of printers, Scanner, Modem, Video, Sound cards and Speakers.
17. Explain the usefulness of Computers in our daily life.

❑❑❑

2 Chapter

NUMBER SYSTEMS AND DATA REPRESENTATION

THINK ABOUT IT

- *You have to grow from the inside out. None can teach you, none can make you spiritual. There is no other teacher but your own soul.*

— Swami Vivekananda

2.1 INTRODUCTION OF DIFFERENT NUMBER SYSTEMS

The base of a number system represents that how many symbols or digits we are using in that number system. The base of number system is also known as Radix. The base of decimal number system is 10, because it uses 10 symbols or digits (0 to 9). The base of any number is indicated in its subscript. For example $(65)_{10}$ is a decimal number.

There are some other number system also that are popular:

(i) Binary Number System

(ii) Octal Number System

(iii) Hexadecimal Number System.

Decimal Number System

This number system consists of 10 symbols (known as digits). These ten symbols are 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. Any decimal number can be represented using any of these 10 digits, it is also known as base-10 number system.

The decimal number system evolved naturally because the human hand has 10 fingers and initially counting was done using fingers. In fact, the word digit is a latin word used for fingers.

In any number system every digit have a positional value which depends on the position of that digit in the number.

For example, in decimal number 583.5 represents five hundreds, 8 represents 8 tens and 3 represent three units, Hence, the local weight of 5 is maximum and hence it is called most significant digit or MSD. 3 has the least local weight and hence called least significant digit or LSD.

Lets take an example. The decimal number 63.58 represent 6 tens, 3 units, 5 tenths and 8 hundredths. The decimal point separates the integer and fractional part. In this example, 63 is the integer part and 0.58 is the fraction part. The point is also known as Radix point.

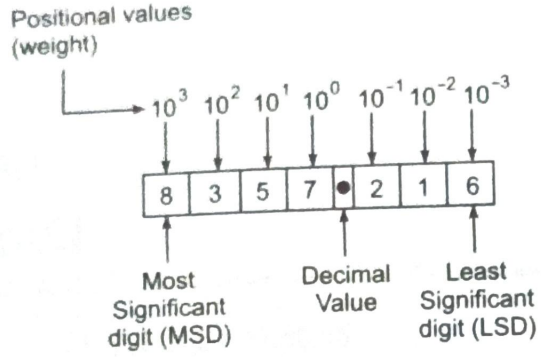


Fig. 2.1 Define values of decimal positional to the power of 10

Hence, we see that the position relative to decimal point represents the local value of the digit. Fig. 2.1 shows the position values of various digits in the number 8357.216. It is clear from this figure that this number actually represents:

$$(8 \times 10^{+3}) + (3 \times 10^{+2}) + (5 \times 10^{+1}) + (7 \times 10^{0}) + (2 \times 10^{-1}) + (1 \times 10^{-2}) + (6 \times 10^{-3})$$

Decimal Counting

In any number system the number of symbols are limited. But the counting has no limits. It can go on and on to infinity. So, the symbols have to be repeated for counting to go on and this repetition is related to the base of number.

When the counting is done in decimal number system then the counting starts from zero at the units place and is increased one by one till 9 is reached. After that a 1 is placed at the next higher position and 9 is reset to zero so that it becomes 10. After that, 0 is increased to 1 and so on till we reach 19. Now again, 1 is increased to 2 and 9 is again reset to zero, so that we get 20, this process is repeated till 99 is reached. After 99 both the units and tens place are resetted to zero and 1 is placed at the hundreds place to get 100. (See Fig. 2.2).

The main point here to notice is that the unit place is changed after every count, tens place changes after every 10 counts, hundreds place changes after every 100 count and so on. One more point to notice is that by using one decimal place we can count upto 10 objects ($10^1 = 10$) means 0 to 9, by using two decimal places we can count upto $10^2 = 100$ objects means from 0 to 99, by using 3 decimal places we can count upto $10^3 = 1000$ objects from 0 to 999 and by using n decimal places we can count upto 10^n objects.

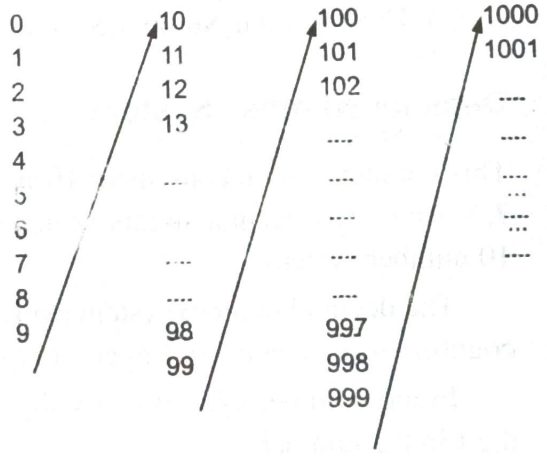


Fig. 2.2 Decimal counting

Binary Number System

The decimal number system is very widely used number system but unfortunately it is very difficult and uncomfortable to use decimal system in digital systems because when we have to design electronic

circuits which will work for 10 different voltage levels (because we need a different voltage level for each digit from 0 to 9) but practically it is easy to design electronic circuits which work on only two voltage levels because the transistor while working as a switch can work in two regions that is cut off and saturation (OFF and ON respectively). So, all digital systems are based on binary number system.

In binary system, we have only two states, 0 and 1, hence a much simpler, faster, more reliable and less expensive equipment can be implemented for binary number system.

In binary number system also, every binary digit has a local place value or weight which depends on its position. Hence, binary number system is also a positional number system in which the positional value or weight of digit is expressed in powers of 2 (Fig. 2.3).

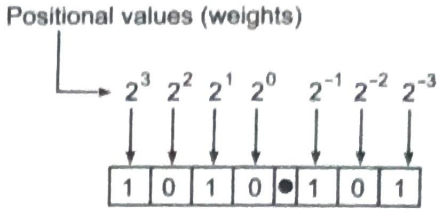


Fig. 2.3 Binary positional values (in the powers of 2)

The digits to the left of binary point are expressed as positive powers of 2 while number to the right of binary point are expressed as negative powers of 2. For example, the binary number $(1010.101)_2$ can be converted into decimal by taking the positional value of every binary digit and then taking the sum of all these positional values (Fig. 2.3).

$$(1010.101)^2 = (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (0 \times 2^0) + (1 \times 2^{-1}) + (0 \times 2^{-2}) + (1 \times 2^{-3})$$
$$= 8 + 0 + 2 + 0 + 0.5 + 0 + 0.125$$
$$= (10.625)_{10}$$

Note that, the subscript 2 or 10 indicates the base of number i.e. subscript 2 represents a binary number while the subscript 10 represents a decimal number. The binary digit is known as bit also in short (binary digit = bit). In the binary number shown in Fig. 2.3, there are four bits to the left of binary point while there are 3 bits to the right of binary point. The four bits to the left of binary point represent the integer part while the bits to the right of point represent the factional part. The left most bit has the maximum weight so that it is known as most significant bit or MSB while the right most bit has the minimum weight so it is known as least significant bit or LSB.

Binary Counting

As the binary counting is done using only two symbols so it is done as shown in Fig. 2.4.

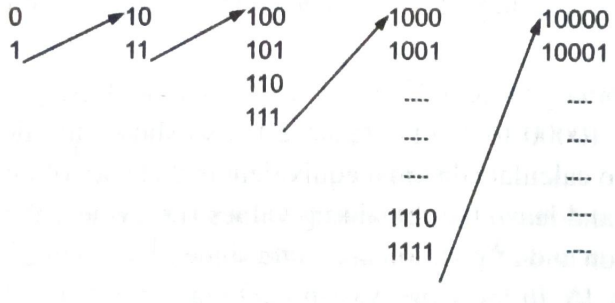


Fig. 2.4 Binary counting

This can be understood using Table 2.1.

Table 2.1 Binary counting

Weights or positional values →	$2^3 = 8$	$2^2 = 4$	$2^1 = 2$	$2^0 = 1$	Decimal equivalent
	0	0	0	0	0
	0	0	0	1	1
	0	0	1	0	2
	0	0	1	1	3
	0	1	0	0	4
	0	1	0	1	5
	0	1	1	0	6
	0	1	1	1	7
	1	0	0	0	8
	1	0	0	1	9
	1	0	1	0	10
	1	0	1	1	11
	1	1	0	0	12
	1	1	0	1	13
	1	1	1	0	14
	1	1	1	1	15

Table 2.1 shows counting of four bit binary number counting starts from 0000 (i.e., all bit zero). Then the bit at position 2^0 (i.e. the LSB) toggles after every count (the change of binary value of the bit i.e., becoming 1 from 0 or 0 from 1 is known as toggling). The bit at position 2^1 toggles whenever the LSB goes from 1 to 0 (note that this happens after every two positions i.e., when decimal 1 changes to 2, 3 changes to 4 etc). The bit at position 2^2 toggles whenever the bit at 2^1 position goes from 1 to 0 (note that this happen every 4 positions, i.e., at the transition 3 to 4, 7 to 8 etc.). In the same way the bit at position 2^3 toggles (changes) whenever the bit at position 2^2 moves from 1 to 0 and this happen after every 8 positions.

Hence, it is clear from Table 2.1 that in a binary number system the LSB changes after every count, 2^1 bit changes after every 2^1 count, 2^2 bit changes after every $2^2 = 4$ counts, 2^3 position bit changes after every $2^3 = 8$ counts, etc.

So, we see that in binary system 2^n objects can be counted using n bits. For example using four bits 2^4 counts can be done (0000 to 1111). Table 2.1 also shows the decimal equivalent of each binary number. An easy way to calculate decimal equivalent is that sum of up all those positional values where the binary digit is one and leave the remaining values (i.e., where the bit is 0). For example, in binary number 1010, 2^1 position and 2^3 position are 1 and since $2^1 = 2$ and $2^3 = 8$ and $8 + 2 = 10$ so the decimal equivalent of $(1010)_2 = 10$. In the same way in the binary number 1011 three positions i.e. $2^0 = 1$, $2^1 = 2$ and $2^3 = 8$ are 1, so its decimal equivalent will be $8 + 2 + 1 = 11$.

Octal Number System

The base of octal number system is eight and hence it uses eight symbols i.e., 0, 1, 2, 3, 4, 5, 6 and 7. So any octal number contains digits from 0 to 7. The position values of the digits in an octal number are as follows:

8^4	8^3	8^2	8^1	8^0	•	8^{-1}	8^{-2}	8^{-3}	8^{-4}	8^{-5}

Hence, we see that the positional value of octal digit is the digit multiplied by power of eight. So, the decimal equivalent of octal number can be calculated by taking the positional values of every digit and summing all these positional values. For example the octal number $(642)_8$ can be converted into decimal as shown below:

$$\begin{aligned}(642)_8 &= 6 \times 8^2 + 4 \times 8^1 + 2 \times 8^0 \\ &= 6 \times 64 + 4 \times 8 + 2 \times 1 \\ &= 384 + 32 + 2 \\ &= (418)_{10}\end{aligned}$$

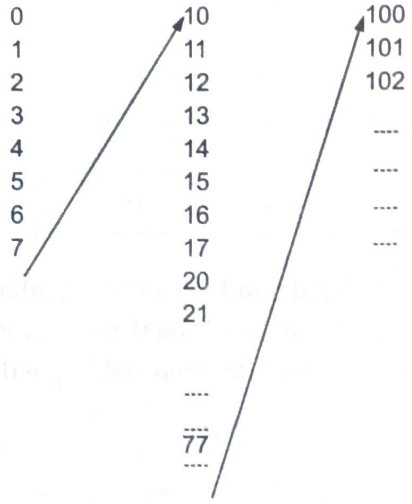


Fig. 2.5 Octal Counting

Octal Counting

Octal counting start from zero and goes to seven and then 7 is reseted to zero and next higher position is made one (See Fig. 2.5), hence n octal digit position can be used to do a maximum of 8^n counts.

Hexadecimal Number System

The base of hexadecimal number system is 16 and there are 16 symbols that is 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, *A*, *B*, *C*, *D*, *E*, *F*. Table 2.2 represents the relation between hexadecimal, decimal and binary numbers. Keep in mind that the hexadecimal digits (also called hexa digits) *A*, *B*, *C*, *D*, *E* and *F* represent 10, 11, 12, 13, 14 and 15 in hexadecimal system.

Table 2.2 Hexadecimal Number

Hexadecimal	Decimal	Binary
0	0	0 0 0 0
1	1	0 0 0 1
2	2	0 0 1 0
3	3	0 0 1 1
4	4	0 1 0 0
5	5	0 1 0 1
6	6	0 1 1 0
7	7	0 1 1 1
8	8	1 0 0 0
9	9	1 0 0 1
A	10	1 0 1 0
B	11	1 0 1 1
C	12	1 1 0 0
D	13	1 1 0 1
E	14	1 1 1 0
F	15	1 1 1 1

The positional value or weights of digit positions in hexadecimal are as follows:

16^3	16^2	16^1	16^0	•	16^{-1}	16^{-2}	16^{-3}	16^{-4}

So, the decimal equivalent of any hexadecimal number can be calculated by calculating the positional value of each digit (by multiplying the digit by its positional weight) and summing all the positional values. For example, the decimal equivalent of hexadecimal $(642)_{16}$ will be

$$(642)_{16} = 6 \times 16^2 + 4 \times 16^1 + 2 \times 16^0$$
$$= 6 \times 256 + 4 \times 16 + 2 \times 1$$
$$= 1536 + 64 + 2 = (1602)_{10}$$

Similarly,

$$(2AB)_{16} = 2 \times 16^2 + A \times 16^1 + B \times 16^0$$
$$= 2 \times 256 + 10 \times 16 + 11 \times 1$$
$$= 512 + 160 + 11 = (683)_{10}$$

Hexadecimal Counting

The hexadecimal counting starts from 0 moves to *F* and then *F* is reseted to zero and the next higher digit is made 1 (See Fig. 2.6).

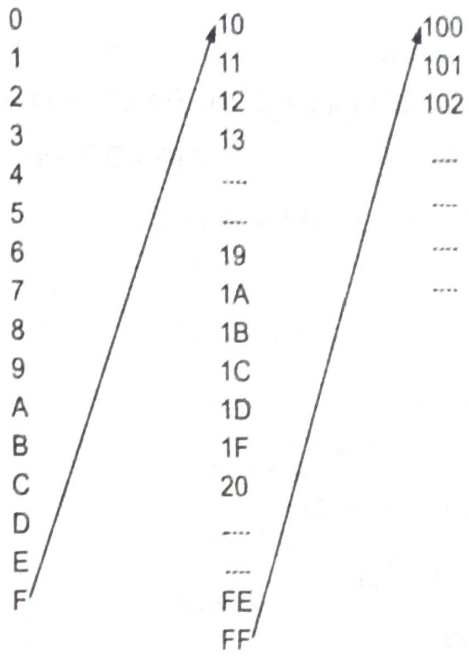


Fig. 2.6 Hexadecimal Counting

2.2 CONVERSION OF A NUMBER FROM ONE NUMBER SYSTEM TO ANOTHER

The following rules can be used to convert a number from one system to another:

(i) If a binary or octal or a hexadecimal number is to be converted to decimal then taken the weighted sum of each digit position (i.e., multiply each digit by its positional weight then sum these positional values).

(ii) When converting from decimal to binary (or octal or hex); divide the number repeatedly by 2 (or 8 or 16) and write the remainders in reverse order. This is known as double dabble method.

(iii) When converting from binary to octal (or hex), group the bits in group of 3 (or 4) and write the correct octal (or hexadecimal) number for each group.

(iv) When converting from octal (or hex), convert each digit into its 3-bit (or 4 bit) binary equivalent).

(v) When converting from octal to hex (or vice versa) first convert to binary and then convert the binary into desired number system.

The methods of using above rules given below:

(a) Binary to Decimal Conversion

Example 2.1. $(111010)_2 = (\_\_\_\_\_)_{10}$

Solution: $(111010)_2 = (1 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (0 \times 2^0)$

$= 32 + 16 + 8 + 0 + 2 + 0 = \mathbf{(58)_{10}}$

Example 2.2. $(111010.101)_2 = (\_\_\_\_\_)_{10}$

Solution: $(111010.101)_2 = (1 \times 2^5) + (1 \times 2^4) + (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1)$
$+ (0 \times 2^0) + (1 \times 2^{-1}) + (0 \times 2^{-2}) + (1 \times 2^{-3})$

$= 32 + 16 + 8 + 0 + 2 + 0.5 + 0 + 0.125$

$= \mathbf{(58.625)_{10}}$

(b) Octal to decimal conversion

Example 2.3. $(235)_8 = (\_\_\_\_\_)_{10}$

Solution: $(235)_8 = (2 \times 8^2) + (3 \times 8^1) + (5 \times 8^0)$

$= (2 \times 64) + (3 \times 8) + (5 \times 1)$

$= 128 + 24 + 5 = \mathbf{(157)_{10}}$

Example 2.4. $(347.25)_8 = (\_\_\_\_\_)_{10}$

Solution: $(347.25)_8 = (3 \times 8^2) + (4 \times 8^1) + (7 \times 8^0) + (2 \times 8^{-1}) + (5 \times 8^{-2})$

$= (3 \times 64) + (4 \times 8) + (7 \times 1) + (2 \times 0.125) + (5 \times 0.015625)$

$= 192 + 32 + 7 + 0.25 + 0.078125$

$= \mathbf{(231.328125)_{10}}$

(c) Hexadecimal to Decimal Conversion

Example 2.5. $(249)_{16} = (\_\_\_\_\_)_{10}$

Solution: $(249)_{16} = (2 \times 16^2) + (4 \times 16^1) + (9 \times 16^0)$

$= (2 \times 256) + (4 \times 16) + (9 \times 1)$

$= 512 + 64 + 9 = \mathbf{(585)_{10}}$

Example 2.6. $(6AB)_{16} = (\_\_\_\_\_)_{10}$

Solution: $(6AB)_{16} = (6 \times 16^2) + (10 \times 16^1) + (11 \times 16^0)$ $\{\because \quad A = 10, B = 11\}$

$= (6 \times 256) + (10 \times 16) + (11 \times 1)$

$= 1536 + 160 + 11 = \mathbf{(1707)_{10}}$

Example 2.7. $(235.17)_{16} = (\_\_\_\_\_)_{10}$

Solution: $(235.17)_{16} = (2 \times 16^2) + (3 \times 16^1) + (5 \times 16^0) + (1 \times 16^{-1}) + (7 \times 16^{-2})$

$= (2 \times 256) + (3 \times 16) + (5 \times 1) + (1 \times 0.0625) + (7 \times 0.0039)$

$= 512 + 48 + 5 + 0.0625 + 0.0273 = \mathbf{(565.0898)_{10}}$

Example 2.8. $(7A \cdot D)_{16} = (\_\_\_\_\_)_{10}$

Solution: $(7A \cdot D)_{16} = (7 \times 16^1) + (10 \times 16^0) + (13 \times 16^{-1})$

$= (7 \times 16) + (10 \times 1) + (13 \times 0.0625)$

$= 112 + 10 + 0.8125 = \mathbf{(122.8125)_{10}}$

Decimal to Binary Conversion

For converting a decimal number to its binary equivalent, the decimal number is repeatedly divided by 2 and the remainders are written in reverse order. For example—The decimal number 69 is converted into binary as follows:

$69 \div 2 = 34$	Remainder = 1
$34 \div 2 = 17$	Remainder = 0
$17 \div 2 = 8$	Remainder = 1
$8 \div 2 = 4$	Remainder = 0
$4 \div 2 = 2$	Remainder = 0
$2 \div 2 = 1$	Remainder = 0
$1 \div 2 = 0$	Remainder = 1

Write the remainders in reverse order.

Writing the remainders in reverse order, we get

$$(69)_{10} = (1000101)_2$$

Conversion of Fractional Part of a Decimal Number into Binary

If the decimal number has a fractional part also then take this fractional part separately and multiply it by 2. The fractional part of the product is again multiplied by 2 and this process goes on repeatedly. The integer part of products (i.e., the numbers appearing to the left of the point are written in direct order and a binary point is placed at the left most position to obtain the binary equivalent of fraction. For example the decimal number 0.625 can be converted into binary as shown below:

Fractional part	Product	Integer part of product	Fractional part of product
0.625×2	$= 1.250$	1	0.250
0.250×2	$= 0.500$	0	0.500
0.500×2	$= 1.000$	1	0.000
0.000×2	$= 0.000$	0	0.0000

Write the integer part of products in direct order

On writing the integer part of products in direct order

$$(0.625)_{10} = (0.1010)_2$$

If the decimal number has both the integer and fraction part then convert them separately and write them together after conversion.

Example 2.9. $(69.625)_{10} = (\_\_\_\_\_)_2$

Solution: $\because$ $(69)_{10} = (1000101)_2$

$$(0.625)_{10} = (0.1010)_2$$

Hence $(69.625)_{10} = (1000101.1010)_2$

Example 2.10. $(96)_{10} = (\_\_\_\_\_)_2$

Solution: On repeated division of 96 by 2

2	96	0
2	48	0
2	24	0
2	12	0
2	6	0
2	3	1
2	1	1
	0	

Writing the remainders in reverse order, we get,

$$(96)_{10} = (1100000)_2$$

Example 2.11. $(47.96)_{10} = (\_\_\_\_\_)_2$

Solution: On repeated division of 47,

2	47	1
2	23	1
2	11	1
2	5	1
2	2	0
2	1	1
	0	

Hence $(47)_{10} = (101111)_2$

On repeated multiplication of 0.96,

$$0.96 \times 2 = 1.92$$
$$0.92 \times 2 = 1.84$$
$$0.84 \times 2 = 1.68$$
$$0.68 \times 2 = 1.36$$
$$0.36 \times 2 = 0.72$$

Hence, $(0.96)_{10} = (0.11110)_2$

Hence, $(47.96)_{10} = (101111.11110)_2$

Note: If the repeated multiplication of the fractional part is non-terminating then you can stop after four or five multiplications.

Decimal to Octal Conversion

The rules of decimal to octal conversions are same as decimal to binary conversion but the repeated division is done by 8. In the same way, for fractional part the repeated multiplication is also done by 8.

Example 2.12. $(76)_{10} = (\_\_\_\_\_)_8$

Solution: On repeated division of 76 by 8

8	76	4
8	9	1
8	1	1
	0	

Hence $(76)_{10} = (114)_8$

Example 2.13. $(94.6)_{10} = (\_\_\_\_\_)_8$

Solution: First we will convert the integer part and the we will convert the fraction part separately. On repeated division of 94 by 8,

8	94	6
8	11	3
8	1	1
	0	

Hence $(94)_{10} = (136)_8$

Now multiplying 0.6 repeatedly by 8, we get

$0.6 \times 8 = 4.8$

$0.8 \times 8 = 6.4$

$0.4 \times 8 = 3.2$

$0.2 \times 8 = 1.6$

Hence $(0.6)_{10} = (0.4631)_8$

Hence $(94.6)_{10} = (136.4631)_8$

Decimal to Hexadecimal Conversion

The rule for decimal to hexadecimal conversion are also same as the rules for decimal to binary conversion but in this case the repeated division is done by 16. In the same way the repeated multiplication for fractional part is also done by 16. [Note that, if the remainder of repeated division (or the integer of the repeated multiplication) comes out to be 10 or greater than 10 then write it as *A*, *B*, *C*, *D*, *E*, *F* for 10, 11, 12, 13, 14, 15 respectively]

Example 2.14. $(99)_{10} = (\_\_\_\_\_)_{16}$

Solution: On repeated division of 99 by 16

16	99	3
16	6	6
	0	

Hence $(99)_{10} = (63)_{16}$

Example 2.15. $(250)_{10} = (\_\_\_\_\_)_{16}$

Solution:

16	250	*A*
16	15	*F*
	0	

Hence $(250)_{10} = (FA)_{16}$

Example 2.16. $(280.85)_{10} = (\_\_\_\_\_)_{16}$

Solution:

16	280	8
16	17	1
16	1	1
	0	

Hence $(280)_{10} = (118)_{16}$

$0.85 \times 16 = \mid D.6$

$0.6 \times 16 = \mid 9.6$

$0.6 \times 16 = \downarrow 9.6$

Hence, $(0.85)_{10} = (0.D99)_{16}$

Hence, $(280.85)_{10} = (118.D99)_{16}$

Example 2.17. $(96.8)_{10} = (\_\_\_\_\_)_{16}$

Solution:

16	96	0
16	6	6
	0	

Hence $(96)_{10} = (60)_{16}$

$0.8 \times 16 = \mid C.8$

$0.8 \times 16 = \downarrow C.8$

Hence, $(0.8)_{10} = (0.CC)_{16}$

Hence, $(96.8)_{10} = (60.CC)_{16}$

Binary to Octal Conversion

Use the given Table 2.3 for binary to octal (or octal to binary) conversion.

Table 2.3

Binary	Octal
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

For binary to octal conversion, group the bits in three. The digits to the left of octal point should be grouped separately starting from right and the digits to the right of octal point should be grouped separately starting from left. If the last group is incomplete then add zeros to the left of integer and to the right of fraction to complete the group.

Then write the equivalent octal number of each group using Table 2.3.

Example 2.18. $(1100111)_2 = (\quad)_8$

Solution: Group from right to left in three

$$(001\ 100\ 111)_2$$

Write the octal equivalent each group using Table 2.3.

Hence $(1100111)_2 = (147)_8$

Example 2.19. $(1110111.11001)_2 = (\quad)_8$

Solution: $(\underbrace{001}\ \underbrace{110}\ \underbrace{111}\cdot\underbrace{110}\ \underbrace{010})_2 = (167.62)_8$

(Note that to complete the incomplete groups two zeros are added to the left of integer and 1 zero to the right of fraction)

Binary to Hexadecimal Conversion

For converting binary to hexadecimal (or hexadecimal to binary) use Table 2.2.

For binary to hexadecimal conversion, group the bits in four. The digits to the left of octal point should be grouped separately starting from right and the digits to the right of octal point should be grouped separately starting from left. If the last group is incomplete then add zeros to the left of integer and to the right of fraction to complete the group.

Then write the equivalent octal number of each group using Table 2.2.

Example 2.20. $(1011111111000)_2 = (\ \ )_{16}$

Solution : Group the bits in four, starting from right to left.

$$(\underbrace{0001}\ \underbrace{0111}\ \underbrace{1111}\ \underbrace{1000})_2$$

Now write the hexadecimal equivalent of each group, using Table 2.2.

$$(17F8)_{16}$$

Hence $(1011111111000)_2 = (17F8)_{16}$

Example 2.21. $(111000 . 1110001)_2 = (\ \ )_{16}$

Solution: $(\underbrace{0011}\ \underbrace{1000} \cdot \underbrace{1110}\ \underbrace{0010})_2 = (38.E2)_{16}$

Octal to Binary Conversion

To convert octal number to binary number follow the reverse process of binary to octal i.e., write the equivalent three bit for each octal digit using Table 2.3.

Example 2.22. $(247)_8 = (\ \ )_2$

Solution: Use Table 2.4,

Octal	2	4	7
Binary	010	100	111

Hence $(247)_8 = (010100111)_2$

Example 2.23. $(34.77)_8 = (\ \ )_2$

Solution: Use Table 2.4,

Octal	3	4	7	7
Binary	011	100	111	111

Hence $(34.77)_8 = (011100.111111)_2$

Hexadecimal to Binary Conversion

To convert hexadecimal number to binary number follows the reverse process of binary to hexadecimal i.e., write the equivalent four bit for each hexadecimal digit using Table 2.2.

Example 2.24. $(1977)_{16} = (\ \ )_2$

Solution : Because

Hexadecimal	1	9	7	7
	↓	↓	↓	↓
Binary	0001	1001	0111	0111

Hence $(1977)_{16} = (0001100101110111)_2$

Since the three left most zeroes are insignificant, we can remove them. Hence,

$$(1977)_{16} = (1\ 1001\ 0111\ 0111)_2$$

Example 2.25. $(7A5.B2)_{16} = (\quad)_2$

Solution : From Table 2.2:

Hexadecimal	7	A	5	B	2
	↓	↓	↓	↓	↓
Binary	0111	1010	0101	1011	0010

Hence $(7A5.B2)_{16} = (0111\ 1010\ 0101.1011\ 0010)_2$

Octal to Hexadecimal Conversion

Firstly convert the given octal number to binary and then convert this binary number to hexadecimal.

Example 2.26. $(72.3)_8 = (\quad)_{16}$

Solution : From Table 2.3:

Octal	7	2	3
	↓	↓	↓
Binary	111	010	011

Hence $(72.3)_8 = (111010.011)_2$

Now grouping them in four:

$$(\underline{0011}\,\underline{1010}\cdot\underline{0110})_2 = (3A.6)_{16} \qquad \text{(See Table 2.2)}$$

Hence $(72.3)_8 = (3A.6)_{16}$

Hexadecimal to Octal Conversion

Firstly convert the given hexadecimal number to binary and then convert this binary number to octal.

Example 2.27. $(5B.23)_{16} = (\quad)_8$

Solution : Because

Hexadecimal	5	B	2	3
	↓	↓	↓	↓
Binary	0101	1011	0010	0011

Hence $(5B.23)_{16} = (01011011.00100011)_2$

Now grouping them in three:

$$(\underline{001}\,\underline{011}\,\underline{011}\cdot\underline{001}\cdot\underline{000}\,\underline{110})_8$$

Hence $(01011011.00100011)_2 = (133.106)_8$

Hence $(5B.23)_{16} = (133.106)_8$

Practice Questions

(*i*) $(25.25)_{10} = (\quad)_2$ (*ii*) $(75.27)_8 = (\quad)_2$

(*iii*) $(A5.7)_{16} = (\quad)_2$ (*iv*) $(23.24)_8 = (\quad)_{16}$

(*v*) $(23.51)_8 = (\quad)_{10}$ (*vi*) $(11110.11)_2 = (\quad)_{16}$

(*vii*) $(1101.010)_2 = (\quad)_{10}$ (*viii*) $(1010.10)_2 = (\quad)_8$

(*ix*) $(999.99)_{10} = (\quad)_{16}$ (*x*) $(725.4)_{10} = (\quad)_8$

(*xi*) $(A5.7)_{16} = (\quad)_{10}$ (*xii*) $(A7.B)_{16} = (\quad)_8$

2.3 BINARY ADDITION, SUBTRACTION, MULTIPLICATION AND DIVISION

Binary Addition

The rules of binary addition are:

$$0 + 0 = 0 \quad \text{...(2.1)}$$

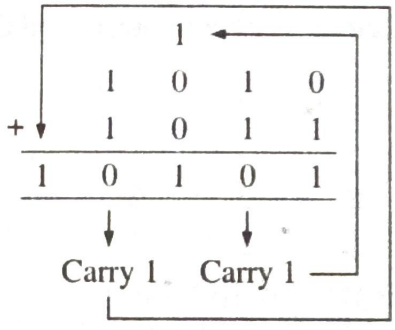
$$0 + 1 = 1 \quad \text{...(2.2)}$$

$$1 + 0 = 1 \quad \text{...(2.3)}$$

$$1 + 1 = 10 \quad \text{...(2.4)}$$

It is clear from equation 2.4 that 1 + 1 = 10, this means if a binary 1 is added to binary 1, we get 10 (because in binary 2 is written as 10). Also keep in mind that don't read 10 as ten but read it as one, zero because this is a binary number not a decimal number.

We can add any two binary numbers using these rules in the same way as we have added decimal numbers. Start from LSB and write the sum and if there is a carry then move it to the next higher position. For example, binary number 1010 can be added to another binary number 1011 as follows:



So on adding binary number 1010 to the binary number 1011 the sum is binary number 10101.

Do you want to check this answer whether it is correct or not? For this you can convert these numbers to their decimal equivalents.

Because $(1010)_2 = (10)_{10}$

$(1011)_2 = (11)_{10}$

$(10101)_2 = (21)_{10}$

As we know that on adding decimal number 10 and 11, we get 23, so its verified that the answer is correct.

Example 2.28. Add binary numbers 10101 and 11000

Solution:

	1 ← Carry					
		1	0	1	0	1
+		1	1	0	0	0
	1	0	1	1	0	1

Hence $10101 + 11000 = 101101$

Example 2.29. Add binary numbers 11100 and 10111

Solution:

	1	1	1 ← Carry			
		1	1	1	0	0
+		1	0	1	1	1
	1	1	0	0	1	1

Hence $11100 + 10111 = 110011$

Example 2.30. Add binary numbers 11111 and 111

Solution:

	1	1	1	1	1 ←	Carry
		1	1	1	1	1
+		0	0	1	1	1
	1	0	0	1	1	0

Hence $11111 + 111 = 100110$

Example 2.31. Add binary numbers 11.01 and 101.11

Solution:

	1	1	1	1	1 ←		Carry
			1	1	• 0	1	
+		1	0	1	• 1	1	
	1	0	0	1	• 0	0	

Binary Subtraction

The binary number can be subtracted by another binary number using the following rules:

$$0 - 0 = 0 \quad \text{...(2.5)}$$

$$0 - 1 = 1 \text{ (Borrow = 1)} \quad \text{...(2.6)}$$

$$1 - 0 = 1 \quad \text{...(2.7)}$$

$$1 - 1 = 0 \quad \text{...(2.8)}$$

The second rule of these (Equation 2.6) needs to be understood very carefully. When you do subtraction on de_imal numbers and you have to subtract a bigger number from a smaller what you do?

You borrow a number from next higher place and add to this to small number and then do the subtraction. Since the base of decimal number is 10 so, every time you borrow a 10 and add to the smaller number. For example to subtract 9 from 6, you borrow and add 10 to 6 to make it sixteen and after subtraction it becomes 16 – 9 = 7.

In case of binary number to borrow is two instead of 10. So for doing 0 – 1 you borrow 2 from next higher position and 2 + 0 = 2 so 2 – 1 = 1. Another way to understand this is that when a number is borrowed 0 becomes 10 and when 1 is subtracted from 10 we get 1.

Also keep in mind that the number from which borrow is taken also decreases by 1.

For example—The binary number 1011 can be subtracted from binary number 1101 as follows:

Borrow

$$\begin{array}{rcccc} & & 0 & 1 & \\ & 1 & \not{1} & 0 & 1 \\ - & 1 & 0 & 1 & 1 \\ \hline & 0 & 0 & 1 & 0 \end{array}$$

Understand this binary subtraction very carefully. In the second bit position 1 has to be subtracted from 0. For this a borrow is taken from the third position so it becomes 0 then the subtraction is done using rules given in 2.5 to 2.8.

Example 2.32. $(110.01)_2 - (101.1)_2 =$ _____.

Solution:

$$\begin{array}{rcccccc} & & 0 & 1 & 1 & & \\ & 1 & \not{1} & \not{0} & \cdot & 0 & 1 \\ - & 1 & 0 & 1 & \cdot & 1 & 0 \\ \hline & 0 & 0 & 1 & \cdot & 1 & 1 \end{array}$$

Example 2.33. $(10000)_2 - (11)_2 =$ _____.

Solution:

$$\begin{array}{rccccc} & 1 & 1 & 1 & 1 & \\ & \not{1} & \not{0} & \not{0} & \not{0} & 0 \\ - & 0 & 0 & 0 & 1 & 1 \\ \hline & 0 & 1 & 1 & 0 & 1 \end{array}$$

Note: As a precaution, always check the difference by adding it to subtrahend to get the minuend. Lets check this result:

$$\begin{array}{r} 01101 \\ +\,00011 \\ \hline 10000 \end{array}$$

Hence, the answer is verified.

Binary Multiplication

The method for binary multiplication are same as decimal multiplication. The rules for binary multiplication are:

$$0 \times 0 = 0$$
$$0 \times 1 = 0$$
$$1 \times 0 = 0$$
$$1 \times 1 = 1$$

Example 2.34: Find the product of binary numbers 1011 and 110.

Solution:

```
      1  0  1  1      (multiplicant)
   ×  1  1  0        (multiplier)
   ----------
      0  0  0  0
   1  0  1  1
1  0  1  1
-------------------
1  0  0  0  0  1  0   (product)
```

Example 2.35. $(1.01)_2 \times (10.1)_2 =$ ——

Solution:

```
      1  0  1
      1  0  1
      ---------
      1  0  1
   0  0  0
1  0  1
-------------
1  1  0  0  1
```

Hence $(1.01)_2 \times (10.1)_2 = (11.001)_2$

(Note that the decimal points has been put three places from the right.)

> Note that in a binary subtraction if you take a burrow from, a next higher 1, than this next higher 1 will become zero. However, if you are borrowing from a next higher 0, then before borrowing, this next higher zero will again take a borrow from its next higher bit, so it will become 10, and then after giving a borrow it will become 10 – 1 = 1.

Binary Division

The Binary division is same as decimal division. The rules of binary division are as follows:

$0 \div 1 = 0$ (remainder 1)

$1 \div 1 = 1$ (remainder 0)

Note that zero cannot be divided by any number.

Example 2.36. Divide the binary number 1100111 by 101.

Solution:

```
          10100 ──► quotient
     101 )1100111(
          101
          ───
           010
           000
           ───
            101
            101
            ───
             01
             00
             ──
              11
              00
              ──
              11 ──► Remainder
```

Example 2.37. Divide the binary number 10011100 by 1100.

Solution:

```
          1101 ──► quotient
    1100 )10011100(
          1100
          ────
           1111
           1100
           ────
            110
            000
            ───
             1100
             1100
             ────
               × ──► Remainder
```

Example 2.38: $(1100.11)_2 + (10)_2 =$ __________.

Solution:

```
          110.011
      10 )1100.11(
          10
          ──
           10
           10
           ──
            00
            00
            ──
             11
             10
             ──
              10
              10
              ──
               ×
```

Practice Questions

(*i*) 10101.110 + 101.01 = (*ii*) 1011.1 – 101.01 =

(*iii*) 101.11 × 10.11 = (*iv*) 10101.1 + 11.01 =

2.4 COMPLEMENT OF A NUMBER

Negative Numbers

Generally, a minus sign is placed before a number to represent a negative number. For example, negative 32 is represented as –32.

In digital machines, the negative numbers are stored as complements. Using this technique both the addition and subtraction operations can both be done using addition circuits.

Complement Types

For any number system, two types of complement are defined:

Radix complement and radix-1 complement.

For example, decimal number can have 10's complement and 9's complement, binary number system can have 2's complement and 1's complement, octal number system can have 8's complement and 7's complement and hexadecimal number system can have 16's complement and 15's complement.

Even if the base is other than these popular bases, then also you can define the complement for example, if the base is 5 you can define 5's complement and 4's complement.

Radix Complement or True Complement

To find this complement, subtract each digit by radix-1 (9 in the decimal system and 1 in the binary system) and add 1 to the least significant digit. In the decimal number system the true complement is the 10's complement while in the binary number system it is called 2's complement. In other words, given a positive number N in base r, with integer part of n digits, the r's complement of the number is defined as $r^n - N$ for $N \neq 0$ and 0 for $N = 0$.

Radix Minus—One Complement

To find radix-minus—one complement subtract each digit from radix-minus one (i.e., 9 in the decimal system and 1 in the binary system). In decimal system radix-minus-one complement means 9's complement and in binary system it means 1's complement.

In other word, given a positive number N in base r with integer part of n digits and a fraction part of m digits, the $(r - 1)$'s complement is defined as $r^n - r^{-m} - N$.

Example 2.39. Find the 9's and 10's complement of decimal number 76.

Solution: To find 9's complement of 76 subtract each digit from 9.

Decimal Number = 76

9's Complement = 23.

To find 10's complement of 76 subtract each digit from 9 and then add one to the LSD

Decimal number = 76

9's Complement = 23

+ 1

10's Complement 24

Example 2.40. Find the 9's complement and 10's complement of $(253.56)_{10}$

Solution:

Decimal number = 253.56

9's complement = 746.43

+1

10's complement 746.44

Example 2.41. Find 1's complement and 2's complement of $(1110010)_2$

Solution: To find 1's complement of a binary number subtract each bit from 1 (or in other words change each 1 to 0 or 0 to 1). To find the 2's complement. Add 1 to the LSB of 1's complement.

Given

Binary number = 1110010

1's complement = 0001101

+ 1

2's Complement 0001110

Example 2.42: Find 1's and 2's complement of $(101110.1101)_2$

Solution :

Binary number = 101110.1101

1's complement = 010001.0010

+ 1

2's complement 010001.0011

1's and 2's Complement Method of Subtraction

Note that in the process of subtraction, the number from which the other number is subtracted is called the minuend and the number which is subtracted is called the subtrahend. For example, if you want to subtract *B* from *A* means you want to find $A - B = C$, then *A* is the minuend *B* is the subtrahend and the answer you get after subtraction i.e. *C* is called the difference. So, in other words we can say that minuend – subtrahend = difference.

2's Complement Method of Subtraction

Suppose you want to subtract *B* from *A* (i.e., you want to find $A - B$). Here as *A* is the minuend and *B* is the subtrahend, so the following process should be followed for 2's complement method of subtraction:

(*i*) Find the 2's complement of subtrahend (i.e. *B*)

(*ii*) Add the minuend to the 2's complement of subtrahend obtained in step (1) (i.e. find *A* + 2's complement of *B*).

(*iii*) One of the two conditions may arise when you do the addition i.e. end carry may occur or end carry may not occur (the carry at the MSB after adding 2 numbers is called the end carry) for example if the addition of 4 bit number gives a fifth bit, then this fifth bit is called end carry.

(*a*) If end carry occurs then reject this end carry and represent the answer by the remaining bits. Place a positive sign before the answer.

(*b*) If end carry does not occurs then again find the 2's complement of the sum of *A* and 2's complement of *B* which was obtained in step (2). This is the final answer, place a negative sign before answer.

The subtraction of two positive numbers $(A - B)$ both of base *r*, using *r*'s complement method may be done as follows:

(*i*) Add the minuend *A* to *r*'s complement of subtrahend *B*.

(*ii*) Inspect the result obtained in step (*i*) for an end carry:

(*a*) If an end carry occurs, discard it.

(*b*) If an end carry does not occurs, take the *r*'s complement of the number obtained in step (*i*) and place a negative sign in front of the *r*'s complement obtained.

Example 2.43: Solve the following binary subtraction using 2's complement method.

(*i*) 1101011 – 1011000

(*ii*) 1101 – 1000

(*iii*) 1000 – 1101

Solution:

$A = 1101011$

$B = 1011000$

1's complement of $B = 0100111$

$+ 1$

2's complement of $B = 0101000$

$A = 1101011$

2's complement of $B + 0101000$

10010011

Since end carry occurs, so discard it, and take the answer as positive.

Hence $1101011 - 1011000 = 0010011$

(*ii*) 1101 – 1000

$A = 1101$

$B = 1000$

1's complement of B $= 0111$

$+ 1$

2's complement of B $= 1000$

$A = 1101$

2's complement of B $+ 1000$

10101

Since end carry occurs, reject this end carry and take the answer as positive.

$1101 - 1000 = 0101$

(*iii*) $A = 1000$

$B = 1101$

1's complement of B $= 0010$

$+1$

2's complement of B $= 0011$

$A = 1000$

2's complement of B $+ 0011$

1011

Since end carry does not occur, so we have to again take the 2's complement of this sum and this.

1's complement of 1011 0100

$+ 1$

2's complement of 1011 0101

Hence $1000 - 1101 = -0101$

Example 2.44: Perform the following binary subtractions using 2's complement method.

(*i*) 0.111 – 0.1001

(*ii*) 11.11 – 101.01101

Solution: (*i*) $A = 0.111$

$B = 0.1001$

1's complement of B $= 1.0110$

$+1$

2's complement of B $= 1.0111$

Hence $A = 0.0111$

2's complement of B $= +1.0111$

10.0101

Rejecting end carry.

Hence $0.111 - 0.1001 = 0.0101$

(*ii*)

$A =$ 11.11

$B =$ 101.01101

1's complement of B $=$ 010.10010

$+1$

2's complement of B $=$ 010.10011

Hence $A =$ 11.11

2's complement of B $= +010.10011$

110.01011

No end carry, take 2's complement of the sum, put negative sign.

Hence

1's complement of 110.01011 = 001.10100

$+1$

2's complement of 110.01011 = 001.10101

Hence

$$11.11 - 101.01101 = -001.10101$$

1's Complement Method of Substraction

Suppose we want to subtract B from A means B is the subtrahend and A is the minuend, then the following step must be followed for subtraction using 1's complement.

(*i*) Find the 1's complement of subtrahend (i.e., B).

(*ii*) Add the 1's complement of B to A (minuend) means find A + 1's complement of B. One of the two conditions will arise i.e. carry may occur or carry may not occur.

(*a*) If end carry occurs then add this end carry to LSB of the sum obtained in step (*ii*). This is the final answer. Place a positive sign before the answer.

(*b*) If end carry does not occurs then again find the 1's complement of the sum of A and 1's complement of B which was obtained in step (*a*). This is final answer, place a negative sign before the answer.

The substraction of two positive numbers $(A - B)$, both of base r, using $(r - 1)$'s complement may be done as follows:

(*i*) Add the minuend A to the $(r - 1)$'s complement of the subtrahend B

(*ii*) Inspect the result obtained in step (i) for end carry:

(*a*) If an end carry occurs, add 1 to least significant digit (end around carry).

(*b*) If an end carry does not occur, again take the $(r - 1)$'s complement of the sum obtained in step (*i*) and place a negative sign in front of the complement obtained to get the final answer.

Example 2.45: Perform the following binary subtractions using 1's complement method:

(*i*) 1101011 – 1011000

(*ii*) 1101 – 1000

(*iii*) 1000 – 1101

Solution: (*i*)

$A = 1101011$

$B = 1011000$

Hence A = 1's complement of B

```
  1101011
+ 0100111
----------
  10010010
+        1
----------
  0010011
```

Since we obtained an end around carry, so this end around carry have been added to the LSB to get the final answer.

Hence $1101011 - 1011000 = 0010011$

(*ii*)

$A =$ 1101

$B =$ 1000

Hence A = B complement 1's

End around carry

```
  1101
+ 0111
------
  10100
+    1
------
  0101
```

Hence $1101 - 1000 = 0101$

(*iii*)

$A = 1000$

$B = 1101$

Hence A = 1's complement of B

```
  1000
+ 0010
------
  1010
```

Since no end around carry occurs, so we have to again take the 1's complement of the sum obtained and place a negative sign before this 1's complement to get the final answer.

1's complement of $1010 = 0101$

Hence $1000 - 1101 = -0101$

Example 2.46: Subtract the following using 1's complement method:

(*a*) 1011.101 – 1000.011

(*b*) 11011.001 – 11100.110

Solution: (*a*)

$A =$ 1011.101

$B =$ 1000.011

1's complement of B = 0111.100

A = 1011.101

1's complement of $A + B$ = 10011.001

+ 1

0011.010

Hence 1011.101 – 1000.011 = 0011.010

(*b*) A = 11011.001

B = 11100.110

1's complement of B = 00011.001

A = 11011.001

1's complement of $A + B$ 11110.010

Since no end around carry occurs, so we have to again take the 1's complement of the sum obtained and place a negative sign before this 1's complement to get the final answer.

Hence 11011.001 – 1100.110 = – 00001.101

Practice Questions

(*a*) Subtract the given binary numbers using 1's and 2's complement method:

(*i*) 1101.101 – 101.11 **(*ii*) 1011.10 – 1.101**

(*iii*) 101.10 – 11101.1 **(*iv*) 1010101 – 0.101**

(*v*) 1 – 0.1111 **(*vi*) 0.1111 – 1**

(*b*) Subtract the given decimal numbers using 9's and 10's complement method.

(*i*) 78 – 26 **(*ii*) 25 – 72**

(*iii*) 75.26 – 25.7 **(*iv*) 199 – 2.76**

(*v*) 1 – 0.999 **(*vi*) 0.999 – 1**

(*c*) Subtract using 15's complement method.

(*i*) $(ECD)_{16} - (EDC)_{16}$ **(*ii*) $(EDC)_{16} - (ECD)_{16}$**

(*d*) Subtract using 5's complement method.

(*a*) $(214)_5 - (214.23)_5$ **(*b*) $(214.23)_5 - (214)_5$**

(*c*) $(214)_6 - (214.23)_6$ **(*d*) $(214.23)_6 - (214)$**

(*e*) $(12345)_6 - (54321)_6$

(*e*) Subtract using 16's complement method.

(*i*) $(BAD)_{16} - (BAD.BAD)_{16}$ **(*ii*) $(BAD.BAD)_{16} - (BAD)_{16}$**

Use of 2's Complement Numbers for Storing Negative Numbers in Computers

The 2's complement method of representing numbers is commonly used in microprocessor-based systems. Uptil now, we have assumed that all numbers are positive. However, microprocessors should process both positive and negative numbers. By using 2's complement representation, the sign as well as the magnitude of a number can be determined.

Assume a microprocessor register 8-bit wide as that shown in Fig. 2.7(a). The most significant bit (MSB) is the sign bit. If this bit is 0, then the number is positive. However, if the sign bits is 1, then the number is negative. The other 7 bits in this 8-bit register represent the magnitude of the number.

Table 2.4(a) and (b) show the 2's complement representations for some positive and negative numbers. For example, +127 is represented by the 2's complement number 01111111. A decimal –128 is represented by the 2's complement number 10000000. You can see that the 2's complement representations for all positive values are the same as the binary equivalents for that decimal number.

Let us convert the signed decimal –3 to a 2's complement number.

- Separate the sign and magnitude part of –3. The negative sign means the sign bit will be 1 in the 2's complement representation.
- Convert decimal 3 to its 7-bit binary equivalent i.e. decimal 3 equals 0000011 in binary.
- Convert binary 0000011 to its 1's complement form i.e. binary 0000011 equals 1111100 in 1's complement.
- Convert the 1's complement to its 2's complement form i.e. 1111101.
- The 7-bit 2's complement number (1111101 in this example) becomes the magnitude part of the entire 8-bit 2's complement number (check the answer from Table 2.4).

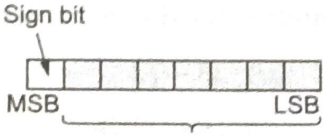


Fig. 2.7 MSB represents the sign of the number

Table 2.4 (a) 2's complement representations of positive numbers

Signed decimal	8-bit 2's complement representation			
+127	0	111	1111	
+126	0	111	1110	
+125	0	111	1101	
⋮	⋮	⋮	⋮	
+ 4	0	000	0100	same as positive binary numbers
+ 3	0	000	0011	
+ 2	0	000	0010	
+ 1	0	000	0001	
+ 0	0	000	0000	

Table 2.4 (b) 2's complement representations of negative numbers

Signed decimal	8-bit 2's complement representation		
– 1	1	111	1111
– 2	1	111	1110
– 3	1	111	1101
– 4	1	111	1100
⋮	⋮	⋮	⋮
– 126	1	000	0010
– 127	1	000	0001
– 128	1	000	0000

} represented in 2's complement form

The result is that the signed decimal –3 equals 1111 1101 in 2's complement notation. The 2's complement number is shown in the register in Fig. 2.8.

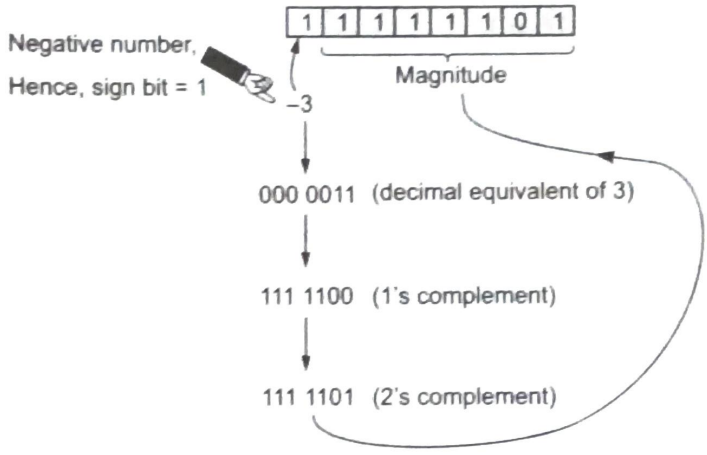


Fig. 2.8 Converting a negative decimal number in 2's complement form

Reverse the process and convert the 2s complement 1111 1001 to a signed decimal number.

- Separate the sign bit from the magnitude part of the 2s complement number. The MSB is a 1; therefore, the sign of decimal number will be negative.
- Take the 1s complement of the magnitude part i.e. 0000110.
- Add +1 to the 1s complement number i.e. 0000111. The 7-bit number 0000111 is now in binary.
- Convert the binary number to its decimal equivalent. This is –7.

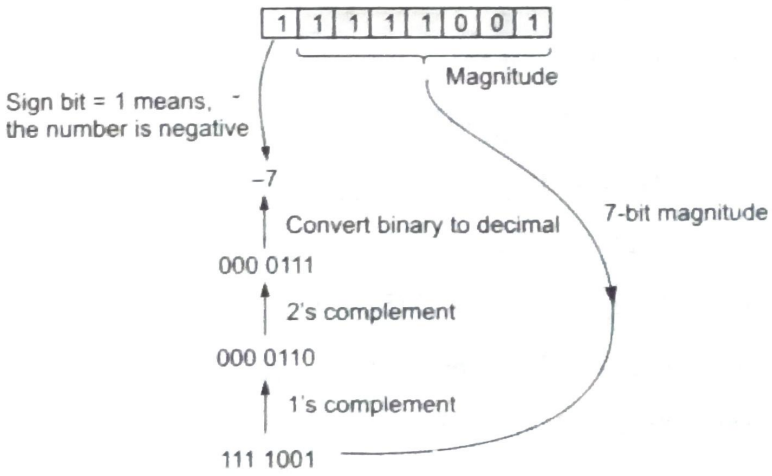


Fig. 2.9 Converting a 2's complement negative number to its signed decimal equivalent

Some Tips for Addition and Subtraction in Other Bases:

If you add two numbers in decimal, and the sum is more than 10, then you subtract 10 from it and send one carry to the higher position! Why? Because you are working in base 10. For example, 9 + 6 = 15, now you write 5 and send a carry to next higher position. Similarly, if you are working in some other base and the sum is more than the base, then subtract the base and send a carry to higher position. Similarly, during subtraction, if you are borrowing from the next higher position, you have to add the base and complete the subtraction process.

Let us understand using a few examples:

(i)
$$\begin{array}{r} 1 \\ (2\ 5)_8 \\ +\ (3\ 5)_8 \\ \hline 6\ 2 \end{array}$$
5 + 5 = 10
and 10 – 8 = 2

(ii)
$$\begin{array}{r} (2\ 8)_{16} \\ +\ (4\ 9)_{16} \\ \hline 7\ 1 \end{array}$$
9 + 8 = 17
and 17 – 16 = 1

(iii)
$$\begin{array}{r} 4 \\ (5\ 5)_8 \\ -\ (2\ 7)_8 \\ \hline 2\ 6 \end{array}$$
8 added to 5 give 13
and 13 – 7 = 6

Practice Questions

(*i*) $(2335)_8 + (45676)_8 = (\_\_\_\_)_8$

(*ii*) $(99.99)_{16} + (99.99)_{16} + (99.99)_{16} = (\_\_\_\_)_8$

(*iii*) $(2A)_{16} + (3B)_{16} + (4C)_{16} + (5D)_{16} + (6E)_{16} + (7F)_{16} = (\_\_\_\_)_{16}$

(*iv*) $(555)_8 - (16)_8 = (\_\_\_\_)_8$

(*v*) $(ABC)_{16} - (BAC)_{16} = (\_\_\_\_)_{16}$

(*vi*) $(EDC.ECD)_{16} - (ECD.FDC)_{16} = (\_\_\_\_)_{16}$

(*vii*) $(BED.BED)_{16} - (ABC)_{16} = (\_\_\_\_)$

(*viii*) $(252)_6 - (123.32)_6 = (\_\_\_\_)_6$

(*ix*) $(123)_6 + (234)_6 + (345)_6 = (\_\_\_\_)_6$

(*x*) $(88)_9 + (77)_9 + (66)_9 = (\_\_\_\_)_9$

(*xi*) $(88)_9 + (44)_9 + (55)_9 = (\_\_\_\_)_{10}$

NUMERICAL EXAMPLES

Example 1. Convert the following numbers from one number system to other as directed:

(*a*) $(1110.11)_2$ = ( )$_{10}$
(*b*) $(237.24)_8$ = ( )$_{10}$
(*c*) $(3A.B2)_{16}$ = ( )$_{10}$
(*d*) $(24.25)_{10}$ = ( )$_2$
(*e*) $(32.41)_{10}$ = ( )$_8$
(*f*) $(251.4)_{10}$ = ( )$_{16}$
(*g*) $(11110011.1101)_2$ = ( )$_8$
(*h*) $(1101011011.11011)_2$ = ( )$_{16}$
(*i*) $(74.43)_8$ = ( )$_2$
(*j*) $(2A.5)_{16}$ = ( )$_2$
(*k*) $(72.5)_8$ = ( )$_{16}$
(*l*) $(52.AB)_{16}$ = ( )$_8$

Solution: (*a*) $(1110.11)_2 = 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 + 1 \times 2^{-1} + 1 \times 2^{-2}$

$= 8 + 4 + 2 + 0 + 0.5 + 0.25$

$= (14.75)_{10}$

(*b*) $(237.24)_8 = 2 \times 8^2 + 3 \times 8^1 + 7 \times 8^0 + 2 \times 8^{-1} + 4 \times 8^{-2}$

$= 128 + 24 + 7 + 0.25 + 0.0625 = (159.3125)_{10}$

(*c*) $(3A.B2)_{16} = 3 \times 16^1 + 10 \times 16^0 + 11 \times 16^{-1} + 2 \times 16^{-2}$

$= 48 + 10 + 0.6875 + 0.0078125$

$= (58.695313)_{10}$

(*d*)

2	24	0
2	12	0
2	6	0
2	3	1
2	1	1
	0	

$0.25 \times 2 = 0.50$
$0.50 \times 2 = 1.00$
$0.00 \times 2 = 0.00$

$(24)_{10} = (11000)_2$, $(0.25)_{10} = (0.010)_2$

Hence $(24.25)_{10} = (11000.010)_2$

(*e*)

8	32	0
8	4	4
	0	

$0.41 \times 8 = 3.28$
$0.28 \times 8 = 2.16$
$0.16 \times 8 = 1.28$
$0.28 \times 8 = 2.24$

$(32)_{10} = (40)_8$, $(0.41)_{10} = (0.3212)_8$

Hence $(32.41)_{10} = (40.3212)_8$

(*f*)

16	251	*B*
16	15	*F*
	0	

$0.4 \times 16 = 6.4$
$0.4 \times 16 = 6.4$

$$(251)_{10} = (FB)_{16}, (0.4)_{10} = (0.66)_{16}$$

Hence $(251.4)_{10} = (FB.66)_{16}$

(*g*) $(011\,110\,011 \cdot 110\,100)_2 = (363.64)_8$

(*h*) $(0011\,0101\,1011 \cdot 1101\,1000)_2 = (35B.D8)_{16}$

(*i*) $(74.43)_8 = (011\,100 \cdot 100\,011)_2$

(*j*) $(2A.5)_{16} = (00101010.0101)_2$

(*k*) $(72.5)_8 = (0011\,1010 \cdot 1010)_2 = (3A.A)_{16}$

(*l*) $(52.AB)_{16} = (001\,010\,010.101\,010\,110)_2 = (122.526)_8$

Example 2. Solve the following:

(*a*) 1101.110 + 100.101 **(*b*) 1011.10 – 1001.01**

(*c*) 110.10 × 11.10 **(*d*) 111100 + 101**

Solution:

(*a*) Carry → 1111
1101.110
+ 100.101
10010011

(*b*) Borrow → 01
1011.10
–1001.01
0010.01

(*c*)
110.11
11.10
000 00
1101 1
11011
+ 11011
1011110.10

(*d*) 101) 111100 (1100
101
101
101
0
0
0
0
×

Example 3. If $(215)_x = (110)_{10}$, find the value of *x*.

Solution: Given

$$(215)_x = (110)_{10}$$

Hence,

$$2x^2 + x + 5 = 110$$
$$2x^2 + x - 105 = 0$$
$$\Rightarrow \quad 2x^2 - 14x + 15x - 105 = 0$$

$\Rightarrow \quad 2x(x-7)+15(x-7)=0$

$\Rightarrow \quad x-7=0 \quad \text{or} \quad 2x+15=0$

$\Rightarrow \quad x=7 \quad \text{or} \quad x=\dfrac{-7}{2}$

Since base of a number cannot be fractional or negative, hence

$$\boxed{x=7}$$

EXERCISES

1. (*a*) What do you mean by a number system? What is the base of the number system? How are decimal number converted to other number systems.

(*b*) Explain decimal, binary, octal and hexadecimal number systems and their interconversion.

(*c*) Explain the method to convert decimal, octal and hexadecimal numbers to binary and vice versa.

(*d*) Explain the addition, subtraction, multiplication and division of binary numbers.

(*e*) Explain 1's and 2's complement methods to subtract one binary number from other.

2. Convert the following binary numbers to decimal.

(*a*) 10110 (*b*) 1111010111 (*c*) 100100100111001

(*d*) 110110.10101 (*e*) 10101.01010 (*f*) 1010111.11

3. Convert the following decimal numbers to binary.

(*a*) 37.45 (*b*) 73.22 (*c*) 111.11

(*d*) 101.010 (*e*) 298.29 (*f*) 756.82

4. Convert the following from one number system to other.

(*a*) $(1101.11)_2 = (\quad)_8 = (\quad)_{16}$

(*b*) $(75.43)_{10} = (\quad)_2 = (\quad)_8 = (\quad)_{16}$

(*c*) $(8B.A2)_{16} = (\quad)_2 = (\quad)_8$

(*d*) $(75.92)_{16} = (\quad)_{10} = (\quad)_8$

(*e*) $(11101.110)_8 = (\quad)_2 = (\quad)_{16}$

(*f*) $(2C0.B)_{16} = (\quad)_{10} = (\quad)_8$

(*g*) $(3E1C)_{16} = (\quad)_{10}$

(*h*) $(25)_7 = (\quad)_{10}$

(*i*) $(29)_{10} = (\quad)_5$

(*j*) $(59)_{10} = (\quad)_6$

(*k*) $(35)_9 = (\quad)_4$

5. Perform the following operations on the given binary numbers.

(*a*) 1101.1 + 1011.1 (*b*) 1100.011 + 1011.011

(*c*) 11111.11 + 10101.1 (*d*) 111.11 − 101.1

(*e*) 1101.1 − 1010.01 (*f*) 11.11 − 10.111

(*g*) 1010.11 × 10.1 (*h*) 11.101 × 11.01

(*i*) 101010 ÷ 101.1 (*j*) 1110001.10 ÷ 11.01

6. Solve using 1's complement method and 2's complement method.
   (*a*) 1101.11 – 101.1 (*b*) 11.101 – 11.01
   (*c*) 1.1 – 11.101 (*d*) 1.111 – 111.1
7. Subtract using 9's complement method and 10's complement method.
   (*a*) 78.25 – 23.52 (*b*) 99.13 – 22.87
   (*c*) 72.65 – 95.9 (*d*) 3.8 – 125.92
8. Fill in the blanks.
   (*a*) $(100101)_2 + (101.101)_2 = (\ )_8$
   (*b*) $(0FAC)_{16} + (382.F)_{16} = (\ )_{10}$
   (*c*) $(1.98)_{10} + (1.98)_{16} = (\ )_8$
   (*d*) $(101)_2 + (101)_8 + (101)_{10} = (\ )_{16}$
   (*e*) $(783)_{10} + (783)_8 = (\ )_2$
9. (*a*) Convert $(1100.11)_2$ to decimal.
   (*b*) Solve 1111011 + 1001
10. Find x, such that
    $(211)_x = (152)_8$ (**Hint:** $2x^2 + x + 1 = 1 \times 8^2 + 5 \times 8 + 2$)
11. Convert $(5EF7)_{16}$ to decimal.
12. A man has 11 fingers in his hand. If he is counting using his fingers, what will be his count if an ordinary man counts 20.
13. Fill in the blanks:
    (i) $(12)_3 + (12)_4 + (12_5) + (12)_6 = (\ )_7$
    (ii) $(25)_{10} - (25)_8 = (\ )_{16}$
    (iii) $(99)_{16} - (99)_{15} = (\ )_8$
    (iv) $(222)_{15} - (222)_{10} = (\ )_2$
    (v) $(ABCD)_{16} + (ABC.D)_{16} + (AB.CD)_{16} + (A.BCD)_{16} + (0.ABCD)_{16} = (\ )_{16}$
14. Subtract using 5's complement method: $(234)_6 - (155)_6$
15. Convert the binary:
    (i) $(25)_{10}$ (ii) $(25)_8$ (iii) $(25)_{16}$ (iv) $(25)_9$ (v) $(25)_{11}$
16. While taking the viva, I asked a student to convert $(29)_8$ to decimal she did it like this:

$$(29)_8 = 9 \times 8^0 + 2 \times 8^1 = 9 + 16 = (25)_{10}$$

Now I asked her to convert this back to octal and she did it like this:

8	25	1 ↑
8	3	3
	0	

$$(25)_{10} = (31)_8$$

Now, I asked that is the decimal equivalent of $(29)_8$ came to be 25, then while the octal equivalent of $(25)_{10}$ came equal to $(31)_8$ and not $(29)_{10}$. She said that there might be some calculation mistake! Is really there some calculation mistake or there is some other problem!

❑❑❑

3 Chapter

DOS & WINDOWS OPERATING SYSTEMS

THINK ABOUT IT

There are two types of seeds in the mind: those that create anger, fear, frustration, jealousy, hatred and those that create love, compassion, equanimity and joy. Spirituality is germination and sprouting of the second group and transforming the first group.

— Amit Ray

3.1 INTRODUCTION

As you know that Operating system is the heart of softwares and application which typically runs on a machine. It has a lot of benefits and importance from technical point of view. The operating system sits on top of a physical system and talks to the hardware. This insulates application software from many hardware implementation details. This provides more freedom to innovate in hardware because it's the operating system that shoulders most of the responsibilities of supporting new processors and other aspects of the server design and hence reduces the tensions of the programmers.

The operating system specifically the kernel performs common tasks that applications require i.e. it manages process scheduling, power management, root access permissions, memory allocation, and all the other low-level housekeeping and operational details needed to keep a system running efficiently and securely.

The operating system serves as the interface to both its own programs and utilities such as logging, performance profiling etc. and also to the applications that a user has written.

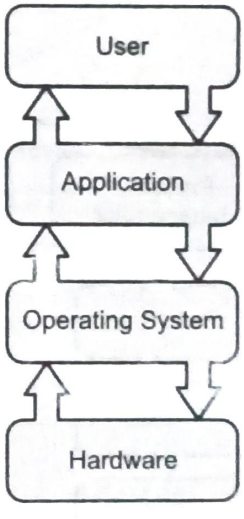


Fig. 3.1 Operating system is a system software program that enables the computer hardware to communicate and operate with the application software and the user

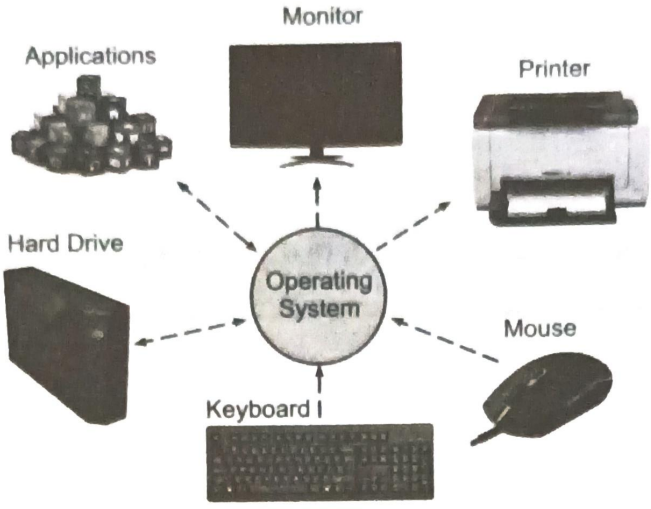


Fig. 3.2 Coordination and control of various input and output devices is an important function of the operating system

Operating system manages many tasks such as:

- Memory management
- Device management
- Process management
- File management
- Network and Security
- Error and Bug

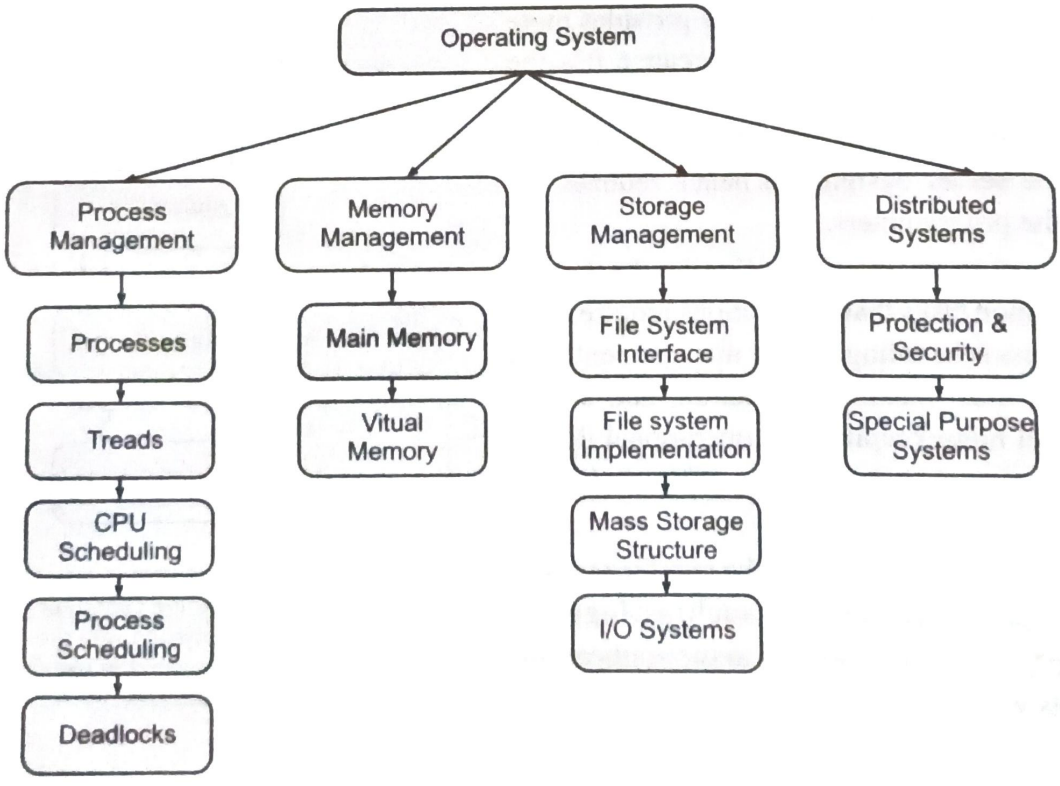


Fig. 3.3 Operating system manages many tasks

3.2 HARDWARE AND SOFTWARE

A computer system consists of two major elements: hardware and software. Computer hardware is the collection of all the parts you can physically touch i.e. the parts which can be physically touched are referred to as hardware. Computer software are programs i.e. something you cannot touch. Software is a set of instructions for a computer to perform specific operations. You need both hardware and software for a computer system to work. In simple language, what you can touch i.e. the physical components are referred to as hardware and the instructions and programs i.e. the non physical part that cannot be touched but only can be felt is referred to as software. As an analogy , you can understand it like that: if a flower is considered a hardware than its fragrance is like a software! Do you agree?

- All software utilizes at least one hardware device to operate.
- Word processing softwares use the computer processor, memory, and hard drive to create and save documents.

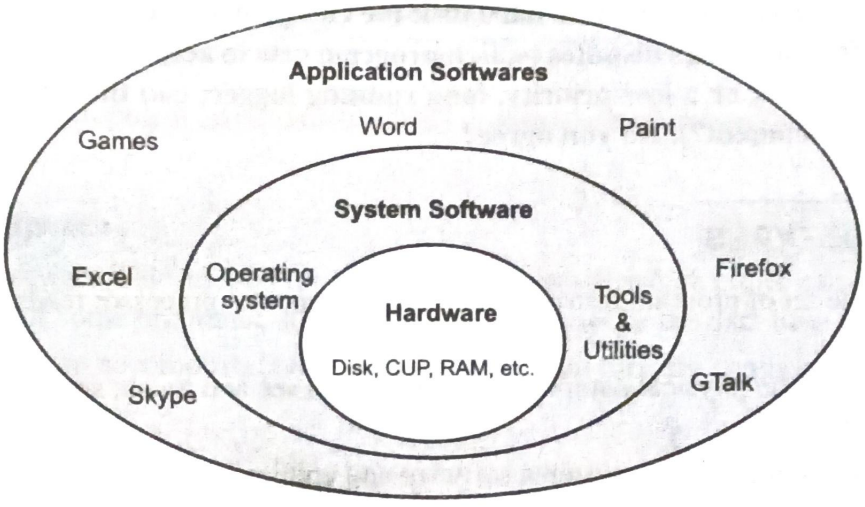


Fig. 3.4 A computer system consists of two major elements: hardware and software

Every computer is composed of two basic components: hardware and software.

- Hardware includes the physical features, which are every part that you can either see or touch, for example: monitor, case, keyboard, mouse, and printer.
- The part which activates the physical components is called software. It includes the features that responsible for directing the work to the hardware. Software can be divided into other programs and data.
- Hardware refers to the physical elements of a computer.
- Also sometime called the machinery or the equipment of the computer.
- Examples of hardware in a computer are the keyboard, the monitor, the mouse and the central processing unit.
- Computer's hardware is comprised of many different parts, the most important of these is the motherboard.

- Motherboard is made up of even more parts that power and control the computer.
- Hardware is a physical entity Hardware and software are interconnected, without software, the hardware of a computer would have no function.
- Without the creation of hardware to perform tasks directed by software via the central processing unit, software would be useless.
- Hardware is limited to specifically designed tasks.
- Software implements algorithms that allow the computer to complete much more complex tasks.

Thought Question

The operating system has the same duties as a government: It establishes and maintains order (where each program will operate and what resources it has access to); it provides services that would be uneconomical or infeasible for the user to provide for himself (every program does not have to know how to access a printer or hard disk the O/S provides a standard interface for each such device); and it adjudicates disputes (which program gets to access the C: drive this instant, a high-priority system task or a low-priority, long running logger; can the printer be interrupted for this important document?). Do you agree?

3.3 SOFTWARE TYPES

Software refers to the set of program instructions or data a computer processor reads in order to perform a task or operation.

Hardware refers to the physical components that you can see and touch, such as the computer hard drive, mouse, and keyboard.

Software can be categorized as: systems software and application software.

Systems Software

- Systems software includes the programs that are dedicated to managing the computer itself, such as the operating system, file management utilities, and disk operating system (or DOS).
- Operating system manages the computer hardware resources in addition to applications and data.
- Practical computer systems divide software systems into three major classes: system software, programming software and application software.
- System software provides the basic functions for computer usage and helps run the computer hardware and system.
- Includes a combination of the following:
  - Device drivers
  - Operating systems
  - Servers
  - Utilities
  - Window systems

- System software is responsible for managing a variety of independent hardware components, so that they can work together harmoniously.
- Its purpose is to unburden the application software programmer from the often complex details of the particular computer being used, including such accessories as communications devices, printers, device readers, displays and keyboards, and also to partition the computer's resources such as memory and processor time in a safe and stable manner.

Programming Software

- Provides tools to assist a programmer in writing computer programs, and software using different programming languages in a more convenient way.
- Tools include:
  - Compilers
  - Debuggers
  - Interpreters
  - Linkers
  - Text editors
- An Integrated development environment (IDE) is a single application that attempts to manage all these functions.

Application Software

- Application software is developed for some certain purpose, which either can be a certain program or a collection of some programs, such as a graphic browser or the data base management system.
- Allows end users to accomplish one or more specific (not directly computer development related) tasks.
- Typical applications include:
  - Industrial automation
  - Business software
  - Video games
  - Quantum chemistry and solid state physics software
  - Telecommunications
  - Databases
  - Educational software
  - Mathematical software
  - Medical software
  - Molecular modelling software
  - Image editing
  - Spreadsheet
  - Simulation software
  - Word processing

3.4 SOFTWARE CHARACTERISTICS

- **Functionality:** Degree of performance of the software against its intended purpose.
- **Reliability:** Ability of the software to provide desired functionality under the given conditions.
- **Usability:** Extent to which the software can be used with ease.
- **Maintainability:** Ease with which the modifications can be made in a software system to extend its functionality, improve its performance, or correct errors.
- **Efficiency:** Ability of the software to use system resources in the most effective and efficient manner.
- **Portability:** Ease with which software developers can transfer software from one platform to another, with or without changes.
- **Robustness:** Degree to which the software can keep on functioning in spite of being provided with invalid data.
- **Integrity:** Degree to which unauthorized access to the software or data can be prevented.

3.5 OPERATNG SYSTEM

An operating system is the most important software that runs on a computer. It manages the computer's memory and processes, as well as all of its software and hardware. It also allows you to communicate with the computer without knowing how to speak the computer's language. Without an operating system, a computer is useless.

- Operating system is a system software program that enables the computer hardware to communicate and operate with the application software and the user.
- Operating systems usually come pre-loaded on any computer.
- Common operating system for personal computers is Microsoft Windows based on GUI.
- DOS is an operating system based on CUI.
- Examples of other operating systems are Mac OS X, and Linux.
- Modern operating systems use a graphical user interface.
- Lets you use your mouse to click icons, buttons, and menus, and everything is clearly displayed on the screen using a combination of graphics and text.
- Operating System is an essential component of a computer system.
- It is a large set of large and complex program that acts as an interface between the computer hardware and its user.
- Interprets the user program instructions to the hardware.
- Provides coordination services necessary to enable a group of users to share computer system resources efficiently.

Need of Operating System

- Easy interaction between the human and computer.
- Starting computer operation automatically when power in turned on.
- Loading and scheduling users program.

- Controlling input and output.
- Controlling program execution.
- Managing use of main memory.
- Providing security to users program.

Functions of Operating System

- **Process Management:**
  - The process management module of an Operating System takes care of the creation and deletion of processes, scheduling of various system resources to the different process requesting them, and providing mechanism for synchronization and communication among processes.
- **Memory Management**
  - The memory management module of an Operating System takes care of the allocation and reallocation of memory space to the various program in need of this resource.
- **File Management**
  - Computer use a lot of data and programs, which are, stored on secondary storage devices.
  - Involves keeping track of all different files and maintaining the integrity of data stored in the files including file directory structure.
- **Security**
  - Protect the resources and information of a computer system against destruction and unauthorized access.
- **Command Interpretation**
  - Takes care of interpreting of user commands, and directing the system resources to handle the requests.
  - With this mode of interaction with the system, the user is usually not too concerned with the hardware details of the system.
- **Input/Output or Device Management**
  - Coordination and control of various input and output devices is an important function of the Operating System.
  - Receiving the request for I/O interrupts, and communicating back to the requesting process.

3.6 TYPES OF OPERATING SYSTEMS

Batch Operating System

Batch means a group of persons moving together. The users of a batch operating system do not interact with the computer directly. Each user prepares his job on an off-line device like punch cards and submits it to the computer operator.

- To speed up processing, jobs with similar needs are batched together and run as a group.
- The programmers leave their programs with the operator and the operator then sorts the programs with similar requirements into batches.

Limitations

- Lack of interaction between the user and the job.
- CPU is often idle, as the speed of the mechanical I/O devices is slower than the CPU.

Time-Sharing Operating Systems

Time-sharing is a technique which enables many people, located at various terminals, to use a particular computer system at the same time. Time-sharing or multitasking is a logical extension of multiprogramming. Processor's time which is shared among multiple users simultaneously is termed as time-sharing.

- Main difference between Multiprogrammed Batch Systems and Time-Sharing Systems is that in case of Multiprogrammed batch systems, the objective is to maximize processor use, whereas in Time-Sharing Systems, the objective is to minimize response time.
- Multiple jobs are executed by the CPU by switching between them, but the switches occur so frequently.
- User can receive an immediate response.
- Operating system uses CPU scheduling and multiprogramming to provide each user with a small portion of a time.

Advantages

- Quick response.
- No duplication of software.
- Reduces CPU idle time.

Limitations

- Reliability under question.
- Question of security and integrity of user programs and data.
- Data communication problems.

Distributed Operating System

Distributed systems use multiple central processors to serve multiple real-time applications and multiple users. Data processing jobs are distributed among the processors accordingly.

- Processors communicate with one another through various communication lines such as high-speed buses or telephone lines.
- Processors in a distributed system may vary in size and function.
- Processors are referred as sites, nodes, computers, etc.

Advantages

- With resource sharing facility, a user at one site may be able to use the resources available at another.
- Speedup the exchange of data with one another via electronic mail.
- If one site fails, the remaining sites can potentially continue operating.

- Reduction of the load on the host computer.
- Reduction of delays in data processing.
- Better service.

Network Operating System

A Network Operating System runs on a server and provides the server the capability to manage data, users, groups, security, applications, and other networking functions.

- Primary purpose of this system is to allow shared file and printer access among multiple computers in a network, typically a local area network (LAN), a private network or to other networks.
- Examples of network operating systems include Microsoft Windows Server 2003, Microsoft Windows Server 2008, UNIX, Linux, Mac OS X, Novell NetWare, and BSD.

Advantages

- Highly stable centralized servers.
- Security is server managed.
- Upgrades to new technologies and hardware can be easily integrated into the system.
- Remote access to servers is possible from different locations and types of systems.

Limitations

- High cost of buying and running a server.
- Dependency on a central location for most operations.
- Regular maintenance and updates are required.

Real Time Operating System

A real-time system is a data processing system in which the time interval required to process and respond to inputs is so small that it controls the environment.

- The time taken by the system to respond to an input and display of required updated information is termed as the response time.
- Response time is very less as compared to online processing.
- Used when there are rigid time requirements on the operation of a processor or the flow of data and real-time systems can be used as a control device in a dedicated application.
- Must have well-defined, fixed time constraints, otherwise the system will fail.
- Scientific experiments, medical imaging systems, industrial control systems, weapon systems, robots, air traffic control systems, etc. are the examples of real time systems.

Two types of real-time operating systems are:

Hard Real-time Systems

- Guarantee that critical tasks complete on time.
- Secondary storage is limited or missing and the data is stored in ROM.
- Virtual memory is almost never found.

Soft Real-time Systems

- Soft real-time systems are less restrictive.
- A critical real-time task gets priority over other tasks and retains the priority until it completes.
- Have limited utility than hard real-time systems.
- Multimedia, virtual reality, Advanced Scientific Projects like undersea exploration and planetary rovers etc. are the examples of soft real time systems.

An Operating System provides services to both the users and to the programs.

- Provides programs an environment to execute.
- Provides users the services to execute the programs in a convenient manner.

Common services provided by an operating system are:

- Program execution
- I/O operations
- File System manipulation
- Communication
- Error Detection
- Resource Allocation
- Protection

Program execution

Operating systems handle many kinds of activities from user programs to system programs like printer spooler, name servers, file server, etc. Each of these activities is encapsulated as a process.

- Loads a program into memory.
- Executes the program.
- Handles program's execution.
- Provides a mechanism for process synchronization.
- Provides a mechanism for process communication.
- Provides a mechanism for deadlock handling.

I/O Operation

An I/O subsystem comprises of I/O devices and their corresponding driver software. Drivers hide the peculiarities of specific hardware devices from the users.

- Operating System manages the communication between user and device drivers.
- I/O operation means read or write operation with any file or any specific I/O device.
- Operating system provides the access to the required I/O device when required.

File System Manipulation

- Operating system gives the permission to the program for operation on file.
- Permission varies from read-only, read-write, denied and so on.
- Provides an interface to the user to create or delete files.

- Provides an interface to the user to create or delete directories.
- Provides an interface to create the backup of file system.

Communication

- OS handles routing and connection strategies, and the problems of contention and security.
- Two processes often require data to be transferred between them.
- Both the processes can be on one computer or on different computers, but are connected through a computer network.
- Communication may be implemented by two methods, either by Shared Memory or by Message Passing.

Error Handling

- Constantly checks for possible errors.
- OS takes an appropriate action to ensure correct and consistent computing.

Resource Management

- In case of multi-user or multi-tasking environment, resources such as main memory, CPU cycles and files storage are to be allocated to each user or job.
- Manages all kinds of resources using schedulers.
- CPU scheduling algorithms are used for better utilization of CPU.

Protection

- Protection refers to a mechanism or a way to control the access of programs, processes, or users to the resources defined by a computer system.
- OS ensures that all access to system resources is controlled.
- Ensures that external I/O devices are protected from invalid access attempts.
- Provides authentication features for each user by means of passwords.

Batch Processing

- Batch processing is a technique in which an Operating System collects the programs and data together in a batch before processing starts.
- The OS defines a job which has predefined sequence of commands, programs and data as a single unit.
- Keeps a number a jobs in memory and executes them without any manual information.
- Jobs are processed in the order of submission, i.e., first come first served i.e. FCFS basis.
- When a job completes its execution, its memory is released and the output for the job gets copied into an output spool for later printing or processing.

Multitasking

- Multitasking is when multiple jobs are executed by the CPU simultaneously by switching between them. Switches occur so frequently that the users may interact with each program while it is running.

- User gives instructions to the operating system or to a program directly, and receives an immediate response.
- OS handles multitasking in the way that it can handle multiple operations and executes multiple programs at a time.
- Also known as Time-sharing systems.
- Time-shared operating system uses the concept of CPU scheduling and multiprogramming to provide each user with a small portion of a time-shared CPU.
- Each user has at least one separate program in memory.
- A program that is loaded into memory and is executing is known as **process**.
- When a process executes, it typically executes for only a very short time before it either finishes or needs to perform I/O.
- Since interactive I/O typically runs at slower speeds, it may take a long time to complete.
- During this time, a CPU can be utilized by another process.
- OS allows the users to share the computer simultaneously. Since each action or command in a time-shared system tends to be short, only a little CPU time is needed for each user.
- As the system switches CPU rapidly from one program to the next, each user is given the impression that he has his own CPU, whereas actually one CPU is being shared among many users.

Multiprogramming

Sharing the processor, when two or more programs reside in memory at the same time, is referred as multiprogramming.

- Multiprogramming assumes a single shared processor.
- Increases CPU utilization by organizing jobs so that the CPU always has one to execute.
- Operating system keeps several jobs in memory at a time.
- Set of jobs is a subset of the jobs kept in the job pool.
- Operating system picks and begins to execute one of the jobs in the memory.
- Multiprogramming operating systems monitor the state of all active programs and system resources using memory management programs to ensures that the CPU is never idle, unless there are no jobs to process.

Advantages

- High and efficient CPU utilization.
- User feels that many programs are allotted CPU almost simultaneously.

Limitations

- CPU scheduling is required.
- To accommodate many jobs in memory, memory management is required.

Real Time System

Real-time systems are usually dedicated, embedded systems.

- In such systems, Operating Systems typically read from and react to sensor data.
- Operating system must guarantee response to events within fixed periods of time to ensure correct performance.

3.7 BIOS (BASIC INPUT/OUTPUT SYSTEM)

BIOS is the short form for basic input/output system, the built-in software that determines what a computer can do without accessing programs from a disk. On personal computers (PCs), for example, the BIOS contains all the code required to control the keyboard, display screen, disk drives, serial communications, and a number of miscellaneous functions.

- BIOS (basic input/output system) is the program a personal computer's microprocessor uses to get the computer system started after you turn it on.
- Manages data flow between the computer's operating system and attached devices such as the hard disk, video adapter, keyboard, mouse and printer.
- An integral part of your computer and comes with it when you bring it home.
- BIOS is a program that is made accessible to the microprocessor on an erasable programmable read-only memory (EPROM) chip.
- When you turn on your computer, the microprocessor passes control to the BIOS program, which is always located at the same place on EPROM.
- When BIOS boots up (starts up) your computer, it first determines whether all of the attachments are in place and operational and then it loads the operating system into your computer's RAM from your hard disk or diskette drive.

- BIOS stands for Basic Input Output System.
- Software stored on a small memory chip on the motherboard.
- Responsible for the POST and therefore makes it the very first software to run when a computer is started.
- BIOS firmware is non-volatile, meaning that its settings are saved and recoverable even after power has been removed from the device.
- BIOS instructs the computer on how to perform a number of basic functions such as booting and keyboard control.
- BIOS is also used to identify and configure the hardware in a computer such as the hard drive, floppy drive, optical drive, CPU, memory, etc.
- Accessed and configured through the BIOS Setup Utility.
- Unlike an operating system like Windows, which is often downloaded or obtained on a disc, and needs to be installed by the user or manufacturer, BIOS is pre-installed when the computer is purchased.

- All modern computer motherboards contain BIOS software.
- BIOS access and configuration on PC systems is independent of any operating system because the BIOS is part of the motherboard hardware.
- BIOS is a program pre-installed on Windows-based computers that the computer uses to start up.
- CPU accesses the BIOS even before the operating system is loaded.
- BIOS then checks all your hardware connections and locates all your devices.
- If everything is OK, the BIOS loads the operating system into the computer's memory and finishes the boot-up process.
- Since the BIOS manages the hard drives, it can't reside on one, and since it is available before the computer boots up, it can't live in the RAM.
- Located in the ROM of the computer.
- Resides in an erasable programmable read-only memory (EPROM) chip.
- As soon as you turn your computer on, the CPU accesses the EPROM and gives control to the BIOS.
- BIOS also is used after the computer has booted up.
- Acts as an intermediary between the CPU and the I/O devices.

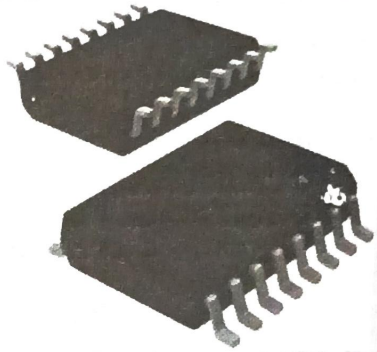


Fig. 3.5

3.8 SYSTEM UTILITIES

A utility or software utility is computer system software intended to analyze, configure, monitor, or help maintain a computer. A utility is smaller than an program in size and may be included with an operating system or installed separately.

- Utility is a small program that provides an addition to the capabilities provided by the operating system.
- An application that is very specialized and relatively limited in capability.

Examples of computer utilities:

- Antivirus
- Backup software
- Clipboard
- Compression utility DirectX
- Disk checkers
- Disk partition editors
- Cryptography software
- Debuggers
- Dr. Watson
- Encryption tools

Difference Between Linker and Loader

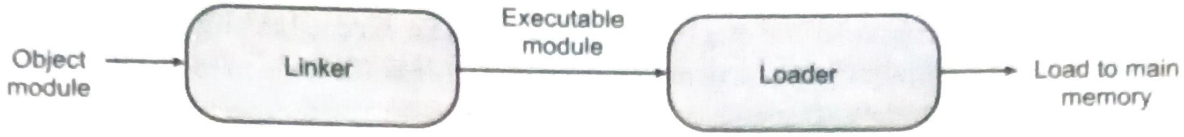


Fig. 3.6 Role of linker and loader

- Linker and Loader are the utility programs.
- Play a major role in the execution of a program.
- Source code of a program passes through compiler, assembler, linker, loader in the respective order, before execution.
- Linker intakes the object codes generated by the assembler and combine them to generate the executable module.
- Loader loads this executable module to the main memory for execution.

FEATURES	LINKER	LOADER
Basic	generates the executable module of a source program.	loads the executable module to the main memory.
Input	takes as input, the object code generated by an assembler.	takes executable module generated by a linker.
Function	combines all the object modules of a source code to generate an executable module.	allocates the addresses to an executable module in main memory for execution.
Type	Linkage Editor, Dynamic linker.	Absolute loading, Relocatable loading and Dynamic Run-time loading.

Compiler

A compiler is a special type of program that transforms the source code written in a programming language (source code) in to the machine language (object code or machine code), which uses only binary language i.e. 0 or 1. The resultant code is 0s and 1s is known as the object code. The object code is used to create an executable program.

- Compiler is used to translate the source code from a high-level programming language to a lower level language i.e. machine code).
- Translates human readable source code in to computer-executable machine code.

Interpreter

- Like the compiler, the interpreter also executes instructions written in a high-level language.
- The compiler translates instructions written in a high-level programming language directly in to machine language; the interpreter, on the other hand, translate the instructions line by line.

Linker

- Also called link editor or binder.
- Program that combines the object modules to form an executable program.
- In case of a large program, programmers prefer to break the code in to smaller modules, as this simplifies the programming task.
- When the source code of all the modules has been converted in to object code, all the modules need to be put together, which is done by the linker.

Loader

- A loader is a special type of a program that copies programs from a storage device to the main memory, where they can be executed. Most loaders are transparent to the users.

3.8.1 EDITOR

A text editor is a computer program that lets a user enter, change, store, and usually print text (characters and numbers). A text editor provides an empty display screen with a fixed-line length and visible line numbers. You can then fill the lines in with text, line by line.

- Special command line lets you move to a new page, scroll forward or backward, make global changes in the document, save the document, and perform other actions.
- After saving a document, you can then print it or display it.
- Before printing or displaying it, you may be able to format it for some specific output device or class of output device.
- Text editors can be used to enter program language source statements or to create documents such as technical manuals.
- **Text editor** is a software program that allows users to create or manipulate plain text computer files.
- Examples of text editors.
- **Notepad** and **WordPad** — Microsoft Windows included text editors.
- **TextEdit** — Apple computer text editor.
- **Emacs** — Text editor for all platforms that is a very powerful text editor once you've learned all of its commands and options.
- **Vi** and **vim** — Other great editors primarily used with Linux but also available with multiple platforms.
- **Word** — Word processor for Windows and Apple computers.
- **Writer** — Text editor and word processor.
- **Ed** — A ubiquitous file editor on Unix-like systems.
- **Microsoft Edit** — MS-DOS text editor.
- **Notepad++** — free text editor.

- Text editor is a program that enables you to create and edit text files
- **Line editors:** A primitive form of editor that requires you to specify a specific line of text before you can make changes to it.
- **Screen-oriented editors:** Also called full-screen editors, these editors enable you to modify any text that appears on the display screen by moving the cursor to the desired location.

3.9 FILE MANAGER

A **file manager** is a software program that helps a user manage all the files on their computer. For example, all file managers allow the user to view, edit, copy, and delete the files on their computer storage devices.

- A computer program that provides a user interface to manage files and folders.
- Most common operations performed on files or groups of files include creating, opening (e.g. viewing, playing, editing or printing), renaming moving or copying, deleting and searching for files, as well as modifying file attributes, properties and file permissions.
- Folders and files may be displayed in a hierarchical tree based on their directory structure.
- Some file managers contain features inspired by web browsers, including forward and back navigational buttons.

File Manager IS a program used to organize, list, and locate files and directories on a computer. A file manager or file browser is a computer program that provides a user interface to work with file systems. The most common operations performed on files or groups of files are: create, open, edit, view, print, play, rename, move, copy, delete, search/find, and modify file attributes, properties and file permissions. Files are typically displayed in a hierarchy. Some file managers contain features inspired by web browsers, including forward and back navigational buttons. Some file managers provide network connectivity via protocols, such as FTP.

3.10 CONCEPT OF GUI AND CUI

CUI: CUI stands for Character User Interface, it means that you have to type commands to interact with your computer. For example, in DOS for every thing we type the commands.

- CUI stands for character user interface.
- Can also be referred to as the command prompt, C prompt or command line.
- In DOS this is generally displayed on the screen by a "C:>" or "C>".
- This is the point at which commands are written out before being sent to the computer by pressing "Enter" on the keyboard.

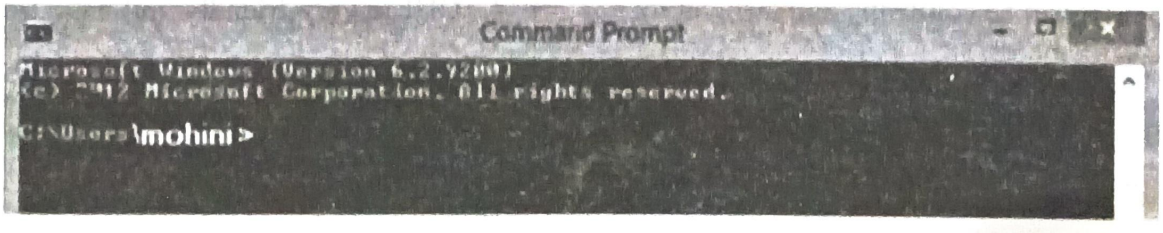


Fig. 3.7(a) In CUI , you have to type commands to interact with your computer

GUI : GUI stands for Graphical User Interface, it means that you do not need to type commands to interact with your computer, instead you have to click with the help of mouse on the icons of readymade commands For example, Windows.

- GUI stands for graphical user interface.
- Eliminates the need to type commands on the C prompt or command line.
- You use a mouse to move the cursor around the screen, place it on an icon and click.
- By doing so a command is sent that would otherwise have to be typed using the CUI.

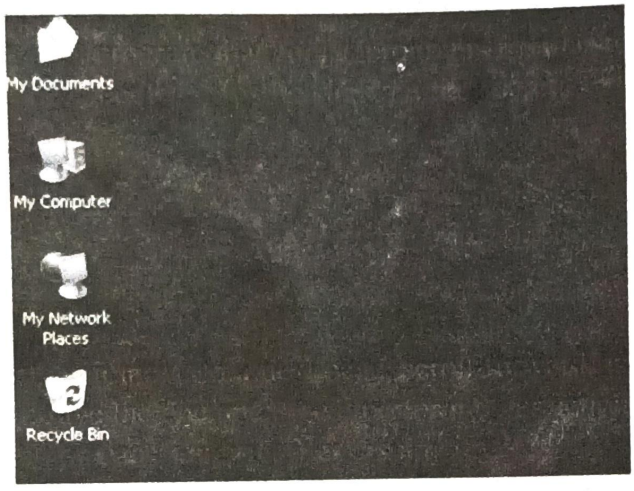


Fig. 3.7(a) In GUI ,you have to use a mouse to move the cursor around the screen, place it on an icon and click.

CUI and GUI are two techniques used to send commands to a computer processor. Both accomplish the same goal, but employ somewhat different methods to do so. CUI, invented by Xerox in the seventies, predates GUI, which was introduced by Apple in 1984.

CUI	GUI
1. CUI is the Character User Interface.	1. GUI is Graphical User Interface.
2. DOS is the characterized as CUI.	2. Windows is characterized as GUI.
3. A CUI use characters on screen that control with keyboard.	3. A GUI use pictures, symbols, word that control with mouse.
4. CUI can be confusing and difficult to remember.	4. GUI is very friendly and easy to remember.

10.1 ICON

- A small picture that represents an object or program.
- Principal feature of GUI.
- Very useful in applications that use windows, because with the click of a mouse button you can shrink an entire window into a small icon i.e., you can minimize it.
- To redisplay i.e. Restore or maximize the window, you just move the pointer to the icon and click (or double click) a mouse button.

3.11 DIRECTORIES AND FILES

A file is a collection of data that is stored on disk and that can be manipulated as a single unit by its name.

A directory is defined as an organizational unit, or container, used to organize folders and files into a hierarchical structure. A directory is a file that acts as a folder for other files. A directory can also contain other directories (subdirectories); a directory that contains another directory is called the parent directory of the directory it contains.

A directory tree includes a directory and all of its files, including the contents of all subdirectories. Note that Each directory is a branch in the tree. A slash character alone (/) is the name of the root directory at the base of the directory tree hierarchy; it is the trunk from which all other files or directories branch.

A directory is a location for storing files on your computer. Directories are found in a hierarchical file system, such as Linux, MS-DOS, OS/2, and Unix.

Files, Paths and the Root Directory

The topmost directory in any file is called the root directory. A directory that is below another directory is called a subdirectory. A directory above a subdirectory is called the parent directory. Under DOS and Windows, the root directory is a back slash (\).A path points to a file system location by following the directory tree hierarchy expressed in a string of characters in which path components, separated by a delimiting character, represent each directory.

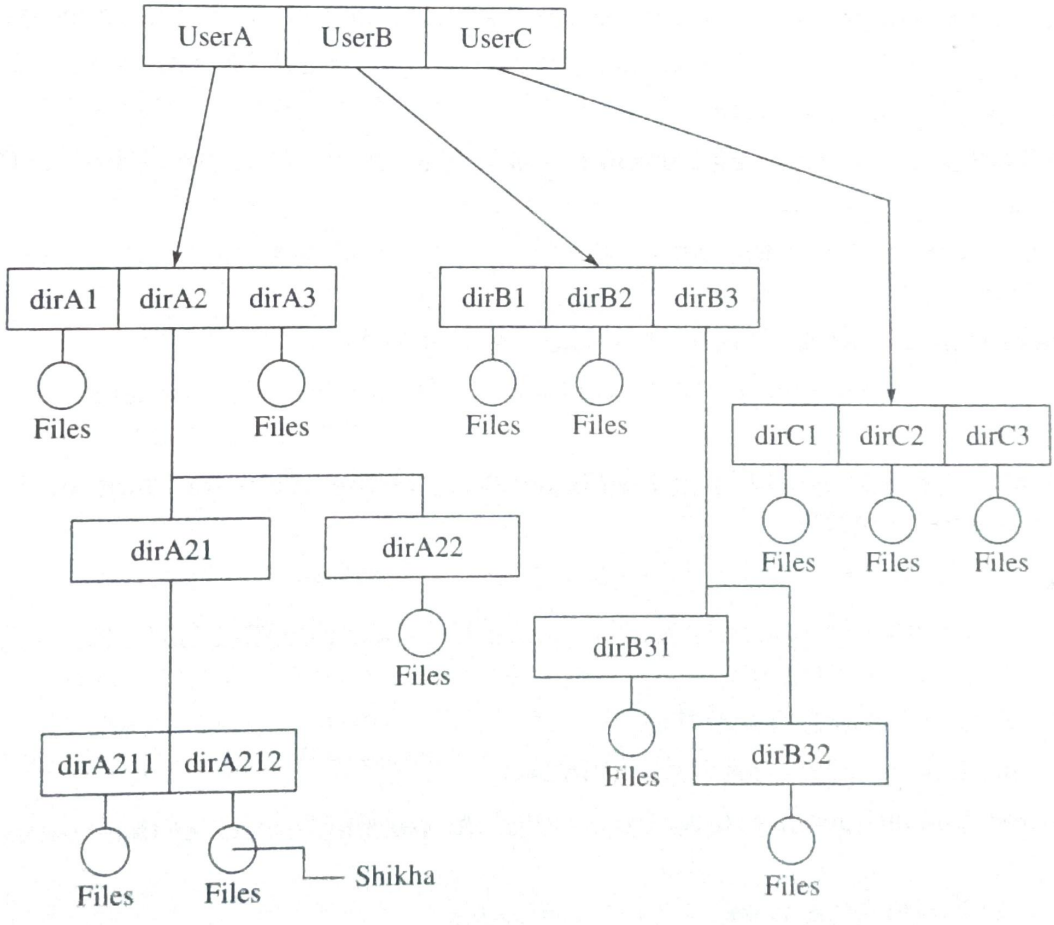


Fig. 3.8 Directories and files

Path

A path, specifies a unique location in a file system. A path points to a file system location by following the directory tree hierarchy expressed in a string of characters in which path components, separated by a delimiting character, represent each directory. The delimiting character is most commonly the slash ("/"), the backslash character ("\"), or colon (":"), though some operating systems may use a different delimiter.

Files

- A file is a collection of data that is stored on disk and that can be manipulated as a single unit by its name.
- Each file is made up of data, but also metadata is embedded into the file to help the operating system (OS) manage how the file works and how it is stored.
- Metadata records file information such as the author, file creation date, modified date, and file size.

Attributes

- Attributes can be applied to each file.
- If a file is flagged as read-only then the file can be viewed but not modified. A file with a write privilege can be modified.
- Files can be also flagged as hidden for security or to prevent accidental deletion.
- Another flag frequently used is execute, which allows a file to run as a computer program.
- From the command line on a Windows computer, you would use the **attrib** command.
- Files are named in a standard way.
- On most OS, there are file naming conventions, or a fundamental standard giving the OS a clue as to how to use the file.
- For example, if you have a file named saloni.txt the name of the file is 'saloni' and the **extension** is .txt.
- .txt indicates there is only text in the file (hence, no graphics).
- If the extension is .com (command file), .exe (executable file), the extension tells the OS to run the file.
- Other extensions are available like .jpg for high-quality photos, .docx for Microsoft Word documents and many others.

Directories

- An organizational unit, or container, used to organize folders *and* files *into a* hierarchical *structure*.
- A file that acts as a folder for other files.
- Can also contain other directories (subdirectories).
- Directory that contains another directory is called the parent directory of the directory it contains.
- Directory can be thought of as an invented root system.

- It starts at the top with a single entity of a computer hard drive.
- On a PC, the primary drive is called C: (where the ':' indicates the drive letter assigned or mapped).
- On a Linux system, the drive prompt is a dollar sign ($). In both these cases, this is called the root of the drive.
- Directory system is just like a series of branches or folders containing collections of similar files.

Path

- A path defines the location of a file or folder in a computer's file system.
- Also called "directory paths" because they often include one or more directories that describe the path to the file or folder.
- Just as in the real world, paths are trails or streets than lead to a certain location, in the same way, path defines the location of a file or folder in a computer's file system in the computer world.
- A path can either be relative or absolute.
- A relative path defines a location that is relative to the current directory or folder. For example, the relative path to a file named "nishu.txt" located in the current directory is simply the filename, or "nishu.txt". If the file was stored inside a folder named "kavita" within the directory, the relative path would be "kavita/nishu.txt." If the file was located one folder up from the current directory, the relative path would be defined as "../nishu.txt".
- Absolute paths are defined from the root directory of the file system.
- No matter what folder is currently open, the absolute path to any given file is the same.
- Example of root path is "/" for a Unix root directory.
- For example, if a home directory could be **/kavya/vineeta**, on which there is a directory called **abhilasha**, with a directory inside called **shiwi**, on which there is a file called **anita.txt** Then, the full path of this last file will be **/kavya/vineeta/abhilasha/shiwi/ anita.txt**

What is importance of naming a file?

- A file can be fully and uniquely identified by its full name, including all directories to which it belongs
- The system starts at the root directory, with its name /
- Splits into (sub)directories, and these split further, and so on, until you get to a file.
- For example, if a home directory could be **/kavya/vineeta**, on which there is a directory called **abhilasha**, with a directory inside called **shiwi**, on which there is a file called **anita.txt** The full path of this last file will be **/kavya/vineeta/abhilasha/shiwi/anita.txt**

Creating and Removing directories

- To make a new directory , the command is:

```
mkdir name of directory
```

- To remove a directory that does **not** files inside, the command is:
  `rmdir name of directory`
- If the directory has files, the command is:
  `rm -rv name of directory`
  and you will be asked for each file (or subdirectory) if you want to remove it or not;
- However, the command
  `rm -frv name of directory`
  that will remove all files (and subdirectories) without asking any questions.

Changing the Working Directory

- To change (enter) into a directory the command is:
  `cd name of directory`
- This assumes that the new directory is a subdirectory of the one you are currently working on.
- If the other directory is not in the current directory, you have to specify the complete path, for example:
  `cd /manju/home/krishna/radha`
- To go to your home directory the command is:
  `cd`

Renaming Directories

- To change the name of a directory the command is:
  `mv name of directory new name`
  It will move all the files inside as well.

Creating and Removing files

Creating files can be done in many different ways:

- With an editor)
  `editor name of file`
- By copying an existing file:
  `cp existing file name new file name`
- By type stuff directly into a file:
  `cat > filename`
- Creating an empty file the command is:
  `touch filename`

Renaming Files

- You can change the names of files, similar to renaming a directory:
  `mv filename new file name`

File Extensions

Type of file	Common Extensions
Text	.txt, .text
Images	.jpg, .gif, .pnm, .xpm, .bpm
PostScript	.ps
PDF	.pdf
DOS-generated	.doc, .xls
ZIP compression	.zip
DOS executable	.exe
Movie	.mpeg, .mpg
sound	.wav
MP3 sound	.mp3
HTML	.html, .htm

3.12 WILD CARDS

A wild card refers to a character that can be substituted for zero or more characters in a string. Wild cards are generally used in computer programming, database SQL search queries, and when navigating through DOS or Unix directories via the command prompt.

Uses for Wild cards

- Regular Expressions — A period (.) matches a single character, while .* matches zero or more characters and .+ matches one or more characters.
- SQL Queries — A percent symbol (%) matches zero or more characters, while an underscore (_) matches a single character.
- Directory Navigation — An asterisk (*) matches zero or more characters, while a question mark (?) matches a single character.
- Wild cards are used to search for partial matches instead of exact matches. This can be helpful when searching for files or looking up information from a database.

- **Wild card** is a symbol used to replace or represent one or more characters.
- Wild cards are typically either an asterisk (*), which represents one or more characters or question mark(?), which represents a single character.
- Wild card refers to a character that can be substituted for zero or more characters in a string. Wild cards are commonly used in computer programming, database SQL search queries, and when navigating through DOS or Unix directories via the command prompt.
- An asterisk (*) matches zero or more characters, while a question mark (?) matches a single character.
- An **asterisk** (*) may be used to specify any number of characters. It is typically used *at the end of a root word*, when it is referred to as "**truncation**."

- Example: searching for *INTER** would tell the database to look for all possible endings to that root like INTERNAL, INTERVIEW, INTERMEDIATE etc.
- A **question mark** (?) may be used to represent a single character, anywhere in the word. It is most useful when there are *variable spellings* for a word, and you want to search for all variants at once.
- For example, searching for ***c?r*** would return both ***car*** and ***cover***.

3.13 AUTOEXEC.BAT AND CONFIG.SYS

- Autoexec.bat is a file containing Disk Operating System commands that are executable when the computer is booted (started).
- The commands in autoexec.bat tell the operating system which application programs are to be automatically started, how memory is to be managed, and initialize other settings.
- Each command in autoexec.bat could be typed in manually after the computer is started, but that would take too long. The autoexec.bat file is command script that is written beforehand so that it can be automatically executed when the operating system is started.
- The bat suffix stands for batch, indicating that this is a file containing a sequence of commands entered from a file rather than interactively by a user.
- **Config.sys** is a system file used with MS-DOS and OS/2 that is loaded each time the computer first boots up.
- This file controls components connected to the computer such as memory and other hardware devices with early computers.

3.14 DOS

DOS (Disk Operating System) is an operating system that runs from a hard disk drive. The term in general terms also refers to a particular family of disk operating systems, most commonly MS-DOS (Microsoft Disk Operating System).

- Originally developed by Microsoft for IBM, MS-DOS was the standard operating system for IBM-compatible personal computers.
- First operating system used by IBM-compatible computers
- Originally available in two versions PC-DOS and MS-DOS
- Uses a command line, or text-based interface, that allows the user to type commands
- By typing simple instructions, the user can browse the files on the hard drive, open files, and run programs
- User must know the basic commands in order to use DOS effectively
- Difficult for new comers to use
- Microsoft later bundled the GUI based Windows operating system with DOS
- Dos commands can be classified into internal commands and external commands.

In DOS systems, an internal command is any command that resides in the COMMAND.COM file. This includes the most common DOS commands, such as COPY and DIR. Commands that reside in other COM files, or in EXE or BAT files, are called external commands.

3.14.1 Some Internal Commands

- **Date:** This command is used to display the system current date setting and prompt you to enter a new date. The syntax is: **date [/T | date]**.
- **Time:** This command is used to displays or set the system time. The syntax is: **time [/T | time]**.
- **COPY CON:** It is used to create a file in the existing directory. Here CON is a DOS reserved word which stands for console.

  Syntax is: **COPY CON filename** after that press Enter and start typing your text and after you're done typing your text, to save and exit hit F6 key.
- **TYPE**: This command is used to display the contents of a text file or files. The syntax is: **TYPE [drive:][path]filename**.
- **CLS:** It is used to clear the screen. Syntax is **CLS**.

3.15.2 Some External Commands

- **xcopy:** This command is used to copy files and directory trees from one disk to another disk. Syntax is **xcopy source [destination]**.
- **diskcopy:** This command copies the contents of one floppy from the source drive to a formatted or un-formatted floppy disk in the destination drive. This command copies the data from particular position on the source disk to exactly the same position on the destination disk. Syntax **diskcopy A: B:**
- **tree:** This command is very useful to view the list of directories and subdirectories present on the disk in graphical form. If you wanted to include files also with directories and subdirectories, then you'll have to give the command line as tree/f which presents the tree view of all the content on your disk. Here is the syntax for this command with allowed switches: **tree [drive:path] [/F] [/A]**.
- **deltree:** This command is used to remove a directory along with its contents. Syntax is **deltree [drive:path]**.

3.15 FEATURES OF WINDOWS

Windows is a series of ***operating systems*** developed by Microsoft. Each version of ***Windows*** includes a graphical user interface, with a desktop that allows users to view files and folders in ***windows***. ***Windows*** is the most widely used ***operating system*** for PCs.

- Windows is a collection of programs known as an *operating system* that controls a PC.
- First produced by Microsoft in November 1985.
- frequently updated since, as computer memory has got bigger, as processing chips have got faster.
- Prior to Windows, PCs were operated by a series of text commands.

Icon

An **icon** is a small graphical representation of a program or file. When you double-click an icon, the associated file or program will be opened.

- A small picture that represents an object or program.
- Icons are very useful in applications that use windows.
- principal feature of graphical user interfaces.
- Icons are a component of most GUI operating systems, including Microsoft Windows and Apple macOS X.
- Icons help users quickly identify the type of file represented by the icon.
- icon is pronounced EYE-kahn.
- an image that represents an application, a capability, or some other concept or specific entity with meaning for the user.

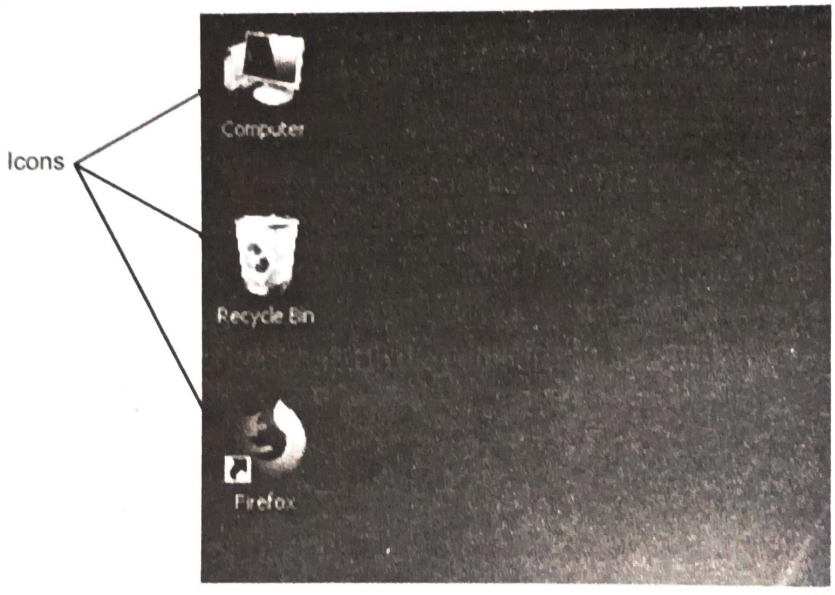


Fig. 3.9 Icons

Windows Features and Advantages

- Allows the user to interact with the computer very easily and comfortably due to the use of GUI
- Controls the storage of data (images, files, music).
- Controls hardware attached to the computer such as webcams, scanners, mouse, keyboards, printers etc.
- Helps to open and close programs and gives them part of the computer's memory to allow them to work.
- Controls access to a computer different users have and the computer's security.
- Promotes multitasking by allowing the user to do several things on the computer at once – for example, watch a video while writing a letter.
- Deals with errors and user instructions, and issues error messages.

- Microsoft Windows is a group of OSs manufactured by Microsoft.
- Windows is available in 32 and 64-bit versions.
- Offers a graphical user interface (GUI), multitasking functionalities, virtual memory management capabilities, and support for several peripheral devices.

Desktop

When you turn on the computer in a window environment, the first screen which appears after the booting process is the desktop. The desktop display is the default display on the computer when it is booted up; auxiliary features provide end users with options for working from a desktop. **Desktop** is a system of organization of icons on a screen. Desktop icons represent files, directories, applications, functions, and removable media, like CDs or DVDs.

What icons and items are found on the Windows Desktop?

- Some of the most common icons on the Desktop include those for My Computer, Recycle Bin, Internet browser (e.g., Internet Explorer, google chrome mozilla firefox etc.), and My Documents.
- On the Windows Desktop, you also have access to the Windows Start Menu through the Start button on the Taskbar, as well as the Windows Notification Area.

Elements of Windows

- **Desktop** refers to the background of your screen on which the various programs run.
- **Icons** are those small pictures on the desktop and inside folders that represent various programs and sometimes folders.
- **Folders** are containers that can contain icons, programs, data or other folders (sub-folders).
- The **Title Bar** contains no text although it still provides the method for moving the folder. **Title bar** refers to the bar at the top of an open window that will tell you what the folder/window is (the title) and contains the minimize, maximize/restore and close buttons. You can also use the title bar to move a window around.
- **Cursor** is the graphic which indicates where the mouse is and what sort of action it is performing. The cursor will change from the default arrow to various shapes according to the purpose it is serving at the time.
- **Cursor** may form an I-beam shape when you are selecting text in a document or a double-arrow when you are resizing a window.
- **Task bar** refers to the bar usually at the bottom of your Windows screen with the Start Button on the left and the clock on the right.
- The **Scroll Bar** appears when there is more information in the window than can be displayed. This is usually a vertical scroll bar, but a horizontal scroll bar may display if the width of the window is too narrow.
- The Address Bar allows you to navigate up and down a series of windows by double-clicking on a folder. The Address Bar has a *bread crumb* menu.
- The Navigation Pane provides quick links to various folders and locations on your computer.
- **My Documents** contains most of your user documents and files except for music, pictures and videos.

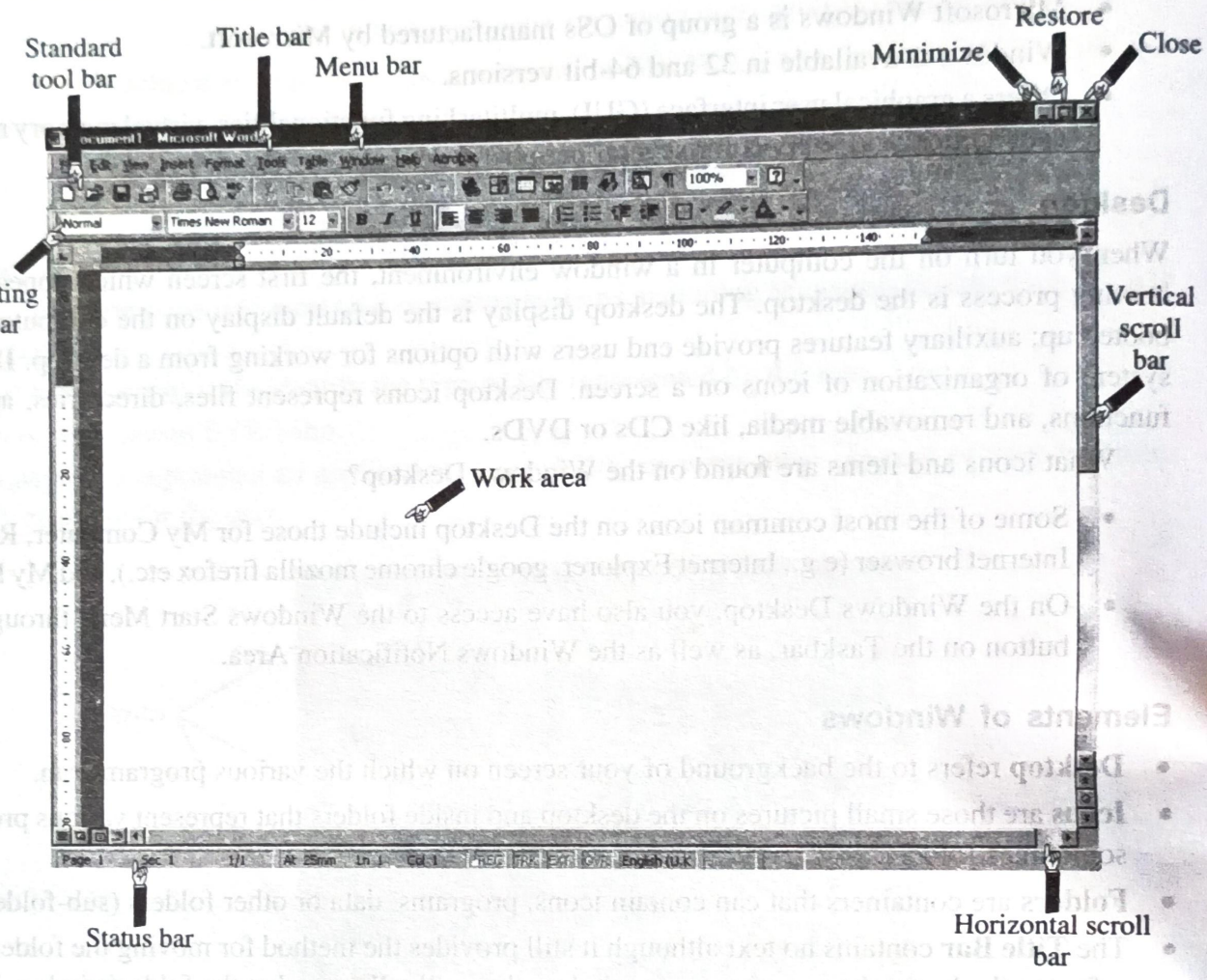


Fig 3.10 Window components

There are at least two buttons on the mouse (current mice also have a middle button). The type of click means the button you push when you click.

- The **left-click** selects items and is used most often.
- If no button is specified, you have to use the left button.
- If you **right-click** on an item you will get a context-sensitive menu with a list of the things that you *can* do with the item you clicked on.
- When you right-click to obtain a menu, you will select the menu with the left.

Common File Extensions

- **.txt** text file.
- **.doc** Microsoft Word document.
- **.docx** Microsoft Word open XML document.
- **.xls** Microsoft Excel spreadsheet.
- **.xlsx** Microsoft Excel open XML spreadsheet.
- **.ppt** Microsoft PowerPoint presentation document.

- **.pptx** Microsoft PowerPoint open presentation document.
- **.html** Web page (Hypertext Markup Language) file.
- **.mp3** audio (music) file.
- **.pdf** Adobe Portable Document Format file (Adobe Reader).
- **.iso** Disc Image File used to create a CD or DVD.
- **.jpg** JPEG image file.
- **.exe** executable (program) file.
- **.bat** batch file — can call other files including program or scripting files.
- **.scr** scripting file — sometimes mistakenly called a screen saver file.

Method of Starting a Program using Start Button

Start Menu or the start button is the primary location in Windows to locate your installed programs and find any files or folders. Start Menu is accessed by clicking the Start button, located in the bottom left-hand corner of the Windows Desktop screen.

- **Start menu** is a user interface element used in Microsoft Windows since Windows 95 and in some other operating systems.
- Provides a central launching point for computer programs and performing other tasks.

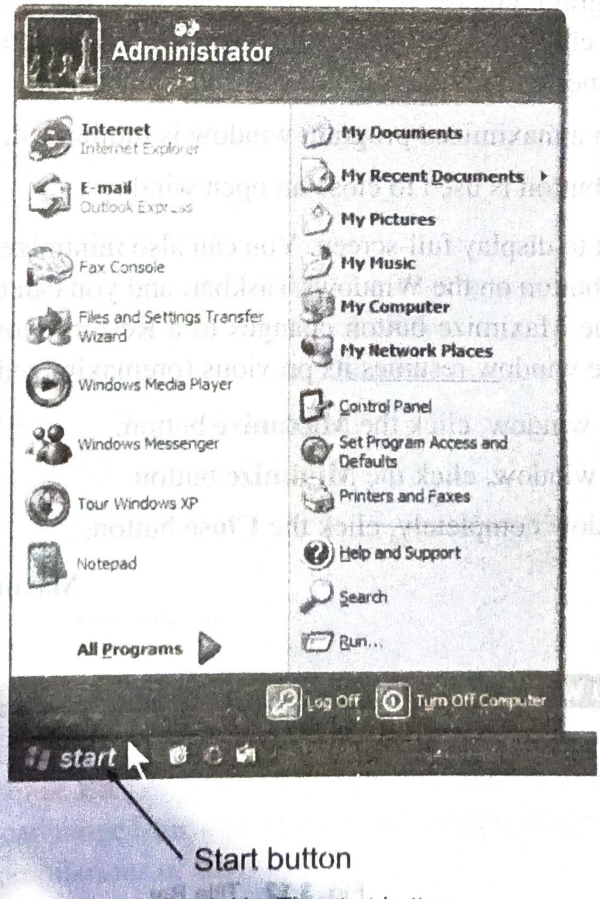


Fig. 3.11 The start button

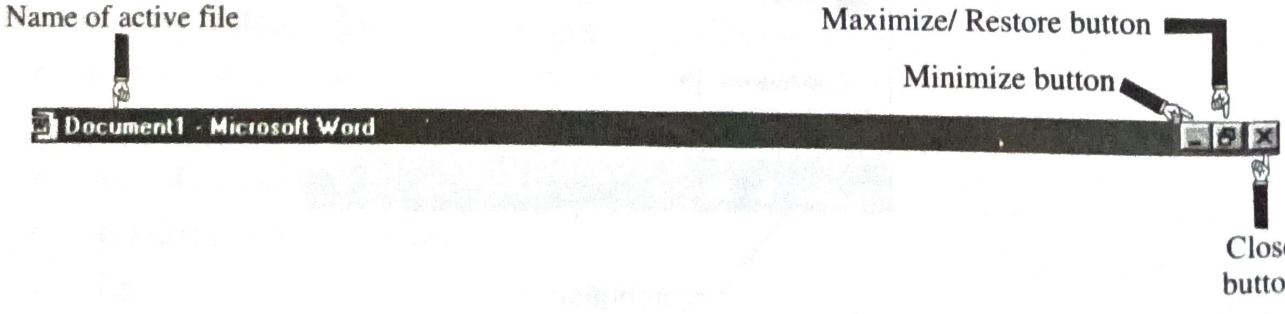
- Start menu is a feature of the Windows operating system that provides quick access to programs, folders, and system settings.
- Start menu is located in the lower-left corner of the Windows desktop.
- Contains two primary columns.
- Left column contains a list of the most commonly used programs, as well as an All Programs submenu, which displays all the currently installed applications.
- Bottom of the left column includes a search box, which can be used to search for programs and files.
- Right column contains links to common folders, such the Documents, Pictures, and Music folders.
- Also includes links to the Control Panel, Default Programs, and other system settings.
- Bottom of the right column includes a "Shut down" button, which can be used to turn off or restart the computer, put the computer to sleep, or switch users.
- Important part of the Windows user interface since it provides shortcuts to many commonly accessed items.
- User is able to use your computer more efficiently.

Maximize/restore, Minimize and Close Button

- **Maximize:** Maximize allows the user to enlarge a window, usually making it fill the entire screen or the program window in which it is contained. If a window is already maximized, the Maximize button changes to a Restore Down button. When you click the Restore Down button, the window resumes its previous (premaximized) dimensions.
- **Minimize:** When a maximized program window is minimized, it is hidden from view.
- **Close:** the close button is used to close an open window.

You can maximize it to display full-screen. You can also minimize it so that it disappears from the desktop and resides as a button on the Windows Taskbar, and you can close it completely. If a window is already maximized, the Maximize button changes to a Restore Down button. When you click the Restore Down button, the window resumes its previous (premaximized) dimensions.

- To maximize the window, click the **Maximize** button.
- To minimize the window, click the **Minimize** button.
- To close the window completely, click the **Close** button.



q 3.12 Title Bar

Maximize

- Mostly, open windows in a graphical user interface (GUI) have resizing options.
- **Maximize** allows the user to enlarge a window, usually making it fill the entire screen or the program window in which it is contained.
- When a window is maximized, it cannot be moved until it is reduced in size using the Restore button.
- You can get this effect by clicking the same button you used to maximize the window or by double-clicking the title bar.
- In Microsoft Windows 95 and above, the **maximize button** is displayed by a single box in the top right-hand of the window.
- When a maximized program window is minimized, it is hidden from view.
- To restore the window click the program's icon on the Windows Taskbar at the bottom of the screen.
- Before a window can be resized, make sure it is not maximized.
- A maximized window cannot be resized.
- If the window is maximized, click the Maximize / Resize button.
- Every window can be resized.

The title bar displays the name of the content or program.

The title bar also allows you to move the window to a different part of the desktop by right-clicking the Title Bar and dragging the window to the new position.

Minimize, Maximize/Restor, and Close buttons can be found on the right side of the Title Bar.

The minimize button is on the left and looks like a minus sign. Clicking on the minimize button places the window on the taskbar, usually found at the bottom of the screen. The windows is not closed or gone, it is simply out of the way of other windows, waiting to be opened or used again. To open the window again, click on it from the taskbar.

The Maximize/Restore button is in the middle and has two states. When a window is "Full Size", you can make it smaller. When the window is small, you can maximize it to full size.

The Close button is the one on the right with the X. Clicking the Close button will close the window or program.

3.16 USES OF FILES AND FOLDERS

A *file* is a collection of data that is stored on disk and that can be manipulated as a single unit by its name.

The **folders** are used to organize **files** on your computer. The **folders** themselves take up virtually no space on the hard drive. **Files** can range from a few bytes to several gigabytes. They can be documents, programs, libraries, and other compilations of data.

- A file is the common storage unit in a computer, and all programs and data are "written" into a file and "read" from a file.
- A folder holds one or more files, and a folder can be empty until it is filled.
- Folders are often referred to as directories.
- A folder can also contain other folders, and there can be many levels of folders within folders.
- Folders within a folder can be called subfolders.
- Folders are also called directories and they are created on the hard drive (HD) when the operating system and applications are installed.
- Files are always stored in folders.
- Even the computer's desktop is a special kind of folder that displays its contents across the screen.
- **File Extensions:** Files are identified by a short "extension" following a period at the end of their name. For example, shama.jpg is a JPEG image, mahima.doc is a Microsoft Word document file, and .EXE is an executable application in Windows.

- All the data on your hard drive consists of files and folders.
- Basic difference between the two is that files store data, while folders store files and other folders.
- Folders, often referred to as directories, are used to organize files on your computer.
- Folders themselves take up virtually no space on the hard drive.
- Files can range from a few bytes to several gigabytes.
- **Folder** is a special type of *file* on your computer's file system which contains other files and folders.

Why are folders important?

- Folder is the virtual location for applications, documents, data or other sub-folders.
- Folders help in storing and organizing files and data in the computer.
- Folders help you keep your files organized and separate.
- If you had no folders on your computer, your documents, programs, and operating system files would all be located in the same place.
- Allow you to have more than one file with the same file name.
- If all your files were in a single place, every file would need a unique file name.
- Although folders can contain large amounts of data, they do not take up any disk space.
- Reason for this is because folders are pointers to file locations within the file system of the computer.
- Operating systems, upon right clicking the folder, provide information on the folder along with its properties.
- Useful in organizing the data found in the system according to the user preferences.
- Can contain one or more files file of any type and can even store other directories with their own files.

3.17 METHOD OF VIEWING THE CONTENTS OF HARD DISK DRIVE USING EXPLORE OPTION

- Viewing the contents of a hard drive is possible using Windows Explorer, a tool integrated into Windows operating systems since Windows 95.
- This tool makes browsing through hard drive folders a breeze, but that assumes the hard drive is accessible to the computer.
- Windows Explorer is the file management application in Windows. Windows Explorer can be used to navigate your hard drive and display the contents of the folders and subfolders you use to organize your files on your hard drive. Windows Explorer is automatically launched any time you open a folder in Windows XP.
- You can also right-click on a folder and select Explore to open that folder using Windows Explorer.
- You may already have some shortcuts on your desktop that point to locations on your hard drive you will frequently use with Windows Explorer, such as My Computer and My Documents.
- My Computer shows you a list of all the drives installed on your system, including floppy drives and USB drives.
- The drive on which Windows is installed is usually displayed as the C: drive when you double-click on My Computer to open it using Windows Explorer.
- My Documents shows the location where Windows saves documents by default when you save them from an application such as Microsoft Word.
- You can view the folders for all the users who have accounts on your computer by opening the folder Documents and Settings, which is on the root of your C: drive.
- Under Documents and Settings, Windows creates a folder with the login name of each user who has an account on your computer.
- Each user's folder will have a subfolder named My Documents used to save any files they create.
- At the top of the window, you will see a series of check boxes you can check to make the My Computer and My Documents shortcuts visible on your desktop.
- To launch Windows Explorer, simply click on one of these shortcuts once they are visible on your desktop or right-click and select Explore.
- The Windows Explorer interface has several parts to it i.e., The Title Bar, The Menu Bar, The Standard Toolbar, The Address Bar, The Status Bar.
- Main Explorer window is divided into two panes.
- Contents of your folders are displayed on the right.
- By default, the pane on the left displays a list of common tasks you might want to perform when you open a folder, such as moving, renaming, and copying.
- You can also set this pane to display a hierarchical list of the folders on your hard drive.
- You can do this by clicking on the Folders button in the Standard Toolbar or by selecting View, Explorer Bar, Folders.
- Any folders that have a plus sign next to them have subfolders in them.

- To view the subfolders, just click on the plus sign and the folder will expand to reveal the subfolders below the folder's name.
- Plus sign then turns to a minus sign to allow you to collapse the contents of the folder.
- When you select a folder, its contents are displayed on the right pane. You can then use drag and drop to move and copy files on your hard drive.
- You can drag files or folders from one location to another to move them, while holding down th Control key when dragging copies the files or folders.
- You can select multiple files or folders using two handy keyboard shortcuts.
- To select several contiguous files, select the first file then hold down the Shift key and select the last file.
- All the files in between will be selected so you can copy or move them.
- To select several non-contiguous files, hold down the Control key while you select each file or folder.

3.18 CONTROL PANEL

The **Control Panel** is a component of Microsoft Windows that provides the ability to view and change system settings. It consists of a set of applets that include adding or removing hardware and software, controlling user accounts, changing accessibility options, and accessing networking settings.

- You can use Control Panel to change settings for Windows.
- These settings control nearly everything about how Windows looks and works, and you can use them to set up Windows.
- Control panel is a software module used to perform administrative and management operating system tasks and/or provide access to specific software features.
- Used to configure and manage almost all aspects of Windows, including keyboard and mouse functionality, users and passwords, power options, network settings, desktop background, display settings, sound settings, mouse settings, hardware and software options, installation and removal of programs, parental control, speech recognition, etc.
- Part of the system's GUI.
- Provides easy management and access to panel components.
- Made up of a group of individual control panel applets.
- Accessible from the Windows System folder or category in the Apps listing.
- Can also be accessed in any version of Windows by executing control from a command line interface like Command Prompt.
- Section of Microsoft Windows that enables a user to change various computer hardware and software features.
- Settings for the mouse, display, sound, network, and keyboard are some examples of what may be modified in the Control Panel.

3.19 DISK DEFRAGMENTATION

3.19.1 Fragmentation

When data, such as a file, is stored on a hard drive the operating system attempts to store that file in one section of contiguous, locations that are connecting without a break, space. When you have a new hard drive, storing data in contiguous spaces is not a problem. As you use the hard drive, though, files will be deleted from it and small pockets of space will be created on your hard drive. These small pockets of space on your hard drive is called fragmentation. If the hard drive is heavily fragmented, there is the possibility that there will not be enough contiguous space available to store the file, and therefore the file will be broken up and stored in multiple locations on the hard drive. This causes the file to become fragmented. This is especially bad when installing new software on your computer because the program will now be installed over multiple locations on your hard drive. Now when you run this particular application its performance will be degraded because it has to be loaded from multiple locations on the hard drive.

3.19.2 Defragmentation

To solve the fragmentation problem, software developers developed a type of program called a Disk Defragmenter. A defragmenter is an application that reorganizes the data on your hard drive's partitions in such a manner that the files are stored in as much contiguous space as possible. The defragmenter will search your hard drive partition and move data from one location to another location, so that the files stored there are one contiguous piece, instead of being spread throughout multiple locations on the hard drive's partition. This allows the programs and data to run more efficiently and quickly as the operating system does not have to read from multiple locations.

Using the Windows Disk Defragmenter: Windows comes with a program called Disk Defragmenter which is installed with the operating system. This program can be found in your System Tools folder under Accessories on your Programs menu. When you click on the Analyze button, the Defragmenter will scan the partition you have selected and give you a report on how badly it is fragmented. Do the defragmentation to work more efficiently.

Thought question: disk defragmentator acts like your maid.....she cleans the kitchen every day so that you have proper space to work and hence , the cooking can be done easily and efficiently! Do you agree?

Disk Defragmenter is a utility in Microsoft Windows designed to increase access speed by rearranging files stored on a disk to occupy contiguous storage locations, a technique called defragmentation. Defragmentation is like cleaning house for your PC, it picks up all of the pieces of data that are spread across your hard drive and puts them back together again. Defragmentation is important because every computer suffers from the constant growth of fragmentation and if you don't defragment, your PC suffers.

- Disk fragmentation occurs when a file is broken up into pieces to fit on the disk.
- Because files are constantly being written, deleted and resized, fragmentation is a natural occurrence.
- When a file is spread out over several locations, it takes longer to read and write.
- Results in slow PC performance, long boot-times, random crashes and freeze-ups – even a complete inability to boot up at all.

Procedure of disk partition and its operation (Shrinking, Extending, Delete, Format).

- In order to use a hard drive, or a portion of a hard drive, in Windows you need to first partition it and then format it.
- This process will then assign a drive letter to the partition allowing you to access it in order to use it to store and retrieve data.
- If you are using Windows 8, type Disk Management at the start screen, click on **Settings**, and then click on the **Create and format hard disk partitions** option. Then skip to one step. Otherwise, click on the **Start** button and select the **Control Panel** option.
- If in Classic control panel mode, double-click on the **Administrative Tools** icon and then double-click on **Computer Management** icon.
- If your control panel is in the Category view, click on **Performance and Maintenance**, then click on **Administrative Tools,** and finally double-click on the **Computer Management** icon.
- When the Computer Management screen opens, click on the **Disk Management** option under the **Storage** category.
- To make a partition from the unused space :
  - Right click on the space listed as unallocated.
  - At the menu that comes up, click on the **New Partition** option.
  - You will now be presented with a wizard as to how you would like the partition to be created. At the first screen press **Next**.
  - At the following screen, determine if you need a primary or extended partition. For more information about these partitions you can read our partition tutorial listed above. Most people will be fine selecting **Primary Partition**. Select **Primary Partition** and press **Next**.
  - At the next screen you will be prompted to type in how much of the unallocated space you would like used for the new partition. Press the **Next** button.
  - At the next screen select the drive letter you would like assigned to it, or use the default one given. When done, press the **Next** button. The drive letter that you assign here will be how you access the partition later.
  - In this step you will determine how you would like the new partition to be formatted.
  - Type a name in the **Volume Label** field that will be associated with this partition or leave it blank.
  - Finally press the **Next** button and you will come to a summary screen. Review how the partition will be created, and if you are satisfied, press the **Finish** button to complete the creation and formatting of your new hard disk partition.

- When the computer finishes creating and formatting the new partition you will be presented with the Disk Management screen again and will see that you have a new partition and drive letter on your computer. Now you can use that drive to start storing your data.

To delete a partition please follow these steps:

- Click on the **Start** button and select the **Control Panel** option.
- If in Classic control panel mode, double-click on the **Administrative Tools** icon and then double-click on **Computer Management** icon.
- If your control panel is in the Category view, click on **Performance and Maintenance**, then click on **Administrative Tools,** and finally double-click on the **Computer Management** icon.
- When the Computer Management screen opens, click on the **Disk Management** option under the **Storage** category.
- Right-click on the partition you would like to delete and choose the **Delete Partition** option.
- A confirmation box will come up asking if you are sure you would like to continue. If you press the yes button, all data on this partition will be deleted. If you are sure about deleting this partition, press the **Yes** button.

Disk Defragmenter is a utility in Microsoft Windows designed to increase access speed by rearranging files stored on a disk to occupy contiguous storage locations, a technique called defragmentation.

3.20 INSTALLING AND UNINSTALLING OF NEW SOFTWARE USING CONTROL PANEL

Installation (or **setup**) of a computer program (including device drivers and plugins), is the act of making the program ready for execution. Because the process varies for each program and each computer, programs (including operating systems) often come with an *installer*, a specialized program responsible for doing whatever is needed for their installation. Installation may be part of a larger software deployment process.

- Installation typically involves code being copied/generated from the installation files to new files on the local computer for easier access by the operating system.
- Because code is generally copied/generated in multiple locations, uninstallation usually involves more than just erasing the program folder.
- For example, registry files and other system code may need to be modified or deleted for a complete uninstallation.
- Some computer programs can be executed by simply copying them into a folder stored on a computer and executing them.
- Other programs are supplied in a form unsuitable for immediate execution and therefore need an installation procedure.

- Once installed, the program can be executed again and again, without the need to reinstall before each execution.

Common operations performed during software installations :

- Making sure that necessary system requirements are met.
- Checking for existing versions of the software.
- Creating or updating program files and folders.
- Adding configuration data such as configuration files, Windows registry entries or environment variables.
- Making the software accessible to the user, for instance by creating links, shortcuts or bookmarks.
- Configuring components that run automatically, such as daemons or Windows services.
- Performing product activation.
- Updating the software versions.

- An *installation program* or *installer* is a computer program that installs files, such as applications, drivers, or other software, onto a computer.
- Installers are specifically made to install the files they contain.
- Installers can also be general-purpose and work by reading the contents of the *software package* to be installed.

3.21 IMPORTANT QUESTIONS AND ANSWERS

Q1. What is Hardware and Software?

Ans. A computer system consists of two major elements: **hardware and software**.

- Computer **hardware** is the collection of all the parts you can physically touch.
- Computer **software** is not something you can touch.
- **Software** is a set of instructions for a computer to perform specific operations.

Q2. What is GUI and CUI?

Ans.
- The **graphical user interface** (**GUI** is a type of user interface that allows users to interact with electronic devices through graphical icons and visual indicators such as secondary notation, instead of text-based user interfaces, typed command labels or text navigation.
- **GUI** stands for **graphical user interface**.
- Interface we are using now a days on windows operating system, smartphones, ATM machine and more.
- Attractive and easy to use.
- **CUI** is Command line user interface or character user interface.
- Means that we have to type commands to interact with the computer.

GUI	CUI
Symbols, pictures and pointing commands are use to execute commands	Set of characters and words are used to execute the commands
No need to remember the command. A small practice enables you to use the commands	The syntax and various options are required to be remembered.
General menu structure and commands are used for all the applications	Different application have their own set of commands.
Number of applications can be opened and executed in different window at the same time	Only one application can run at a time
Minimum use of keyboard	Maximum use of keyboard
Mouse extensively used	Mouse used only in some applications
Easy to operate	Not user friendly hence difficult to operate

Q. What are internal and external commands of DOS?

Ans. In DOS systems, an internal command is any command that resides in the COMMAND.COM file. This includes the most common DOS commands, such as COPY and DIR. Commands that reside in other COM files, or in EXE or BAT files, are called external commands.

Some Internal Commands

- **Date:** This command is used to display the system current date setting and prompt you to enter a new date. The syntax is: **date [/T | date]**.
- **Time:** This command is used to displays or set the system time. The syntax is: **time [/T | time]**.
- **COPY CON:** It is used to create a file in the existing directory. Here CON is a DOS reserved word which stands for console.

  Syntax is: **COPY CON filename** after that press Enter and start typing your text and after you're done typing your text, to save and exit hit F6 key.
- **TYPE:** This command is used to display the contents of a text file or files. The syntax is: **TYPE [drive:][path]filename**.
- **CLS:** It is used to clear the screen. Syntax is **CLS**.

Some External Commands

- **xcopy:** This command is used to copy files and directory trees from one disk to another disk. Syntax is **xcopy source [destination]**.
- **diskcopy:** This command copies the contents of one floppy from the source drive to a formatted or un-formatted floppy disk in the destination drive. This command copies the data from particular position on the source disk to exactly the same position on the destination disk. Syntax **diskcopy A: B:**

- **Tree:** This command is very useful to view the list of directories and subdirectories present on the disk in graphical form. If you wanted to include files also with directories and subdirectories, then you'll have to give the command line as tree/f which presents the tree view of all the content on your disk. Here is the syntax for this command with allowed switches: **tree [drive:path] [/F] [/A]**.
- **Deltree:** This command is used to remove a directory along with its contents. Syntax is **deltree [drive:path]**.

Q. Explain the process of creating file, folder, copying, moving, deleting file, folder in windows.

Ans. Copy a File or Folder

- Open the drive or folder containing the file or folder you want to copy.
- Select the files or folders you want to copy.
- Click the **Organize** button on the toolbar, and then click **Copy**.
- Display the destination folder where you want to copy the files or folder.
- Click the **Organize** button on the toolbar, and then click **Paste**.

Move a File or Folder

- Open the drive or folder containing the file or folder you want to move.
- Select the files or folders you want to move.
- Click the **Organize** button on the toolbar, and then click **Cut**.
- Display the destination folder where you want to move the files or folder.
- Click the **Organize** button on the toolbar, and then click **Paste**.

Copy or Move a File or Folder Using Drag and Drop

- Open the drive or folder containing the file or folder you want to copy or move.
- Select the files or folders you want to copy or move.
- In the Navigation pane, point to a folder list to display the expand and collapse arrows.
- Click the arrows to display the destination folder, and then click the destination folder.
- Right-click the selected files or folders, drag to the destination folder, and then click **Copy Here** or **Move Here**.

Name the Type of Operating Systems

- Simple Batch System
- Multiprogramming Batch System
- Multiprocessor System
- Desktop System
- Distributed Operating System
- Clustered System
- Realtime Operating System
- Handheld System

Simple Batch Systems

- **No direct interaction between user and the computer.**
- The user has to submit a job (written on cards or tape) to a computer operator.
- Then computer operator places a batch of several jobs on an input device.
- Jobs are batched together by type of languages and requirement.
- Then a special program, the monitor, manages the execution of each program in the batch.
- The monitor is always in the main memory and available for execution.

Multiprogramming Batch Systems

- Picks up and begins to execute one of the jobs from memory.
- Once this job needs an I/O operation operating system switches to another job (CPU and OS always busy).
- Jobs in the memory are always less than the number of jobs on disk (Job Pool).
- If several jobs are ready to run at the same time, then the system chooses which one to run through the process of **CPU Scheduling**.
- In Non-multiprogrammed system, there are moments when CPU sits idle and does not do any work.
- In Multiprogramming system, CPU will never be idle and keeps on processing.

Time Sharing Systems are very similar to Multiprogramming batch systems. In fact time sharing systems are an extension of multiprogramming systems.

In Time sharing systems the prime focus is on **minimizing the response time**, while in multiprogramming the prime focus is to maximize the CPU usage.

Q. What is Bios?

Ans.

- The BIOS (basic input/output system) is a program pre-installed on Windows-based computers that the computer uses to start up.
- The CPU accesses the BIOS even before the operating system is loaded.
- BIOS then checks all your hardware connections and locates all your devices. If everything is OK, the BIOS loads the operating system into the computer's memory and finishes the boot-up process.
- BIOS is the program a personal computer's microprocessor uses to get the computer system started after you turn it on.
- Manages data flow between the computer's operating system and attached devices such as the hard disk, video adapter, keyboard, mouse and printer.
- Integral part of your computer.
- Program that is made accessible to the microprocessor on an erasable programmable read-only memory (EPROM) chip.
- When you turn on your computer, the microprocessor passes control to the BIOS program, which is always located at the same place on EPROM.

- When BIOS boots up (starts up) your computer, it first determines whether all of the attachments are in place and operational and then it loads the operating system into your computer's random access memory (RAM) from your hard disk or diskette drive.
- With BIOS, your operating system and its applications are freed from having to understand exact details about the attached input/output devices.
- When device details change, only the BIOS program needs to be changed. Sometimes this change can be made during your system setup. In any case, neither your operating system or any applications you use need to be changed.

Q. What are system utilities?

Ans. • Utility software is system software designed to help analyze, **configure**, optimize or maintain a computer.

- Used to support the computer infrastructure in contrast to application software, which is aimed at directly performing tasks that benefit ordinary users.

Q. Explain Editior, Linker Loader, File Manager.

Ans. A computer system is made of hardware and software. We write programs in high-level language, which are then fed into a series of tools and OS components to get the desired code that can be used by the machine. This is known as Language Processing System.

The high-level language is converted into binary language in various phases. A **compiler** is a program that converts high-level language to assembly language. Similarly, an **assembler** is a program that converts the assembly language to machine-level language.

- User writes a program in C language (high-level language).
- The C compiler, compiles the program and translates it to assembly program (low-level language).
- An assembler then translates the assembly program into machine code (object).
- A linker tool is used to link all the parts of the program together for execution (executable machine code).
- A loader loads all of them into memory and then the program is executed.

Preprocessor

- A tool that produces input for compilers.
- Deals with macro-processing, augmentation, file inclusion, language extension, etc.

Interpreter

- Translates high-level language into low-level machine language.
- Difference between compiler and interpretor lies in the way they read the source code or input.
- Compiler reads the whole source code at once, creates tokens, checks semantics, generates intermediate code, executes the whole program and may involve many passes.
- However, an interpreter reads a statement from the input, converts it to an intermediate code, executes it, then takes the next statement in sequence.
- If an error occurs, an interpreter stops execution and reports it. Whereas a compiler reads the whole program even if it encounters several errors.

Assembler

- Translates assembly language programs into machine code.
- Output of an assembler is called an object file, which contains a combination of machine instructions as well as the data required to place these instructions in memory.

Linker

- Computer program that links and merges various object files together in order to make an executable file.
- All these files might have been compiled by separate assemblers.
- Major task of a linker is to search and locate referenced module/routines in a program and to determine the memory location where these codes will be loaded, making the program instruction to have absolute references.

Loader

- Part of operating system and is responsible for loading executable files into memory and execute them.
- Calculates the size of a program (instructions and data) and creates memory space for it.
- Initializes various registers to initiate execution.

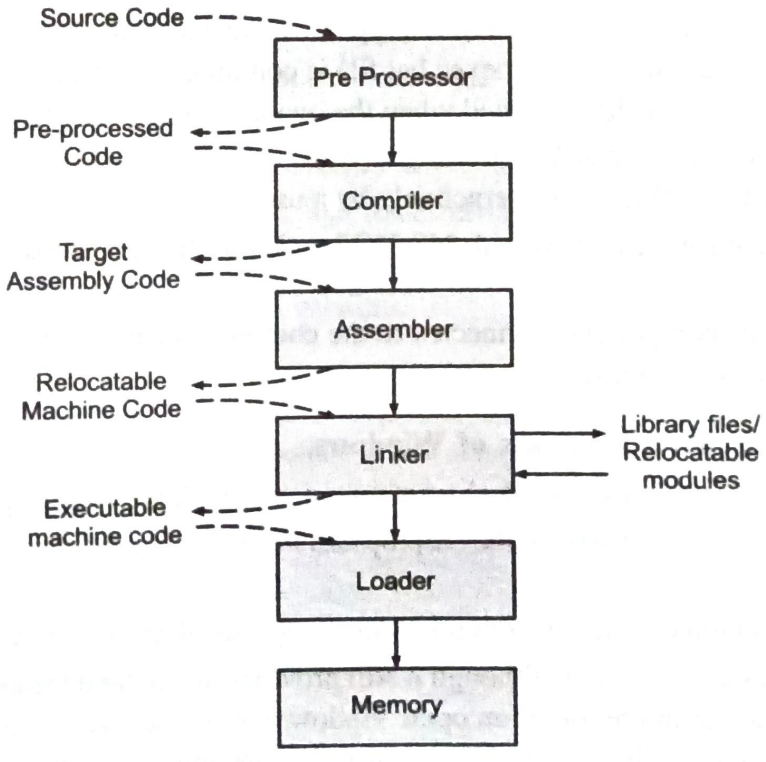


Fig. 3.13

Q. What are Wild cards?

Ans. • **Wildcard** is a symbol used to replace or represent one or more characters.

- Wildcards are typically either an asterisk (*), which represents one or more characters or question mark(?), which represents a single character.

- Wildcard refers to a character that can be substituted for zero or more characters in a string. Wildcards are commonly used in computer programming, database SQL search queries, and when navigating through DOS or Unix directories via the command prompt.
- An asterisk (*) matches zero or more characters, while a question mark (?) matches a single character.
- An **asterisk** (*) may be used to specify any number of characters. It is typically used *at the end of a root word*, when it is referred to as "**truncation**."
- Example: searching for *INTER** would tell the database to look for all possible endings to that root like INTERNAL, INTERVIEW, INTERMEDIATE etc.
- A **question mark** (?) may be used to represent a single character, anywhere in the word. It is most useful when there are *variable spellings* for a word, and you want to search for all variants at once.
- For example, searching for ***c?r*** would return both ***car*** and ***cover***.

Q. Explain autoexec.bat and config.sys.

Ans.
- Autoexec.bat is a file containing Disk Operating System commands that are executablewhen the computer is booted (started).
- The commands in autoexec.bat tell the operating system which application programs are to be automatically started, how memory is to be managed, and initialize other settings.
- Each command in autoexec.bat could be typed in manually after the computer is started, but that would take too long. The autoexec.bat file is command script that is written beforehand so that it can be automatically executed when the operating system is started.
- The bat suffix stands for batch, indicating that this is a file containing a sequence of commands entered from a file rather than interactively by a user.
- **Config.sys** is a system file used with MS-DOS and OS/2 that is loaded each time the computer first boots up.
- This file controls components connected to the computer such as memory and other hardware devices with early computers.

Q. Name and Explain Some Elements of Windows.

Ans.
- **Desktop** refers to the background of your screen on which the various programs run.
- **Icons** are those small pictures on the desktop and inside folders that represent various programs and sometimes folders.
- **Folders** are containers that can contain icons, programs, data or other folders (sub-folders).
- The **Title Bar** contains no text although it still provides the method for moving the folder. **Title bar** refers to the bar at the top of an open window that will tell you what the folder/window is (the title) and contains the minimize, maximize/restore and close buttons. You can also use the title bar to move a window around.
- **Cursor** is the graphic which indicates where the mouse is and what sort of action it is performing. The cursor will change from the default arrow to various shapes according to the purpose it is serving at the time.

- **Cursor** may form an I-beam shape when you are selecting text in a document or a double-arrow when you are resizing a window.
- **Task bar** refers to the bar usually at the bottom of your Windows screen with the Start Button on the left and the clock on the right.
- The **Scroll Bar** appears when there is more information in the window than can be displayed. This is usually a vertical scroll bar, but a horizontal scroll bar may display if the width of the window is too narrow.
- The Address Bar allows you to navigate up and down a series of windows by double-clicking on a folder. The Address Bar has a *bread crumb* menu.
- The Navigation Pane provides quick links to various folders and locations on your computer.
- **My Documents** contains most of your user documents and files except for music, pictures and videos.

Q. Explain Some Features and Advantages of Windows.

Ans.
- Allows the user to interact with the computer very easily and comfortably due to the use of GUI
- Controls the storage of data (images, files, music).
- Controls hardware attached to the computer such as webcams, scanners, mouse, keyboards, printers etc.
- Helps to open and close programs and gives them part of the computer's memory to allow them to work.
- Controls access to a computer different users have and the computer's security.
- Promotes multitasking by allowing the user to do several things on the computer at once – for example, watch a video while writing a letter.
- Deals with errors and user instructions, and issues error messages.
- Microsoft Windows is a group of OSs manufactured by Microsoft.
- Windows is available in 32 and 64-bit versions.

EXERCISES

1. What is an operating system? Why is it important for the computer?
2. What are hardware and software?
3. What are types of softwares?
4. What are types of operating system?
5. What is disk operating system?
6. What are types of dos commands?
7. Explain the role of operating system as a resource manager.
8. What is BIOS?
9. What are system utilities?

10. What are editor, loader, linker and file manager?.
11. What are GUI and CUI?
12. What are directories and files ?
13. What are wild cards?
14. What are autoexec.bat and config.sys?
15. What are features of window desktop?
16. What are components of windows?
17. Explain function of each component of window.
18. What is the method of starting a program using start button?
19. What are maximize, minimize, restore down and close button?
20. What are uses of file and folder?
21. What is the method of viewing the contents of hard disk drive using explore option?
22. What is a control panel?
23. What is disk defragmentation?
24. Explain the installation and un installation of the application software.

❑❑❑

4 Chapter

FUNDAMENTALS OF INTERNET

THINK ABOUT IT

Becoming thoughtless does not mean non-existence of thought. It simply means reaching out to the absolute state of the consciousness which is free of thinking. All of us need a thought to allow universal consciousness to express itself through finite medium – but in the end the expression itself is infinite, whether visible or invisible"

—Drunken Mystic

4.1 CONCEPTS OF COMPUTER NETWORK

A computer network is a group of computer systems and other computing hardware devices that are linked together through communication channels to facilitate communication and resource-sharing among a wide range of users. Networks are commonly categorized based on their characteristics

- A computer network is a set of computers connected together for the purpose of sharing resources and to facilitate communication.
- most common resource shared today is connection to the Internet. Other shared resources can include a printer or a **file server**.
- Internet itself can be considered a computer network.
- Uses of computer networks.
- Resource Sharing.
- Server-Client model.
- Communication Medium.
- eCommerce.
- Access to remote information.

  Person-to-person communication.

  nteractive entertainment.

4.2 CLIENT-SERVER AND PEER-TO-PEER NETWORK

We know that a network consists of two or more computers intended to share resources is a computer network. Now question arises onnect various computers to form a network. There are

two ways or models to connect the computers into a network i.e. Client-Server and Peer-to-Peer network models.

4.2.1 Client-Server Network

A client-server network is a communications model in which multiple client programs share the services of a common server program.

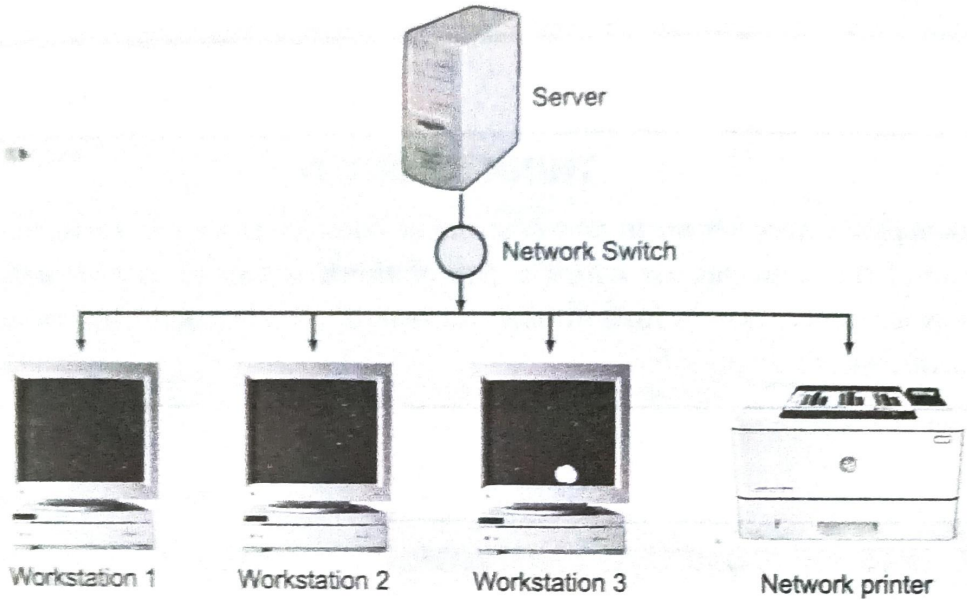


Fig. 4.1 Client server network model

A system where two or more computers connected to central computer to share or use resource and that central computer is known as server is a client-server network. This is named as client-server because the central server computer serves the resources to its connected computer called clients.

A Computer networking model where one or more powerful computers (servers) provide the different computer network services and all other user of computer network (clients) access those services to perform user's tasks is known as client/server computer networking model.

- In such networks, there exists a central controller called server. A server is a specialized computer that controls the network resources and provides services to other computers in the network.
- All other computers in the network are called clients. A client computer receives the requested services from a server.
- A server performs all the major operations like security and network management.
- All the clients communicate with each other via centralized server.
- If client 1 wants to send data to client 2, it first sends request to server to seek permission for it. The server then sends a signal to client 1 allowing it to initiate the communication.
- A server is also responsible for managing all the network resources such as files, directory, applications & shared devices like printer etc.

- If any of the clients wants to access these services, it first seeks permission from the server by sending a request.
- Most Local Area Networks are based on client server relationship.

A client-server network is a central computer, also known as a server, which hosts data and other forms of resources. Clients such as laptops and desktop computers contact the server and request to use data or share its other resources with it.

Advantages of Client Server Networks

- Centralized back up is possible.
- Use of dedicated server improves the performance of whole system.
- Security is better in these networks as all the shared resources are centrally administered.
- Use of dedicated servers also increases the speed of sharing resources.

Disadvantages of Client Server Networks

- Requires specialized servers with large memory and secondary storage. This leads to increase in the cost.
- Cost of network operating system that manages the various clients is high.
- Requires dedicated network administrator.

4.2.1 Peer-to-Peer Network

A peer-to-peer network is group of computers, each of which acts as a node for sharing files within the group. Instead of having a central server to act as a shared drive, each computer acts as the server for the files stored upon it. When a peer-to-peer network is established over the Internet, a central server can be used to index files, or a distributed network can be established where the sharing of files is split between all the users in the network that are storing a given file.

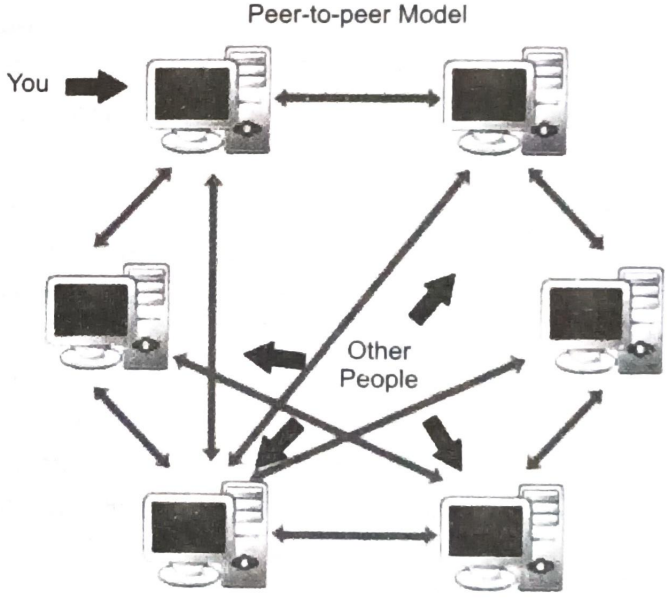


Fig. 4.2 Peer-to-peer (P2P) network

In a P2P network, the peers are computer systems which are connected to each other via the Internet. Files can be shared directly between systems on the network without the need of a central server. Hence, each computer on a P2P network becomes a file server as well as a client. The only requirements for a computer to join a peer-to-peer network are an Internet connection and P2P software. Common P2P software programs include Kazaa, Limewire, BearShare, Morpheus, and Acquisition. Once connected to the network, P2P software allows you to search for files on other people's computers. In addition, other users on the network can search for files on your computer, but typically only within a single folder that you have designated to share. While P2P networking makes file sharing easy and comfortable, is also has led to a lot of software piracy and illegal music downloads.

- Easy to install and so is the configuration of computers on this network.
- All the resources and contents are shared by all the peers, unlike server-client architecture where Server shares all the contents and resources.
- More reliable as central dependency is eliminated. Failure of one peer doesn't affect the functioning of other peers. In case of Client –Server network, if server goes down whole network gets affected.
- No need for full-time System Administrator. Every user is the administrator of his machine. User can control their shared resources.
- Overall cost of building and maintaining this type of network is comparatively very less.

Limitations of Peer to Peer Architecture

- In this network, the whole system is decentralized thus it is difficult to administer.
- Any single person cannot determine the whole accessibility setting of whole network.
- Security in this system is very less.
- Viruses, spywares, trojans, etc. malwares can easily transmitted over this architecture.
- Data recovery or backup is very difficult.
- Each computer should have its own back-up system.
- Lot of movies, music and other copyrighted files are transferred using this type of file transfer.
- Peer to peer networks are good to connect small number (around 8 to 10) of computers and places where high level of security is not required.
- In case of business network where sensitive data can be present this type of architecture is not preferred.

Client-Server and Peer-to-Peer network.

- The main difference between the Client-Server and Peer-to-Peer network model is that in Client-Server model, the data management is centralised whereas, in Peer-to-Peer each user has its own data and applications. In Client-Server network model Server is a powerful system that stores the data or information in it. Client is the machine which let the users access the data on the remote server.

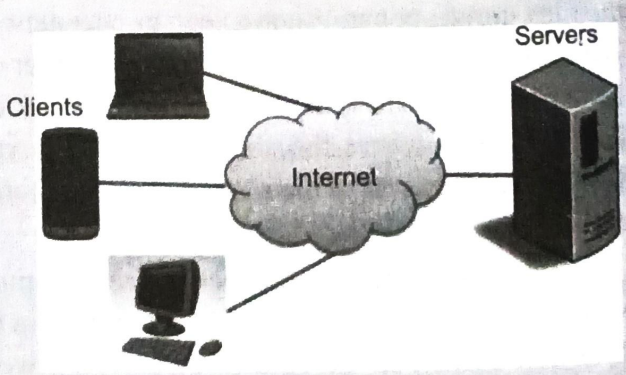


Fig. 4.3 Servers Network Model

- System administrator manages the data on the server.
- Client machines and the server are connected through a network.
- Allows the clients to access data even if the client machine and server are far apart from each other.
- Each node is considered as a peer. Client process on the client machine sends the request to the server process on the server machine.

- When the server receives the client request, it lookouts for the requested data and send it back with the reply.

Peer-to-Peer model does not distinguish between client and server instead each node can either be a client or a server depending on the whether the node is requesting or providing the services.

- To become a part of peer-to-peer, a node must initially join the network.
- After joining it must start to provide services to and must request the services from other nodes in the peer-to-peer system.
- Two ways to know which node provides which services:
- When a node enters the peer-to-peer system, it must register the services it will be providing, into a centralized lookup service on the network. When a node desires for any specific service it must contact centralized lookup services to check out which node will provide the desired services. Now, Rest of the communication is done by the desiring node and the service providing node.

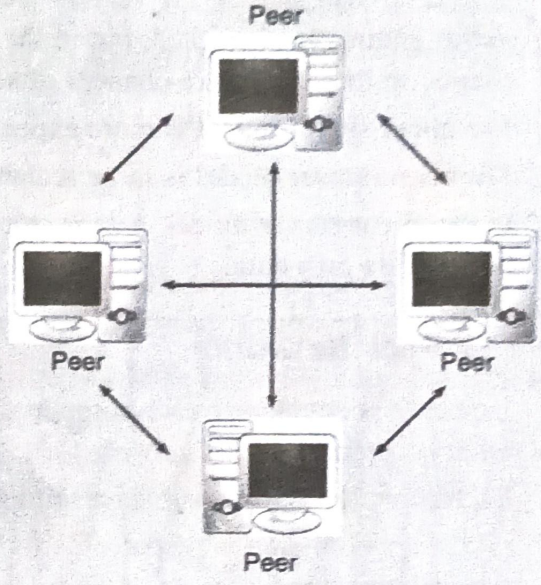


Fig. 4.4

- A node desiring for the specific services must broadcast the request for services to all other nodes in the peer-to-peer system. The node providing the requested service will respond to the node making the request.

Characteristics	Client-server	Peer-to-peer
Basic	Specific server and specific clients connected to the server.	Each node act as client and server.
Service provided	Client request for service and server respond with the service.	Each node can request for services and can also provide the services.
Data storage	Data is stored in a centralized server.	Each peer has its own data.
Server	When several clients request for the services simultaneously, a server can get bottlenecked.	Server not bottlenecked.
Cost	Costly to implement.	Less costly.
Stability	More stable and scalable.	Less stable.

- The main difference between Client-Server and Peer-to-Peer network is that there is a dedicated server and specific clients in the client-server network model whereas in peer-to-peer each node can act as both server and client.

- In the client-server model, the server provides services to the client. However, in peer-to-peer, each peer can provide services and can also request for the services.
- In the client-server model sharing information is more important whereas, in peer-to-peer model connectivity between peers is more important.
- In peer-to-peer model, the servers are distributed in a system, so there are fewer chances of server getting bottlenecked, but in the client-server model, there is a single server serving the clients, so there are more chances of server getting bottlenecked.
- The client-server model is more expensive to implement.
- The client-server model is more scalable and stable.
- In the client-server model, data is stored on a centralized server whereas, in peer-to-peer each peer has its own data.

Peer to Peer Network

- In peer to peer network each computer is responsible for making its own resources available to other computers on the network.
- Each computer is responsible for setting up and maintaining its own security for these resources.
- Also each computer is responsible for accessing the required network resources from peer to peer relationships.
- Peer to peer network is useful for a small network containing less than 10 computers on a single LAN.
- In peer to per network each computer can function as both client and server.
- Peer to peer networks do not have a central control system.
- Peer networks are amplified into home group.

4.3 NETWORKING DEVICES

Network devices are the devices used for organizing a network, connecting to a network, routing the packets, strengthening the signals, communicating with others, surfing the web, sharing files on the network and many more uses.

Most networks are small and even large networks are often divided into smaller segments. That smaller segment is set apart from the larger network by a device that can filter data and help the network be more efficient. These devices that filter traffic are called network or connectivity devices. The important functions of networking devices are:

- **Controlling traffic.** Large networks need a way to filter and isolate data traffic.
- **Connectivity.** These devices can connect different types of networks using different types of network protocols.
- **Hierarchical addressing.** Segmenting the network with connectivity devices provides an actual (physical) example of delivering actual data to the right destination through the IP address's network ID and host ID.

Repeater

A repeater regenerates the signal over the same network before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network. It is a 2 port device.

Repeater is a electronic device that reshapes and amplifies the signal received from one LAN segment to another.

- Used to boost the signals in the network.
- Operates at physical layer in the OSI layer model.
- Best suited for long distances network and bus topology.
- Main advantage is that the remove unwanted noise for the incoming signals.
- Requires separate power supply for functioning.
- Repeater component parts varies from where they are used like in digital communication, wireless communication, fiber-optic system, cellular system etc.
- Operates at the physical layer.
- They do not amplify the signal.
- When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength.

Hub

A hub is a connectivity device to which network cables are attached to form a network segment. A hub serves as a central point to which all of the hosts in a network connect to. It is an OSI layer 1 device. It receives a signal from one port and sends it out to all other ports. A hub is a multiport repeater. It connects multiple wires coming from different branches, for example, the connector in star topology which connects different stations. Hubs cannot filter data, so data packets are sent to all connected devices.

Types of Hub

- **Active Hub:** These are the hubs which have their own power supply and can clean , boost and relay the signal along the network. It serves both as a repeater as well as wiring center. These are used to extend maximum distance between nodes.
- **Passive Hub:** These are the hubs which collect wiring from nodes and power supply from active hub. These hubs relay signals onto the network without cleaning and boosting them and can't be used to extend distance between nodes.

A connectivity device to which network cables are attached to form a network segment. Hubs typically do not filter data, but instead retransmit incoming data packets or frames to all parts.

Almost all networks today use a central hub or switch to which the computers on the network connect. In a hubbed network, each computer is connected to the hub through a single line. That makes adding a host to the network, or taking it off, a simple task.

Hub is a connecting device in which various types of cables are connected to centralize network traffic through a single connecting point.

- Hub with multiple ports are used to connect topologies, segments of LAN and to monitor network traffic.
- It manages and controls the send and received data to and from the computers.
- Hub works on the physical layer of OSI or TCP/IP model.
- To avoid collision of data CSMA/CD protocol is used and protocol varies depending upon the vendor.
- Collision domain of all hosts connected through Hub remains one.
- Do not have intelligence to find out best path for data packets which leads to inefficiencies and wastage.

Bridge

A bridge is a connectivity device that forwards data based on a physical address. A bridge operates at data link layer. A bridge is a repeater, with add on functionality of filtering content by reading the MAC addresses of source and destination. It is also used for interconnecting two LANs working on the same protocol. It has a single input and single output port, thus making it a 2 port device.

Types of Bridges

- **Transparent Bridges:** These are the bridge in which the stations are completely unaware the bridge's existence i.e. whether or not a bridge is added or deleted from the network reconfiguration of the stations is unnecessary. These bridges makes use of two processes i.e. bridge forwarding and bridge learning.
- **Source Routing Bridges:** In these bridges, routing operation is performed by source station and the frame specifies which route to follow. The hot can discover frame by sending a special frame called discovery frame, which spreads through the entire network using all possible paths to destination.

Bridge is a connectivity device that forwards data based on a physical address. A bridge filters and forwards packets by physical address. Bridges operate at the Network Access Layer in the TCP/IP protocol stack.

Bridge is a networking device that connects two or more LAN's together.

- Bridge is used when number of LANs starts increasing, the network traffic begins on overwhelming to available bandwidth.
- Reduces the network traffic of LAN by dividing it into segments.
- Operates at data link layer of OSI model.
- Can transfer data between two different protocols like Ethernet (802.3) and token bus (802.4).
- Checks the MAC address of the frame and decides to forward to frame or to discard the frame.
- Used for interconnecting two LANs working on the same protocol.

Switch

A switch is a computer networking device that connects devices together on a computer network by using packet switching to receive, process, and forward data to the destination device. It is a high-speed device that receives incoming data packets and redirects them to their destination on a local area network. A switch is a multi port bridge with a buffer and a design that can boost its efficiency and performance. Switch is data link layer device. Switch can perform error checking before forwarding data, that makes it very efficient as it does not forward packets that have errors and forward good packets selectively to correct port only. In other words, switch divides collision domain of hosts, but broadcast domain remains same. A switch is used to connect multiple hosts together, but it has many advantages over a hub. Switch is an OSI Layer 2 device, which means that it can inspect received traffic and make forwarding decisions. Each port on a switch is a separate collision domain and can run in a full duplex mode.

Switch is a multiple LAN connecting device, which takes incoming data packet from any multiple input ports and passes the data packet to specific output port.

Description

- **It work same as hub but does its work very efficiently.**
- **It uses MAC address information to switch forward to data packets to a particular destination device.**
- **By monitoring the network traffic, it can learn where the particular addresses is located.**
- **Operates at one or more OSI model layers mainly the data link layers.**
- **Minimizes the collision of data packets.**
- **Provides better security and better utilization of limited bandwidth.**
- **A switch can be said to be a smarter version of a hub.**
- **Each computer is connected through a single line.**
- **However, the difference lies in where it sends data that comes in through one of its ports.**

Routers

Router is inter network connecting device that determines most efficient path for sending a data packet to any given network.

A Routers normally connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets. Router divide broadcast domains of hosts connected through it. A router is a device that routes packets from one network to another. A router is most commonly an OSI Layer 3 device. Routers divide broadcast domains and have traffic filtering capabilities.

Static router

- **System administrator defines the shortest path in the network by executing commands.**
- **Have some limitations and not that much effective than dynamic router.**

Dynamic router

- Router itself determines the shortest path between the computers in the network.
- System administrator doesn't need to interact with router that saves time and cost.
- This type of routers are used in greater extend compare to static router.

Basic types

- Wired routers
- Wireless routers

Router is a device like a switch that routes data packets based on their IP addresses. Router is mainly a Network Layer device.

- Used to connect two or more similar or dissimilar topological LANs or WLANs.
- Shares available bandwidth with multiple computers in a network.
- Provides a better protection as a hardware firewall against hacking.
- Routers are intelligent enough to determine shortest and fastest path from source to destination in a network using algorithms.
- Operates at network layer of OSI model.
- Wireless routers are now widely used in home and offices as they allow a user to connect easily without installing any cables.
- A connectivity device that filters and forwards data based on a logical address. In the case of TCP/IP networks, that would be the IP address.
- An essential part of any larger TCP/IP network
- Without the development of network routers and TCP/IP routing protocols, the Internet would not have become as extensive
- Play a vital role in controlling traffic and keeping the network efficient.

How Routers Work

A router uses IP addresses to figure out where to send packets. If two hosts from different networks want to communicate, they will need a router between them to route packets, for example, Host M and host N are on different networks. If host M wants to communicate with host N, it will have to send a packet to the router. The router receives the packet and checks the destination IP address. If the destination IP address is in the routing table, the router will forward the packet out the interface associated with that network.

Routing Table

A routing table lists a route for every network that a router can reach. It can be statically configured or dynamically learned. It is used by routers when deciding where to forward packets.

Gateway

A gateway is a passage to connect two networks together that may work upon different networking models. They basically works as the messenger agents that take data from one system, interpret it, and transfer it to another system. Gateways are also called protocol converters and can operate at any network layer. Gateways are more complex than switch or router.

Uses

- To route the traffic from one network to another.
- To connect LAN to WAN or VPN (Virtual Private Network).
- Acts as a proxy server and firewall server to protect from virus, malware and harmful attacks.
- To keep history of accessed website, bandwidth usage, timing of each user of the network in a database.

Gateway is a network point that act as entry point to other network and translates one data format to another.

Functions of the gateway:

- *Protocol translation:* Translates protocol format into required protocol format of the network, such as X.25 to TCP/IP.
- *Network address translation:* Translates your public IP address to the private IP addresses on your network.
- *DHCP service:* Automatically assigns IP address to a computer from a defined range of addresses for a given network.
- Monitoring and regulating each packet entering and leaving the network.

Brouter or Bridging Router

It is a device which combines features of both bridge and router. It can work either at data link layer or at network layer. Working as router, it is capable of routing packets across networks and working as bridge, it is capable of filtering local area network traffic.

MODEM

Modem is a device that converts digital signal to analog signal as a modulator and analog signal to digital signals as a demodulator.

- Enables computers to communicate over telephone lines.
- Speed of modem is measured in bits per second and varies depending upon the type of modem. Higher the speed, the faster you can send and receive data over the network.
- Used to connect computer to the internet.

NIC

A Network Interface Card (NIC) is circuit board or a card that allows computers to communicate over a network via cables or wirelessly.

- Also called as LAN adaptor network adaptor or network card.
- Enables client, servers, printers and other devices to transmit and receive data over the network.
- Operates on physical and data link layer of OSI model.
- Every network adaptor is assigned a unique 48-bit Media Access Control (MAC) address, which is stored in ROM to identify themselves in a network or a LAN.

VARIOUS Networking Devices

Repeater: A repeater operates at the physical layer.

- Its job is to regenerate the signal over the same network before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network.
- Do not amplify the signal.
- When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength.
- It is a 2 port device.

Hub: A hub is basically a multiport repeater.

- Connects multiple wires coming from different branches, for example, the connector in star topology which connects different stations. Hubs cannot filter data, so data packets are sent to all connected devices.
- Collision domain of all hosts connected through Hub remains one.
- Do not have intelligence to find out best path for data packets which leads to inefficiencies and wastage.

Types of Hub

- **Active Hub:** These are the hubs which have their own power supply and can clean , boost and relay the signal along the network. It serves both as a repeater as well as wiring center.
- Used to extend maximum distance between nodes.
- **Passive Hub:** These are the hubs which collect wiring from nodes and power supply from active hub. Relay signals onto the network without cleaning and boosting them and can't be used to extend distance between nodes.

Bridge – A bridge operates at data link layer.

- Bridge is a repeater, with add on functionality of filtering content by reading the MAC addresses of source and destination. It is also used for interconnecting two LANs working on the same protocol. It has a single input and single output port, thus making it a 2 port device.

Types of Bridges

- **Transparent Bridges:** These are the bridge in which the stations are completely unaware of the bridge's existence i.e. whether or not a bridge is added or deleted from the network , reconfiguration of the stations is unnecessary.
- Bridges makes use of two processes i.e. bridge forwarding and bridge learning.

Source Routing Bridges

- Routing operation is performed by source station and the frame specifies which route to follow.

Switch – A switch is a multi port bridge with a buffer and a design that can boost its efficiency

- Data link layer device.
- Perform error checking before forwarding data, that makes it very efficient as it does not forward packets that have errors and forward good packets selectively to correct port only.

Routers – A router is a device like a switch that routes data packets based on their IP addresses.

- Network Layer device.
- Connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets.

Gateway – A gateway is a passage to connect two networks together that may work upon different networking models.

- They basically works as the messenger agents that take data from one system, interpret it, and transfer it to another system.
- Protocol converters and can operate at any network layer.
- More complex than switch or router.

Difference Between a Switch and a Bridge

- Bridge has fewer ports than switch.
- Switch operates faster because it is hardware-based, which means that it uses chips (ASICs) when making forwarding decisions.
- Bridge is software based.
- Switch can also have multiple spanning-tree instances while a bridge can have only one.
- Switches can also have multiple broadcast domains, one per VLAN.
- Switch is sometimes called a multiport bridge.

What is a MAC Address Table?

A MAC address table lists which MAC address is connected to which port. It is used by switches to make forwarding decisions. It is populated by examining the source MAC address of the incoming packet. If the source MAC address of a packet is not present in the table, the switch adds an entry to it's MAC address table.

4.4 INTERNET, INTRANET, AND EXTRANET

Internet

The Internet, also called Net, is a worldwide system of computer networks i.e. a network of networks in which users at any one computer can, if they have permission, get information from any other computer.

Internet is a means of connecting a computer to any other computer anywhere in the world via dedicated routers and servers. When two computers are connected over the Internet, they can send and receive all kinds of information such as text, graphics, voice, video, and computer programs. No one owns Internet, although several organizations the world over collaborate in its functioning and

development. The high-speed, fiber-optic cables (called backbones through which the bulk of the Internet data travels are owned by telephone companies in their respective countries.

Uses of the Internet

- Electronic mail or email
- Research
- Downloading files
- Discussion groups
- Interactive games
- Online Education
- Friendship and dating
- Electronic newspapers and magazines
- Ecommerce
- Banking
- Social networking
- Matrimonials
- E lectures
- Sharing information
- E Governance
- Employments
- Online forms

- The Internet is defined as a global network connecting millions of computers.
- More than 180 countries are linked into exchanges of data, news and opinions.
- The Internet is decentralized.
- Each Internet computer, called a host, is independent.
- Operators can choose which Internet services to use and which local services to make available to the global community.
- There are a variety of ways to access the Internet.
- Most online services offer access to some Internet services.
- It is also possible to gain access through a commercial Internet Service Provider.

Is Internet and Web the Same?

- Internet is not synonymous with World Wide Web.
- Internet is a massive network of networks, a networking infrastructure.
- It connects millions of computers together globally, forming a network in which any computer can communicate with any other computer as long as they are both connected to the Internet.
- The World Wide Web is a way of accessing information over the medium of the Internet.
- It is an information-sharing model that is built on top of the Internet.

Intranet

An intranet is a private network that is contained within an enterprise. It may consist of many interlinked local area networks and also use leased lines in the wide area network. Typically, an intranet includes connections through one or more gateway computers to the outside Internet. Like the Internet itself, intranets are used to share information. The main purpose of an intranet is to share company information and computing resources among employees. An intranet can also be used to facilitate working in groups and for teleconferences.

An intranet is a private network based on TCP/IP protocols, belonging to an organization, usually a corporation, accessible only by the organization's members, employees, or others with authorization. An intranet's websites and software applications look and act just like any others, but the firewall surrounding an intranet puts a barrier to any unauthorized access .

Intranet Applications

- Most applications are similar to Internet applications such as browsers, instant messengers, and document publishing software
- Intranet applications reside on the local server.

Difference Between an Intranet, Internet and Extranet

- An intranet is designed to allow a company to share information and resources with others in the company, for group projects and teleconferencing.
- Internet is for public access
- When a company allows access to any part of its intranet, for example, parts are accessible to customers or suppliers outside the company, it is called an *extranet*.
- Outsiders are granted access to the extranet part of the company's intranet with a valid username and password, which determines which parts of the extranet can be viewed.

- An **intranet** is a *private network* accessible only to an organization's staff , a wide range of information and services are available on an organization's internal intranet that are unavailable to the public, unlike the *Internet*.
- A company-wide intranet can constitute an important focal point of internal communication and collaboration, and provide a single starting point to access internal and external resources.
- Intranet is established with the technologies for local area networks (LANs) and wide area networks (WANs).

Advantages

- Workforce productivity: Intranets can help users to locate and view information faster and use applications relevant to their roles and responsibilities.
- **Time:** Intranets allow organizations to distribute information to employees on an as-needed basis; Employees may link to relevant information at their convenience, rather than being distracted indiscriminately by email.

- **Communication:** Intranets can serve as powerful tools for communication within an organization, vertically strategic initiatives that have a global reach throughout the organization.
- **Business operations and management:** Intranets are also being used as a platform for developing and deploying applications to support business operations and decisions.
- **Cost-effective:** Users can view information and data via web-browser rather than maintaining physical documents such as procedure manuals, internal phone list and requisition forms. This can potentially save the business money on printing, duplicating documents, and the environment as well as document maintenance overhead.
- **Enhance collaboration:** Information is easily accessible by all authorised users, which enables teamwork.
- **Cross-platform capability:** Standards-compliant web browsers are available for Windows, Mac, and UNIX.
- **Promote common corporate culture:** Every user has the ability to view the same information within the Intranet.
- **Supports a distributed computing architecture:** The intranet can also be linked to a company's management information system, for example a time keeping system.

Extranet

An extranet is a controlled private network allowing customers, partners, vendors, suppliers and businesses to gain information, typically about a specific company or educational institution, and do without granting access to the organization's entire network

The difference between an intranet and an extranet is:

An intranet is a network where employees can create content, communicate, collaborate, get stuff done, and develop the company culture.

An extranet is like an intranet, but also provides controlled access to authorized customers, vendors, partners, or others outside the company.

An extranet requires security and privacy. These can include firewall server management, the issuance and use of digital certificates or similar means of user authentication, encryption of messages, and the use of virtual private networks (VPNs) that tunnel through the public network.

Uses

- Exchange large volumes of data using E: ctronic Data Interchange (EDI).
- Share product catalogs exclusively with wholesalers.
- Collaborate with other companies on joint development efforts.
- Share news of common interest exclusively with partner companies.
- Jointly develop and use training programs with other companies.
- Provide or access services provided by one company to a group of other companies, such as an online banking application managed by one company on behalf of affiliated banks.

Advantages

- Ability to exchange large volumes of data using electronic data interchange.
- Sharing product data or catalogs with business partners.
- Joint company collaboration and training.
- Sharing services such as online banking applications among affiliated banks.

Limitations

- Expensive implementation and maintenance if hosted internally.
- Compromised sensitive or proprietary information.
- Security of extranets can be a concern.

An extranet is a controlled private network allowing customers, partners, vendors, suppliers and other businesses to gain information, typically about a specific company or educational institution without granting access to the organization's entire network.

- Private part of a website
- Restricted to select users through user IDs, passwords and other authentication mechanisms on a login page.
- Controlled private network that allows access to partners, vendors and suppliers or an authorized set of customers
- Provides subset of the information accessible from an organization's *intranet*

Difference between the Internet, Intranet, and Extranet?

Features	Internet	Intranet	Extranet
Type of Network	Public	Private	Private/VPN
Size	Large	Limited number of connected devices	Limited number of connected devices over internet
Security	Depends on the device connected to the device	Firewall protected	Firewall separates internet and extranet
Policy	Internet communication protocols	Organizational policies	Organizational policies, contractual policies and internet policies
Accessibility	Anyone	Authorized people	Authorized people
Information sharing	Information can be shared across the globe	Information can be shared securely within an Organization	Information can be shared between employees and external people
Owner	Not owned by anyone	Owned by a particular Organization	Owned by one or more Organizations

4.5 LAN, MAN AND WAN

A computer network consists of two or more computers that are interconnected with each other and share resources such as printers, servers, and hardware and exchange the data in the form of files, facilitating electronic communication. These networks can be interconnected using various Topologies and technologies. Computers on a network can be connected through twisted pair cables, telephone lines, radio waves, satellites or optical fiber cables.

Networking Technologies:

- Local Area Network (LAN)
- Wide Area Network (WAN)
- Metropolitan Area Network (MAN)
- Wireless Local Area Network (WLAN)
- Storage Area Network (SAN)
- Controller Area Network (CAN)
- Personal Area Network (PAN)
- Global Area Network (GAN)
- Internet Area Network (IAN)

Local area network (LAN)

A **local area network (LAN)** is a computer network that interconnects computers within a limited area such as a residence, school, laboratory, university campus or office building. A network is a computer network that spans a relatively small area. A local area network may serve as few as two or three users (for example, in a small-office network) or several hundred users in a larger office. LAN networking comprises cables, switches, routers and other components that let users connect to internal servers, websites and other LANs via wide area networks. Ethernet and Wi-Fi are the two primary ways to

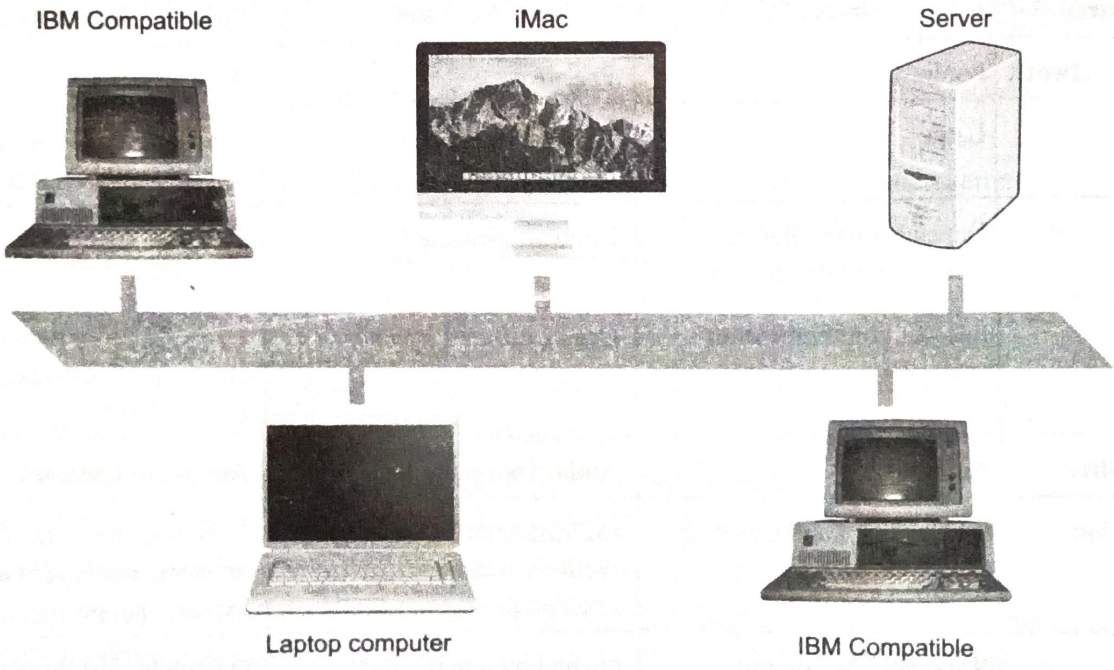


Fig. 4.5 LAN nodes

enable LAN connections. Ethernet is a specification that enables computers to communicate with each other. Wi-Fi uses radio waves to connect computers to the LAN. One LAN can be connected to other LANs over any distance via telephone lines and radio waves. A system of LANs connected in this way is called a wide-area network (WAN). The difference between a LAN and WAN is that the wide-area network spans a relatively large geographical area. Typically, a WAN consists of two or more local-area networks (LANs) and are often connected through public networks.

- Most LANs connect workstations and personal computers
- Each individual computer called node in a LAN has its own CPU with which it executes programs, but it also is able to access data and devices anywhere on the LAN.
- Many users can share expensive devices, such as laser printers, as well as data
- Users can also use the LAN to communicate with each other, by sending email or engaging in chat sessions.
- LANs are capable of transmitting data at very fast rates, much faster than data can be transmitted over a telephone line
- LANs can be differentiated on the following basis:
- **Topology:** The geometric arrangement of devices on the network.
- **Protocols:** The rules and encoding specifications for sending data.
- **Media:** Devices can be connected by twisted-pair wire, coaxial cables, fiber optic cables or via radio waves.

- A local area network (LAN) is a computer network within a small geographical area such as a home, school, computer laboratory, office building or group of buildings.
- A LAN is composed of inter-connected workstations and personal computers which are each capable of accessing and sharing data and devices, such as printers, scanners and data storage devices, anywhere on the LAN. LANs are characterized by higher communication and data transfer rates and the lack of any need for leased communication lines.

Metropolitan area network (MAN)

A metropolitan area network (MAN) is similar to a LAN but spans an entire city or campus. MANs are formed by connecting multiple LANs. Thus, MANs are larger than LANs but smaller than wide area networks (WAN).

A metropolitan area network (MAN) is a network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN). MAN implies to the interconnection of several local area networks by bridging them with backbone lines. MANs are extremely efficient and provide fast communication via high-speed carriers, such as fiber optic cables.

Wide Area Network (WAN)

A **wide area network (WAN)** is a telecommunications network or computer network that extends over a large geographical distance/place. Wide area networks are often established with leased telecommunication circuits. Business, education and government entities use wide area networks to

relay data to staff, students, clients, buyers, and suppliers from various locations across the world. The Internet may be considered a WAN. In an enterprise, a **WAN** may consist of connections to a company's headquarters, branch offices, colocation facilities, cloud services and other facilities.

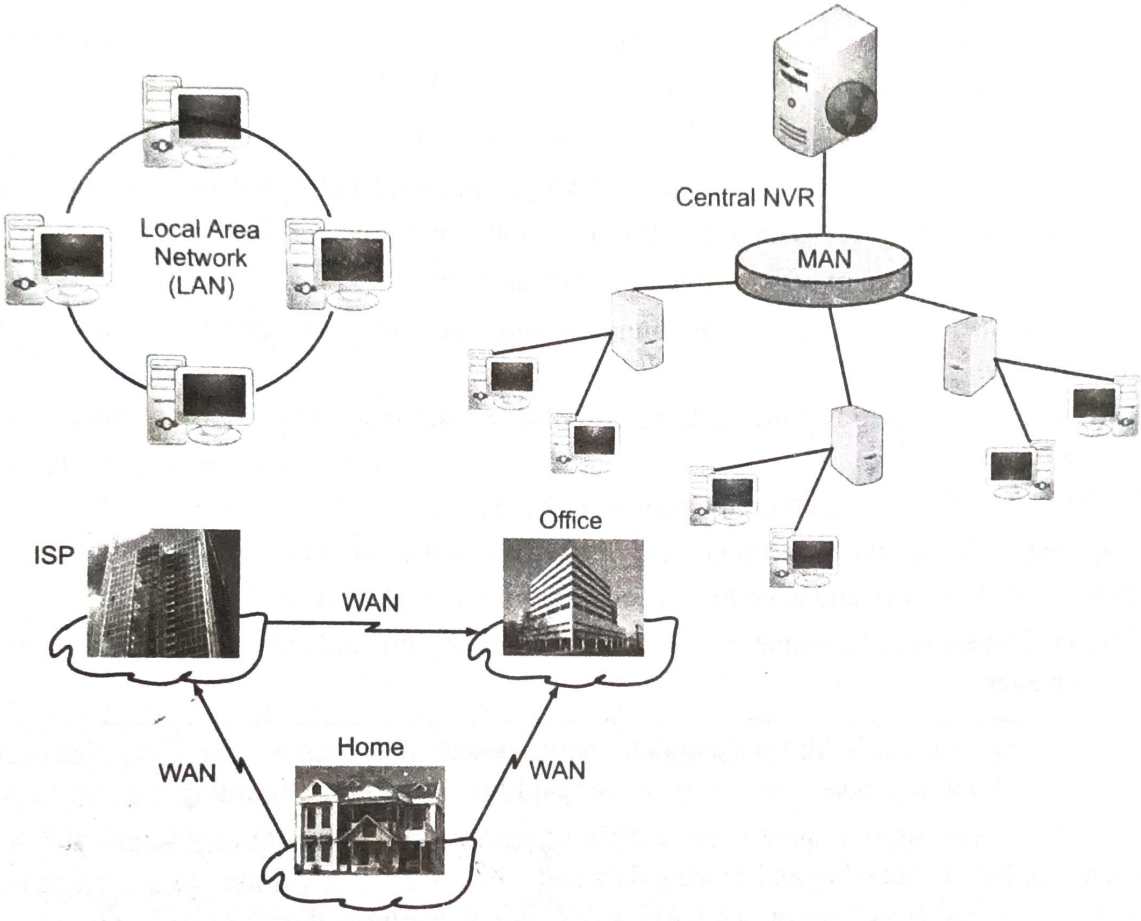


Fig. 4.6 LAN, MAN and WAN

MANs vs LANs and WANs:

- The network size falls intermediate between LANs and WANs. A MAN typically covers an area of between 5 and 50 km diameter. Many MANs cover an area the size of a city.
- A MAN is not generally owned by a single organisation
- A MAN often acts as a high speed network to allow sharing of regional resources
- Used to provide a shared connection to other networks using a link to a WAN.

A LAN (local area network) is a group of computers and network devices connected together, usually within the same building. A LAN is a network that is restricted to smaller physical areas e.g. a local office, school, or house. Approximately all current LANs whether wired or wireless are based on Ethernet.

- Connections must be high speed and relatively inexpensive (e.g., token ring or Ethernet).
- A MAN (metropolitan area network) is a network that connects two or more computers, communicating devices or networks in a single network that has geographic area larger than

that covered by even a large LAN but smaller than the region covered by a WAN. A MAN is a larger network that usually spans several buildings in the same city or town. MANs are mostly built for cities or towns to provide a high data connection and usually owned by a single large organization. Major technologies used in MAN networks are Asynchronous Transfer Mode (ATM), Fiber Distributed Data Interface (FDDI) and Switched Multi-megabit Data Service (SMDS, a connectionless service). MANs can bridge Local Area Networks without any cables by using microwave, radio wireless communication or infra-red laser which transmits data wirelessly.

- A WAN (wide area network), in comparison to a MAN, is not restricted to a geographical location, although it might be confined within the bounds of a state or country. A WAN connects several LANs, and may be limited to an enterprise or accessible to the public. Wide Area Network is a computer network that covers relatively larger geographical area such as a state, province or country. It provides a solution to companies or organizations operating from distant geographical locations who want to communicate with each other for sharing and managing central data or for general communication
- The technology is high speed and relatively expensive
- Internet is an example of a worldwide public WAN.

LAN is a private network used in small offices or homes usually within 1km range with high speed transfer data rate and fulltime service connectivity in low cost. WAN covers a large geographical area for example, a country or a continent. Its data transfer data is usually low as compared to LAN, but it is compatible with a variety of access lines and has an advanced security. MAN covers an area bigger than LAN within a city or town and serves as an ISP for larger LAN. It uses optical fibers or wireless infrastructure to link the LANs therefore, providing high speed regional resource sharing.

4.6 INTERNET SERVICE PROVIDER

An Internet service provider (ISP) is a company that provides customers with Internet access. Data may be transmitted using several technologies, including dial-up, DSL, cable modem, wireless or dedicated high-speed interconnects.

- An ISP (Internet service provider) is a company that provides individuals and other companies access to the Internet and other related services such as Web site building and virtual hosting.
- ISPs also provide their customers with the ability to communicate with one another by providing Internet email accounts.
- Other services, such as telephone and television services, may be provided as well.
- Internet service provider is also known as an Internet access provider (IAP).
- ISP has the equipment and the telecommunication line access required to have a point-of-presence on the Internet for the geographic area served.
- Larger ISPs have their own high-speed leased lines so that they are less dependent on the telecommunication providers and can provide better service to their customers.

- Examples of ISPs are AT&T WorldNet, IBM Global Network, MCI, Netcom, UUNet, and PSINet.
- An ISP provides access to the Internet. Whether you're at home or work, each time you connect to the Internet, your connection is routed through an ISP.
- Early ISPs provided Internet access through dial-up modems.
- This type of connection took place over regular phone lines and was limited to 56 Kbps.
- In the late 1990s, ISPs began offering faster broadband Internet access via DSL and cable modems.
- Some ISPs now offer high-speed fiber connections, which provide Internet access through fiber optic cables.
- To connect to an ISP, you need a modem and an active account.
- When you connect a modem to the telephone or cable outlet in your house, it communicates with your ISP.
- ISP verifies your account and assigns your modem an IP address.
- Once you have an IP address, you are connected to the Internet.
- You can use a router which may also be built into the modem or may be separate to connect multiple devices to the Internet.
- Since each device is routed through the same modem, they will all share the same public IP address assigned by the ISP.
- ISPs act as hubs on the Internet since they are often connected directly to the Internet backbone.
- Because of the large amount of traffic ISPs handle, they require high bandwidth connections to the Internet.

- **Internet service provider (ISP)** is a company that provides Internetconnections and services to individuals and organizations.
- ISPs may also provide software packages such as browsers, e-mail accounts, and a personal Web site or home page
- ISPs can host Web sites for businesses and can also build the Web sites themselves
- ISPs are all connected to each other through network access points, public network facilities on the Internet backbone

4.6.1 Relevance of ISP

To connect with the Internet, all one needs is a computer running Windows, web browser software, and an Internet service provider (ISP). An **ISP** is an organization that provides services accessing and using the Internet. Internet service providers may be organized in various forms, such as commercial, community owned, non profit, or otherwise privately owned.

Internet services typically provided by ISPs include Internet access, Internet transit, domain name registration, web hosting, Usenet service and colocation.

- ISP is the gateway to the internet and everything that you do online.
- Provide internet access to the user through dial up service, DSL service, and cellular data service.

- Internet Service Providers serve large companies by providing a direct connection from the company's network to the internet.
- Provides internet services like email, access to software tools, security service and Web hosting.
- Internet Service Providers host sites for businesses and also build a website themselves.
- Internet Service Providers act as a mediator between the user and internet.
- As a result, Internet has become a very economical way to talk to each other and the fastest way as well and plays an important role in the advancement of mankind.

4.7 MODEM

A modem (modulator–demodulator) is a network hardware device that allows a computer to send and receive data through a telephone line or cable connection. A **modem** modulates one or more carrier wave signals to encode digital information for transmission and demodulates signals to decode the transmitted information.

- **Modem** is a hardware component that allows a computer or other device, such as a router or switch, to connect to the Internet.
- It converts an analog signal from a telephone or cable wire to a digital signal that a computer can recognize.
- Similarly, it converts outgoing digital data from a computer or other device to an analog signal
- Without modems, it would have been impossible for most users to connect to the Internet.
- The first modems were dial-up i.e. they had to dial a phone number to connect to an ISP.
- Modern modems are typically DSL or cable modems, which are considered broadband devices
- DSL modems operate over standard telephone lines, but use a wider frequency range.
- This allows for higher data transfer rates than dial-up modems and enables them to not interfere with phone calls.
- Cable modems send and receive data over standard cable television lines, which are typically coaxial cables.
- Most modern cable modems support DOCSIS (Data Over Cable Service Interface Specification), which provides an efficient way of transmitting TV, cable Internet, and digital phone signals over the same cable line.

Role of the modem in accessing the internet:

- Modem allows a computer to send and receive data through a telephone line or cable connection.
- Connects a computer to the Internet.
- Telephone lines are partly analog and computer technology is purely digital.
- Modem converts analog signals to digital and vice versa, it may also be considered an ADC or DAC.
- Modem has two plugs in it, one that connects it to the telephone line (or the cable provided by your Internet service provider) and the other connecting it to your computer (or a Wi Fi router).

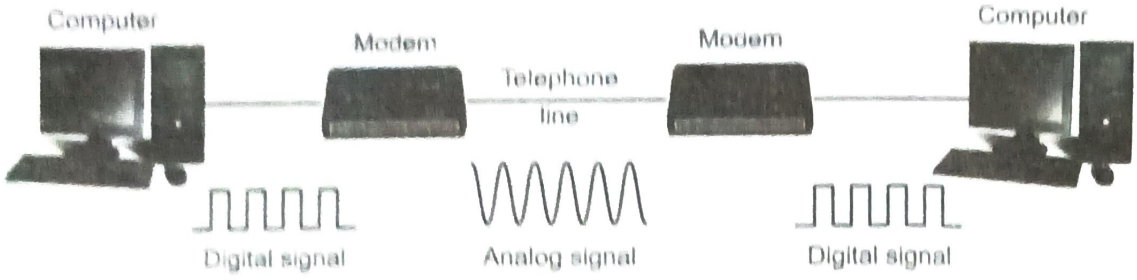


Fig. 4.7 Modem converts analog signals to digital and vice versa

A **modem** (modulator–demodulator) is a network hardware device that modulates one or more carrier wave signals to encode digital information for transmission and demodulates signals to decode the transmitted information.

- Modem is short for Modulator/Demodulator.
- Hardware component that allows a computer or other device, such as a router or switch, to connect to the Internet.
- Converts or "modulates" an analog signal from a telephone or cable wire to a digital signal that a computer can recognize.
- Converts outgoing digital data from a computer or other device to an analog signal.
- Modern modems are typically DSL or cable modems, which are considered "broadband" devices.
- DSL modems operate over standard telephone lines, but use a wider frequency range.
- Allows for higher data transfer rates than dial-up modems and enables them to not interfere with phone calls. Cable modems send and receive data over standard cable television lines, which are typically coaxial cables.
- Most modern cable modems support DOCSIS (Data Over Cable Service Interface Specification), which provides an efficient way of transmitting TV, cable Internet, and digital phone signals over the same cable line.
- A **modem** is a device or program that enables a computer to transmit data over, for example, telephone or cable lines. Computer information is stored digitally, whereas information transmitted over telephone lines is transmitted in the form of analog waves.
- A **modem** converts between these two forms.

Installation procedure of a modem using control panel:

- Click **Start**, then **Control Panel**.
- Double-click **Phone and Modem**, then select the **Modems** tab. If you don't see Phone and Modem, use the search bar at the top right or switch to "small icon" view.
- Highlight your modem by clicking its name and then click the **Remove** button.
- Restart your computer.
- When your computer boots up again, your modem should be detected and reinstalled automatically. If this doesn't happen, check the setup instructions for your modem to complete a manual installation.

4.8 WEB BROWSER

A web browser (also called browser) is an application used to access and view websites. Common web browsers include Microsoft Internet Explorer, Google Chrome, Mozilla Firefox, Apple Safari etc. It is a software program that allows a user to locate, access, and display web pages. Browsers are used primarily for displaying and accessing websites on the internet, as well as other content created using languages such as Hypertext Markup Language (HTML) and Extensible Markup Language (XML). Browsers translate web pages and websites delivered using Hypertext Transfer Protocol (HTTP) into human-readable content. They also have the ability to display other protocols and prefixes, such as secure HTTP (HTTPS), File Transfer Protocol (FTP), email handling (mailto:), and files (file:). Browsers translate web pages and websites delivered using Hypertext Transfer Protocol (HTTP) into human-readable content. They also have the ability to display other protocols and prefixes, such as secure HTTP (HTTPS), File Transfer Protocol (FTP), email handling (mailto:), and files (file:). Most browsers also support external plug-ins required to display active content, such as in-page video, audio and game content. Common browsers include Internet Explorer from Microsoft, Firefox from Mozilla, Google Chrome, Safari from Apple, and Opera.

- The primary function of a web browser is to render HTML, the code used to design or "mark up" webpages.
- Each time a browser loads a web page, it processes the HTML, which may include text, links, and references to images and other items, such as cascading style sheets and JavaScript functions.
- The browser processes these items, then renders them in the browser window.
- Examples of web browsers are Chrome, Firefox, Safari, Internet Explorer, and Edge.

User Interface Features of Browsers

- Back and forward buttons to go back to the previous page visited or forward to the next one.
- A refresh or reload button to reload the current page.
- A stop button to cancel loading the page. (In some browsers, the stop button is merged with the reload button.)
- An address bar to input the URL of a page and display it.
- A search bar to input terms into a search engine.
- A home button to return to the user's home page.

A web browser is a software program that allows a user to locate, access, and display web pages. **A web browser** is a software application for accessing information on the World Wide Web. Each individual web page, image, and video is identified by a distinct URL, enabling browsers to retrieve and display them on the user's device.

- Primarily for displaying and accessing websites on the internet, as well as other content created using languages such as Hypertext Markup Language (HTML) and Extensible Markup Language (XML).
- Browsers translate web pages and websites delivered using Hypertext Transfer Protocol (HTTP) into human-readable content.

- Have the ability to display other protocols and prefixes, such as secure HTTP (HTTPS), File Transfer Protocol (FTP), email handling (mailto:), and files (file:).
- Also support external plug-ins required to display active content, such as in-page video, audio and game content. Variety of web browsers are available with different features, and are designed to run on different operating systems.
- Common browsers include Internet Explorer from Microsoft, Firefox from Mozilla, Google Chrome, Safari from Apple, and Opera.

It is important to note that web browser is not the same thing as a search engine, though the two are often confused For a user, a search engine is just a website, such as google.com, that stores searchable data about other websites. But in order to connect to and display websites on their device, a user needs to have a web browser installed.

PRACTICE QUESTION

Fill in the Blanks

A ....., short for ..... browser, is the software ..... to reach and explor ..... Whereas ..... is a program for spreadsheets and ..... is a program for writing documents, a ..... is a program for ..... exploring.

Thought Question

Someone asked me that what is the full form of Google! I searched the same on Google itself and found that Google doesn't have full form officially. The word originated from a misspelling of the word googol which means, a very very large number i.e. the number 1 followed by one hundred zeroes. But I have read somewhere that Google is an acronym for Global Organization Of Oriented Group Language Of Earth. But this is not authentic! What do you feel!

4.9 URI, URL AND URN

URI (Uniform Resource Identifier): **U**niform **R**esource **I**dentifier is the term for all types of names and addresses that refer to objects on the World Wide Web. A **URI** (Uniform Resource Identifier) is a string that refers to a resource. The most common are URLs, which identify the resource by giving its location on the Web. URNs, by contrast, refer to a resource by a name, in a given namespace, such as the ISBN of a book.

- Uniform Resource Identifier (URI) is a compact sequence of characters that identifies an abstract or physical resource.
- URI can be further classified as a locator, a name, or both.
- Uniform Resource Locator (URL) is the subset of URIs that, in addition to identifying a resource, provide a means of locating the resource by describing its primary access mechanism (e.g., its network"location).

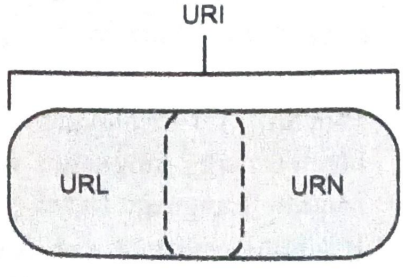


Fig. 4.8 URI has two specializations known as URL and URN.

- One can classify URIs as locators (URLs), or as names (URNs), or as both.
- Uniform Resource Name (URN) functions like a person's name, while a Uniform Resource Locator (URL) resembles that person's home address i.e. the place where the person is located.
- URN defines an item's identity, while the URL provides a method for finding it.
- **URI has two specializations known as URL and URN.**

- *URL* is the abbreviation of Uniform Resource Locator.
- Used to specify addresses on the World Wide Web.
- URL is the fundamental network identification for any resource connected to the web (e.g., hypertext pages, images, and sound files).
- Defined as the global address of documents and other resources on the World Wide Web.
- We use URLs to visit webpages and other resources on the web.
- URL is an address that sends users to a specific resource online, such as a webpage, video or other document or resource.
- When you search Google, for example, the search results will display the URL of the resources that match your search query.
- Title in search results is simply a hyperlink to the URL of the resource.
- The first part of the URL is called a protocol identifier and it indicates what protocol to use, and the second part is called a resource name and it specifies the IP address or the domain name where the resource is located.
- The protocol identifier and the resource name are separated by a colon and two forward slashes.
- A **URL** is a form of URI and is a standardized naming convention for addressing documents accessible over the Internet and Intranet.
- URLs have the following format:
  protocol://hostname/other_information
- example of a URL is https://www.asianpublishers.com/, which is the URL for the asianpublishers website.

4.10 WORLD WIDE WEB (WWW)

The World Wide Web (WWW) is a network of online content that is formatted in HTML and accessed via HTTP. The term refers to all the interlinked HTML pages that can be accessed over the Internet. The World Wide Web was originally designed in 1989 by UK physicist Tim Berners-Lee.

The World Wide Web (WWW) is combination of all resources and users on the Internet that are using the Hypertext Transfer Protocol (HTTP). The World Wide Web is the universe of network-accessible information, an embodiment of human knowledge. There is a difference between www and internet. The World Wide Web is all the Web pages, pictures, videos and other online content that can be accessed via a Web browser. The Internet, on the other hand , is the underlying network connection that allows us to send email and access the World Wide Web. **WWW** is an abbreviation for ›World Wide Web. It appears at the beginning of website addresses in the form **www**.

Note that:
www. Kajalsharma.com indicates a website address while
kajalsharma@gmail.com or kajalsharma@yahoo.com indicates an email address. Also note that website addresses and email addresses are not case sensitive i.e. It does not matter whether you type capital letters or small letters. However, the passwords and captcha are case sensitive. You need a password to login into the email but no password is required for seeing a website.

4.11 FILE TRANSFER PROTOCOL (FTP)

File Transfer Protocol (FTP) is a standard Internet protocol for transmitting files between computers on the Internet over TCP/IP connections. File Transfer Protocol (FTP) is a client/server protocol used for transferring files to or exchanging files with a host computer. It may be authenticated with user names and passwords. Anonymous FTP allows users to access files, programs and other data from the Internet without the need for a user ID or password. Web sites are sometimes designed to allow users to use 'anonymous' or 'guest' as a user ID and an email address for a password.

- FTP is most commonly used to download a file from a server using the Internet or to upload a file to a server.
- An FTP site is a web site where users can easily upload or download specific files.
- FTP by mail allows users without access to the Internet to access and copy files using anonymous FTP by sending an email message to ftpmail@decwrl.dec.com and putting the word help in the body of the text.
- An FTP server is a dedicated computer which provides an FTP service. This invites hackers and necessitates security hardware or software such as utilizing usernames, passwords and file access control.
- An FTP client is a computer application which accesses an FTP server. While doing so, users should block incoming FTP connection attempts using passive mode and should check for viruses on all downloaded files.
- FTP works in the same way as HTTP for transferring Web pages from a server to a user›s browser and SMTP for transferring electronic mail across the Internet in that, like these technologies.
- FTP uses a client-server architecture.
- Users provide authentication using a sign-in protocol, usually a username and password.
- Some FTP servers may be configured to accept anonymous FTP logins where you don›t need to identify yourself before accessing files. Most often, FTP is secured with SSL/TLS.
- FTP is a client-server protocol that relies on two communications channels between client and server: a command channel for controlling the conversation and a data channel for transmitting file content.
- Clients initiate conversations with servers by requesting to download a file. Using FTP, a client can upload, download, delete, rename, move and copy files on a server.

4.12 HYPERTEXT TRANSFER PROTOCOL (HTTP)

HTTP means HyperText Transfer Protocol and it is an application-layer protocol used primarily on the World Wide Web

- underlying protocol used by the World Wide Web and this protocol defines how messages are formatted and transmitted, and what actions Web servers and browsers should take in response to various commands.
- set of rules for transferring files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web.
- As soon as a Web user opens their Web browser, the user is indirectly making use of **HTTP**.
- uses a client-server model where the web browser is the client and communicates with the webserver that hosts the website.
- requests involved in http:
- A connection to the HTTP server is opened.
- A request is sent to the server.
- Some processing is done by the server.
- A response from the server is sent back.
- The connection is closed.

4.13 REMOTE DESKTOP CONNECTION (RDC)

Remote Desktop Connection (RDC) is a Microsoft technology that allows a local computer to connect to and control a remote PC over a network or the Internet. It is done through a Remote Desktop Service (RDS) or a terminal service that uses the company's proprietary Remote Desktop Protocol (RDP).

- Remote desktop is a program or an operating system feature that allows a user to connect to a computer in another location, see that computer's desktop and interact with it as if it were local.

Uses

- Access a workplace computer from home or when traveling.
- Access a home computer from other locations.
- Fix a computer problem.
- Perform administrative tasks.
- Demonstrate something, such as a process or a software application

- RDC requires the remote computer to enable the RDS and to be powered on.
- The connection is established when a local computer requests connection to a remote computer using an RDC-enabled software.
- On authentication, the local computer has full or restricted access to the remote computer.
- Besides desktop computers, servers and laptops, RDC also supports connecting to virtual machines.

4.14 TELNET

Telnet is a user command and an underlying TCP/IP protocol for accessing remote computers. Telnet is a protocol that allows you to connect to remote computers (called hosts) over a TCP/IP network (such as the internet). Using telnet client software on your computer, you can make a connection to a telnet server (i.e., the remote host). Once your telnet client establishes a connection to the remote host, your client becomes a virtual terminal, allowing you to communicate with the remote host from your computer.

- Telnet is a terminal emulation program for TCP/IP networks such as the Internet.
- Through Telnet, an administrator or another user can access someone else›s computer remotely.
- On the Web, HTTP and FTP protocols allow you to request specific files from remote computers, but not to actually be logged on as a user of that computer.
- You log on as a regular user with whatever privileges you may have been granted to the specific application and data on that computer.
- Telnet program runs on your computer and connects your PC to a server on the network.
- You can then enter commands through the Telnet program and they will be executed as if you were entering them directly on the server console.
- This enables you to control the server and communicate with other servers on the network.
- To start a Telnet session, you must log in to a server by entering a valid username and password.
- Common way to remotely control Web servers.
- Telnet protocol is designed to provide a bi-directional, eight-bit byte oriented communications facility to allow for a standard method of interfacing terminal devices and processes.

4.15 MAC ADDRESS

A MAC (Media Access Control) address is a hardware identification number that uniquely identifies each device on a network. The MAC address is manufactured into every network card, such as an Ethernet card or Wi-Fi card, and therefore cannot be changed. In a local area network (LAN) or other network, the MAC address is your computer's unique hardware number. On an Ethernet LAN, it›s the same as your Ethernet address. When you›re connected to the Internet from your computer or host as the Internet protocol thinks of it, a correspondence table relates your IP address to your computer's physical (MAC) address on the LAN.

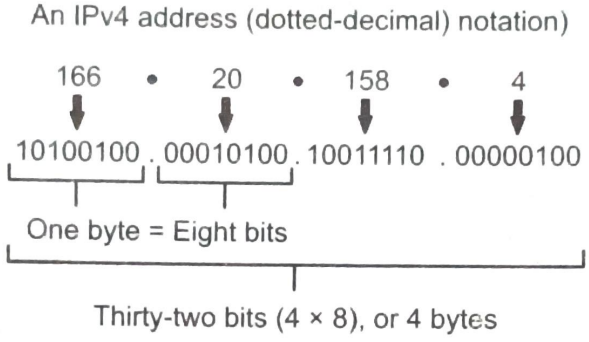
- A MAC address is given to a network adapter when it is manufactured.
- It is hardwired or hard-coded onto your computer's network interface card (NIC) and is unique to it.
- Because there are millions of networkable devices in existence, and each device needs to have a unique MAC address, there must be a very wide range of possible addresses.
- Hence, MAC addresses are made up of six two-digit hexadecimal numbers, separated by colons
- For example, an Ethernet card may have a MAC address of 00:0e:72:c1:d2:4f
- However, you do not need to know this address, since it is automatically recognized by most networks.

4.16 IP ADDRESS

An Internet Protocol **address** (**IP address**) is a numerical label assigned to each device connected to a computer network that uses the Internet Protocol for communication. An **IP address** serves two principal functions: host or network interface identification and location addressing.

The IP Address is a unique address that computing devices such as personal computers, tablets, and smartphones use to identify itself and communicate with other devices in the IP network. Any device connected to the IP network must have a unique IP address within the network.

- An IP address can be considered analogous to your house address or mobile number in that it is used to uniquely identify an entity.
- Traditional IP Address (known as IPv4) uses a 32-bit number to represent an IP address, and it defines both network and host address.
- A 32-bit number is capable of providing roughly 4 billion(to be very exact 2^{32}) unique numbers, and hence IPv4 addresses running out as more devices are connected to the IP network.



Decomposition of an IPv4 address from dot-decimal notation to its binary value.

How to Find The IP Number and Mac Address of a Network Card

- Press the Windows Start key to open the Start screen.
- Type cmd and press Enter to launch the command prompt.
- Type ipconfig/all at the command prompt to check the network card settings.
- The MAC address and IP address are listed under the appropriate adapter as Physical Address and IPv4 Address.
- You can copy the Physical Address and IPv4 Address from the command prompt by right clicking in the command prompt and clicking Mark.
- Select the text you want to copy with the mouse and hit the Enter key to copy it. You should now be able to paste the text elsewhere using the standard clipboard paste function.

4.17 E-MAIL

E-mail or Electronic mail refers to the messages distributed by electronic means from one computer user to one or more recipients via a network. E-mail is a digital mechanism for exchanging messages through Internet or intranet communication platforms. E-mail is a message that may contain text, files, images,

or other attachments sent through a network to a specified individual or group of individuals. It allows you to send and receive messages to and from anyone with an email address, anywhere in the world.

- A method of exchanging messages ("**mail**") between people using **electronic** devices.
- Invented by Ray Tomlinson.
- Email messages are relayed through email servers, which are provided by all Internet service providers (ISP).
- Transmitted between two dedicated server folders: sender and recipient.
- A sender saves, sends or forwards email messages, whereas a recipient reads or downloads emails by accessing an email server.
- Components of email:
  - Message envelope: Describes the email's electronic format.
  - Message header: Includes sender/recipient information and email subject line.
  - Message body: Includes text, image and file attachments.
  - Uses multiple protocols within the TCP/IP suite.
  - SMTP is used to send messages.
  - POP or IMAP protocols are used to retrieve messages from a mail server.
  - When you configure an email account, you must define your email address, password, and the mail servers used to send and receive messages.
  - Most webmail services configure your account automatically, so you only need to enter your email address and password.
  - There is a difference between a website address and email address for example www. Nehagupta.com indicates a website address while Nehagupta@gmail.com or Nehagupta@yahoo.com indicates an email address. Also note that website addresses and email addresses are not case sensitive i.e. It does not matter whether you type capital letters or small letters. However, the passwords are case sensitive. You need a password to login into the email but no password is required for seeing a website.

    e-mail address:

    Lets take an example. My email address is scorp2427@yahoo.co.in
- The first portion all e-mail addresses, the part before the @ symbol (i.e. scorp2427 in the abov example), contains the alias, user, group, or department of a company.
- Next, the @ (at the rate sign) is used as a divider in the e-mail address; it is required for all SMTP e-mail addresses since the first message was sent by Ray Tomlinson.
- Finally, the domain name to which the user belong.

Writing an e-mail

- The To field is where you type the e-mail address of the person who is the recipient of your message.
- The From field should contain your e-mail address.
- If you are replying to a message, the To and From fields are automatically filled out; if it's a new message, you'll need to enter them yourself.

- The Subject should consist of a few words describing the e-mail's contents. The Subject lets the recipient see what the e-mail is about, without opening and reading the full e-mail. This field is optional.
- The CC ("Carbon Copy") field allows you to specify recipients who are not direct addressees (listed in the «To» field). This field is optional.
- The BCC ("blind carbon copy") field is similar to CC, except the recipients are secret. Each BCC recipient will receive the e-mail, but will not see who else received a copy. This field is optional.
- Message Body is the location you type your main message. You can attach files to this message too process of sending and receiving e-mail.

Send Emails with Gmail

- Click "Compose Mail" located above the folder list.
- In the "To:" box, type the address of the person you want to write to.
- For multiple recipients, separate the addresses with commas.
- When entering, Gmail will suggest possible addresses you use frequently, then those in your list of contacts (including groups).
- To view the "Cc:" tab click "Add Cc". Cc means "carbon copy", type here the addresses of people who are not the main recipients of the message, but you still want to send a copy to.
- To view the "Bcc:" tab click "Add Bcc". Bcc stands for " blind carbon copy (i.e. invisible), type here the addresses of people you want to send a copy of the mail to, without the other recipients knowing.
- In "Subject:", enter the subject of the email.
- Enter the text itself.
- To attach files to your mail,, click "Attach a file" then click "Browse" to select a file on the hard disk.
- When you finish typing your post, click the "Send" button to send it immediately or on the "Save" button to save as draft.

Reading Your Email

- All emails received are stored in the inbox.
- The number of unread messages is indicated in brackets to the right of the "Inbox" folder.
- By default, a single message is summed up in one line, which includes the dispatcher, the email subject, the first words in the text, the date (or time) of dispatch.
- To read a message, click on its title. It appears in full and you may respond to your correspondent by clicking the "Answer" button.
- To forward the mail to someone else, click "Forward".

What makes a valid e-mail address?

There are several rules that an e-mail address must follow to be valid:

- e-mail must have a username followed by an @ (at sign) which is followed by the domain name with a domain suffix.

- The username cannot be longer than 64 characters long, and the domain name cannot be longer than 254 characters.
- There should be only one @ sign in an e-mail address.
- The space and special characters: ( ) , : ; < > \ [ ] are allowed. Occasionally, a space, backslash, and quotation mark work but must be preceded with a forward slash. Although valid, some e-mail providers do not allow these characters.
- The username and e-mail addresses as a whole cannot begin or end with a period.
- The e-mail must not have two or more consecutive periods.

Advantages of e-mail

- **Free delivery** — Sending an e-mail is virtually free, outside the cost of Internet service.
- **Global delivery** — Can be sent to nearly anywhere around the world, to any country.
- **Instant transmission** — An e-mail can be instantly sent and received by the recipient over the Internet.
- **File attachment** — An e-mail can include one or more file attachments, allowing a person to send documents, pictures, or other files with an e-mail.
- **Long term storage** — E-mails are stored electronically, which allows for storage and archival over long periods of time.
- **Environmentally friendly** — Sending an e-mail does not require paper

What can be sent in an e-mail?

- Text messages.
- We can attach file or other data in an e-mail.
- For example, an attachment could be a picture, PDF, word processor document, movie, progr or any file stored on your computer.
- e-mail providers have file size restrictions that would prevent any large files or programs from being sent over e-mail.

4.18 DNS (DOMAIN NAME SYSTEM)

DNS (Domain Name System) is the Internet's system for converting alphabetic names into numeric IP addresses. For example, when a Web address (URL) is typed into a browser, **DNS** servers return the IP address of the Web server associated with that name.

A domain is a unique string (Gingernameclub.com) associated with an IP address. An IP address is a string of numbers used to identify a computer or resource on a network or internet. The Domain Name System (DNS) is a network of directories on the internet used to resolve host names (e.g. www.asian.com) into machine-readable IP addresses (e.g. 342.564.353.98).

- Every computer, node, device or resource on the internet has a unique name and unique IP address.
- There are millions of such devices or resources.
- Computers communicate on the internet using the machine-readable IP addresses.

- Imagine if we are to remember the IP addresses of all the pages we needed to visit or resources we needed to access. Browsing the internet would be very tedious and cumbersome.
- DNS makes things so easy.
- Makes navigating this complex network of IP addresses user-friendly.
- It is the internet's address book/directory.
- Footman of our internet requests.
- World Wide Web depends on the DNS to function as we know it today.

How DNS Works?

- With the millions of nodes and resources on the internet their DNS information is not all kept in one place.
- The databases of DNS information are distributed worldwide.
- User Requests Information.
- You are at your computer connected to the internet and type the URL to bteup i.e., www.bteup.ac.in, into your browser.
- You are actually requesting your browser to get you the web page of bteup.
- Your browser cannot work with names but with IP addresses.
- A DNS query is the process by which a computer or device on a network makes an inquiry to other devices to get the IP address for a DNS name.
- In this case, we need the IP address of www.bteup.ac.in.
- Request Information from Recursive DNS Servers.
- Request Information from Root Servers.
- Root servers are servers at the root or form the foundation of the DNS.
- They direct queries to the respective specific domains name servers.

Some Important Terms

- **Uniform Resource Identifier (URI)** is a string of characters used to identify a name or a resource on the Internet.
- URI identifies a resource either by location, or a name, or both. A URI has two specializations known as URL and URN.
- **Uniform Resource Locator (URL)** is a subset of the Uniform Resource Identifier (URI) that specifies where an identified resource is available and the mechanism for retrieving it.
- URL defines how the resource can be obtained.
- A URL is one kind of URI.
- **Uniform Resource Name (URN)** is a Uniform Resource Identifier (URI) that uses the URN scheme, and does not imply availability of the identified resource.
- Both URNs (names) and URLs (locators) are URIs, and a particular URI may be both a name and a locator at the same time.

- The URNs are part of a larger Internet information architecture which is composed of URNs, URCs and URLs.
- URI stands for Uniform Resource Identifier. URI is a text which is used to identify any resource or name on Internet. URI has two specializations in the form of URL (Uniform Resource Locator) and URN (Uniform Resource Name) to identify resource and name.
- URL standards for Uniform resource locator and it is a subset of URI or Uniform Resource Identifier. URL includes location as well as the protocol to retrieve the resource.
  - Every URL and URN is URI because URI is the superset of both URL and URN.
  - URL includes protocol e.g. http://, ftp:// along with location to identify resource e.g. http://www.blogspot.com/abc.html.
  - URN are the unambiguous way to identify a resource. ISBN numbers are best examples of URN.

WWW: The Web, or World Wide Web (W3), is basically a system of Internet servers that support specially formatted documents. The documents are formatted in a markup language called HTML (HyperText Markup Language) that supports links to other documents, as well as graphics, audio, and video files. This means you can jump from one document to another simply by clicking on hot spots. Not all Internet servers are part of the World Wide Web.

FTP: File Transfer Protocol (FTP) is a client/server protocol used for transferring files to or exchanging files with a host computer.

- It may be authenticated with user names and passwords.
- FTP is a protocol designed for transferring files over the Internet.
- Files stored on an FTP server can be accessed using an FTP client, such as a web browser, FTP software program, or a command line interface.
- An FTP server can be configured to enable different types of access.

HTTP: HTTP means HyperText Transfer Protocol. HTTP is the underlying protocol used by the World Wide Web and this protocol defines how messages are formatted and transmitted, and what actions.

- Web servers and browsers should take in response to various commands. For example, when you enter a URL in your browser, this actually sends an HTTP command to the Web server directing it to fetch and transmit the requested Web page.
- Other main standard that controls how the World Wide Web works is HTML, which covers how Web pages are formatted and displayed.
- HTTP is an application layer protocol in TCP/IP suite used for transfer files that make up the web pages from the web servers.
- These transfers are done in plain text and an intruder can easily read the data packets exchanged between the server and a client.
- **HTTP** (Hypertext Transfer Protocol) is the set of rules for transferring files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web.
- As soon as a Web user opens their Web browser, the user is indirectly making use of **HTTP**.

RDC: Remote Desktop Connection (RDC) is a Microsoft technology that allows a local computer to connect to and control a remote PC over a network or the Internet.

- Done through a Remote Desktop Service (RDS) or a terminal service that uses the company's proprietary Remote Desktop Protocol (RDP). RDC requires the remote computer to enable the RDS and to be powered on.
- Connection is established when a local computer requests connection to a remote computer using an RDC-enabled software.
- On authentication, the local computer has full or restricted access to the remote computer. Besides desktop computers, servers and laptops, RDC also supports connecting to virtual machines.

TELNET: Telnet is a protocol used on the Internet or local area network to provide a bidirectional interactive text-oriented communication facility using a virtual terminal connection. Telnet (TN) is a networking protocol and software program used to access remote computers and terminals over the Internet or a TCP/IP computer network.

- Telnet is a user command and an underlying TCP/IP protocol for accessing remote computers. Through Telnet, an administrator or another user can access someone else›s computer remotely.
- On the Web, HTTP and FTP protocols allow you to request specific files from remote computers, but not to actually be logged on as a user of that computer.

E-MAIL: **E-mail (electronic mail)** is the exchange of computer-stored messages by telecommunication.

- Electronic mail (email) is a digital mechanism for exchanging messages through Internet or intranet communication.
- Allows you to send and receive messages to and from anyone with an **email** address, anywhere in the world. Uses multiple protocols within the TCP/IP suite.
- Means or system for transmitting messages electronically (as between computers on a network).

MAC ADDRESS: A media access control **address (MAC address)** of a device is a unique identifier assigned to a network interface controller (NIC) for communications at the data link layer of a network segment. Every NIC has a hardware address that's known as a MAC, for Media Access Control. Where IP addresses are associated with TCP/IP (networking software), MAC addresses are linked to the hardware of network adapters.

- **MAC addresses** are used as a network **address** for most IEEE 802 network technologies, including Ethernet and Wi-Fi. In a local area network (LAN) or other network, the MAC (Media Access Control) address is your computer's unique hardware number.
- **MAC address** is a hardware identification number that uniquely identifies each device on a network.

IP ADDRESS: An Internet Protocol **address (IP address)** is a numerical label assigned to each device connected to a computer network that uses the Internet Protocol for communication.

- An **IP address** serves two principal functions: host or network interface identification and location addressing.
- An **IP address** is an identifier for a computer or device on a TCP/IP network. Networks using the TCP/IP protocol route messages based on the **IP address** of the destination.

DNS: The Domain Name System (DNS) is the phonebook of the Internet. Humans access information online through domain names, like bteup.com or asian.com.

- Web browsers interact through Internet Protocol (IP) addresses. DNS translates domain names to IP addresses so browsers can load Internet resources.
- The process of DNS resolution involves converting a hostname (such as www.kaumdi.com) into a computer-friendly IP address (such as 458.646.2.3).
- An IP address is given to each device on the Internet, and that address is necessary to find the appropriate Internet device.

Domain Name System (DNS) is used to resolve host domain names to IP addresses. Network users depend on DNS functionality mainly during browsing the Internet by typing a URL in the web browser.

4.19 INTERNET SECURITY

Internet security refers to the various steps individuals and companies take to protect computers o computer networks that are connected to the Internet. Internet security is a branch of computer security specifically related to the Internet, Its objective is to establish rules and measures to use against attacks over the Internet. The Internet represents an insecure channel for exchanging information leading to a high risk of intrusion or fraud, such as phishing, online viruses, trojans, worms etc.. Internet security encompasses browser security, the security of data entered through a Web form, and overall authentication and protection of data sent via Internet Protocol.

- Internet security relies on specific resources and standards for protecting data that gets sent through the Internet which include includes various kinds of encryptions.
- Other aspects of a secure Web setup includes firewalls, which block unwanted traffic, and anti-malware, anti-spyware and anti-virus programs that work from specific networks or devices to monitor Internet traffic for dangerous attachments.

Internet security refers to securing communication over the internet. It includes specific security protocols such as:

- Internet Security Protocol (IPSec)
- Secure Socket Layer (SSL)

Internet Security Protocol (IPSec)

- Set of protocols designed by Internet Engineering Task Force (IETF).
- Provides security at network level and helps to create authenticated and confidential packets fo IP layer.

Secure Socket Layer (SSL)

- Security protocol developed by Netscape Communications Corporation.
- Provides security at transport layer. It addresses the security issues like Privacy, Integrity, Authentication etc.

Common Security Problems

- Well-known cause of computer problems are viruses, or damaging programs that are introduced to computers or networks.
- Some viruses rewrite coding to make software programs unusable, while others scramble or destroy data.
- Many viruses spread quickly and operate subtly, so they may not be noticed until the damage has already been done.
- Hackers have two main methods of causing problems for businesses' computer systems.
- They either find a way to enter the system and then change or steal information from the inside.
- They attempt to over-whelm the system with information from the outside so that it shuts down.
- Many hackers are skilled at guessing common passwords, while others run programs that locate or capture password information.
- Another common method of attack used by hackers is e-mail spoofing.
- This method involves sending authorized users of a computer network fraudulent e-mail that appears as if it were sent by someone else, most likely a customer or someone else the user would know.
- Then the hacker tries to trick the user into divulging his or her password or other company secrets.
- Some hackers manage to shut down business computer systems with denial of service attacks. These attacks involve bombarding a company's Internet site with thousands of messages so that no legitimate messages can get in or out.
- Cyber criminals have evolved several techniques to threat privacy and integrity of bank accounts, businesses, and organizations.

Some of the Internet Security Threats are:

- Mobile worms
- Malware
- PC and Mobile ransomware
- Spam
- Phishing
- Large scale attacks like Stuxnet that attempts to destroy infrastructure
- Hacking

Means of Protection

- Personal computers sold today come equipped with virus protection.
- Antivirus software is also available for use on computer networks.

- Software companies and Internet Service Providers put updates online to cover newly emerging viruses.
- Use of firewall.
- A **firewall** is a network security system that monitors and controls incoming and outgoing network traffic based on predetermined security .
- A firewall can be hardware, software, or both.
- A firewall establishes a barrier between a trusted internal network and untrusted external network, such as the Internet.
- Acts like a Web server, routing traffic, but also blocks external users from accessing the internal computer system.
- Firewall cannot protect information once it leaves the network.
- Method of preventing third parties from capturing data while it is being transmitted over the Internet is encryption.
- Encryption programs put data into a scrambled form that cannot be read without a key.
- to help small businesses prevent unauthorized access to their computer systems, most common method is authentication of users through passwords.
- Since passwords can be guessed or stolen, some companies use more sophisticated authentication technologies, such as coded ID cards, voice recognition software, retinal scanning systems, or handprint recognition systems.
- These systems verify that the person seeking access to the computer network is an authorized user.
- Digital signatures can be used to authenticate e-mails and other outside documents.
- Websites are always to prone to security risks.
- Cyber crime impacts business by hacking websites.
- Hackers may also steal important customer data such as credit card information, destroy your business and propagate illegal content to your users.
- *Encryption:* Encryption is a security method in which information is encoded in such a way that only authorized user can read it.
- Uses encryption algorithm to generate ciphertext that can only be read if decrypted.

Types of Encryption

- Symmetric key encryption algorithm that uses same cryptographic keys for both encryption and decryption of cipher text.

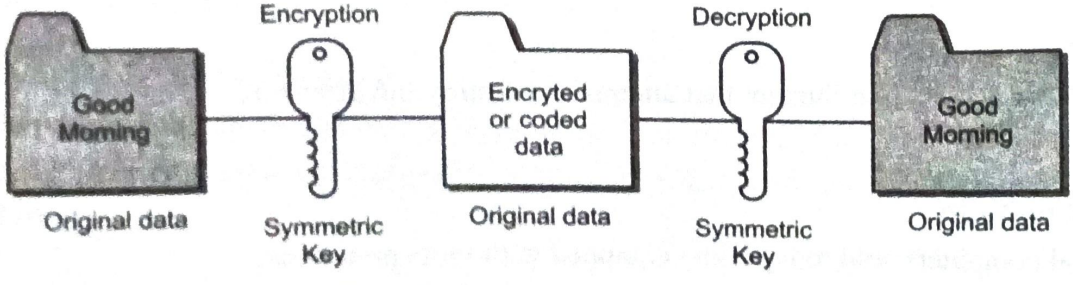


Fig. 4.9 Symmetric key encryption

- Public key encryption algorithm which uses pair of keys, one of which is a secret key and one of which is public. These two keys are mathematically linked with each other.

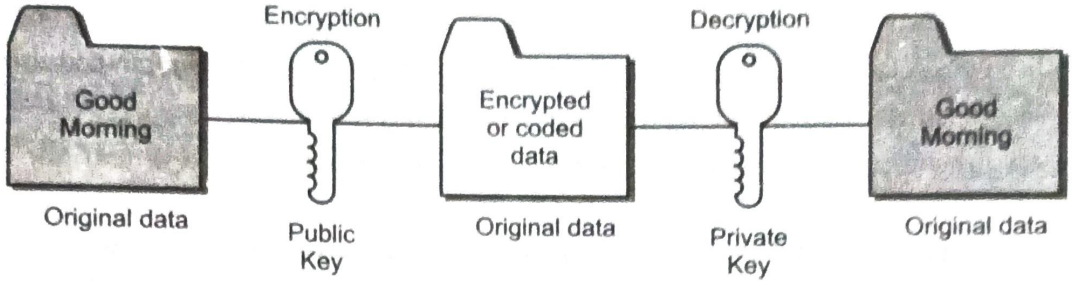


Fig. 4.10 Public key encryption

4.20 FIREWALL

A **firewall** is a network security system that monitors and controls incoming and outgoing network traffic based on predetermined security rules. A firewall typically establishes a barrier between a trusted internal network and untrusted external network, such as the Internet. A firewall can be hardware, software, or both.

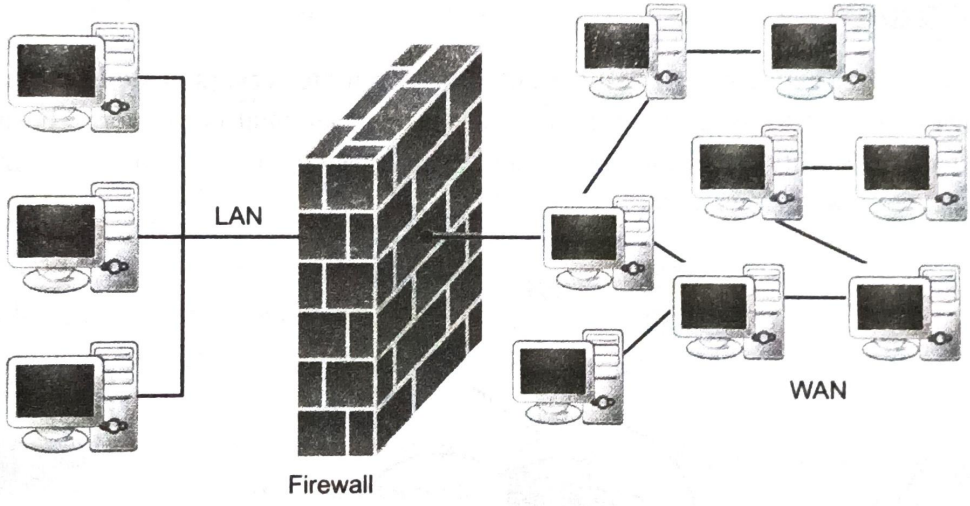


Fig. 4.11 A firewall establishes a barrier between a trusted internal network and untrusted external network

- Firewall is software or firmware that enforces a set of rules about what data packets will be allowed to enter or leave a network.
- Firewalls are incorporated into a wide variety of networked devices to filter traffic and lower the risk that malicious packets traveling over the public internet can impact the security of a private network
- Categorized as network-based or host-based.
- Network-based firewalls are positioned on the gateway computers of LANs, WANs and intranets. They are either software appliances running on general-purpose hardware, or hardware-based firewall computer appliances.

- Network firewalls filter traffic between two or more networks and run on network hardware.
- Also called packet filters.
- Operate at a relatively low level of the TCP/IP protocol stack.
- Do not allow packets to pass through the firewall unless they match the established rule set.
- Firewall administrator may define the rules or default rules may apply.
- Host-based firewalls run on host computers and control network traffic in and out of those machines.
- A host-based firewall is installed on individual servers and monitors incoming and outgoing signals.
- A network-based firewall can be built into the cloud's infrastructure, or it can be a virtual firewall service.

A firewall is a network security device that monitors incoming and outgoing network traffic and decides whether to allow or block specific traffic based on a defined set of security rules. A firewall can be hardware, software, or both.

4.21 CLOUD COMPUTING

Cloud Computing refers to the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer. The name cloud computing comes from the traditional usage of the cloud to represent the internet or a wide area network (WAN) in network diagrams or flowcharts.

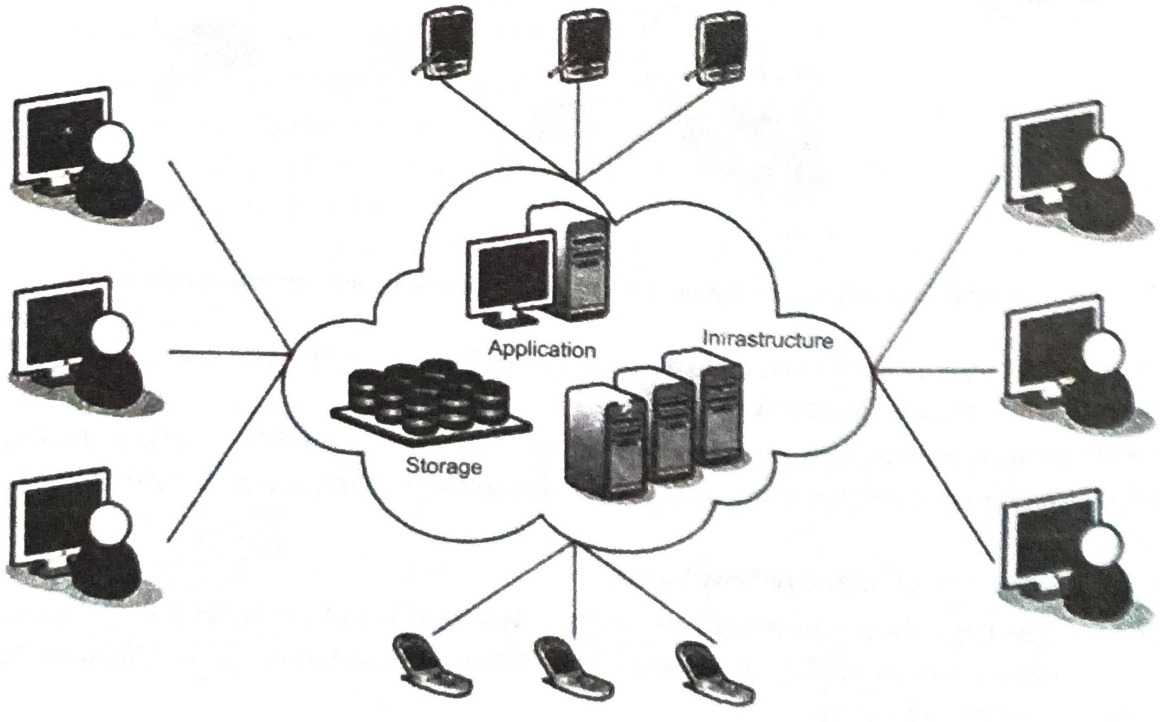


Fig. 4.12 Cloud computing

- **Cloud computing** is an information technology (IT) paradigm that enables ubiquitous access to shared pools of configurable system resources and higher-level services that can be rapidly provisioned with minimal management effort, often over the Internet.
- Enables companies to consume a compute resource, such as a virtual machine storage or an application, as a utility rather than having to build and maintain computing infrastructures in house.
- Use of various services, such as software development platforms, servers, storage and software, over the internet, often referred to as the cloud.
- Cloud computing characteristics:
  - The back-end of the application mainly the hardware is completely managed by a cloud vendor.
  - A user only pays for services used i.e. memory, processing time and bandwidth, etc.
  - Services are scalable

Advantages

- **Direct retrieval from the internet:** Method for delivering information technology (IT) services in which resources are retrieved from the Internet through web-based tools and applications
- Self-service provisioning: End users can use compute resources for almost any type of workload on demand.
- **Elasticity:** Eliminates the need for massive investments in local infrastructure, which may or may not remain active.
- **Pay per use:** Users pay only for the resources and workloads they use.
- **Workload resilience:** Cloud service providers implement redundant resources to ensure resilient storage and to keep users› important workloads running.
- **Migration flexibility:** Organizations can move certain workloads to or from the cloud as desired. Users are able to carry over their files and settings to other devices in a completely seamless manner.
- Cloud-computing services also make it possible for users to back up their music, files and photos, ensuring that those files are immediately available in the event of a hard drive crash.
- Cloud computing offers big businesses cost-saving potential.
- Instead of investing millions in huge server centers and intricate, global IT departments that require constant upgrades, a firm can use versions of workstations with lightning fast internet connections, and the workers will interact with the cloud online to create presentations, spreadsheets and interact with company software
- Cloud-like structure allows users to upgrade software more quickly because software companies can offer their products via the web rather than through discs or flash drives.

- Cloud computing is a method for delivering IT services in which resources are retrieved from the Internet through web-based tools and applications, rather than direct connection to a server.
- Cloud-based storage makes it possible to save them to a remote database rather than keeping files on a hard drive or local storage device.
- As long as the device has access to the web, it has access to the data and the software programs to run it.
- It's called cloud computing because the information being accessed is found in the cloud and does not require a user to be in a specific place to gain access to it.
- Allows employees to work remotely.
- Companies providing cloud services enable users to store files and applications on remote servers, and then access all the data via the internet.
- Your data, work and applications are available from any device with which you can connect to the internet, anywhere in the world.
- Cloud computing is comprised of three services: infrastructure as a service (IaaS), software as a service (SaaS) and platform as a service (PaaS).
- SaaS involves the licensure of a software application to customers.
- IaaS involves a method for delivering everything from operating systems to servers and storage through IP-based connectivity as part of an on-demand service.
- PaaS shares some similarities with SaaS, the primary difference being that instead of delivering software online, it is actually a platform for creating software that is delivered via the internet.
- SaaS is expected to experience the fastest growth, followed by IaaS.

Limitations and Risks of Cloud Computing

- Sensitive information has made its way into the hands of malicious hackers who may delete, manipulate or otherwise exploit the data Although encryption protects vital information, but if the encryption key is lost, the data disappears.
- Servers maintained by cloud computing companies can fall victim to a natural disasters, internal bugs and power outages, too.
- With many individuals accessing and manipulating information through a single portal, inadvertent mistakes can transfer across an entire system.

What do you mean by internet security? What are firewall and cloud computing?

In modern times, organizations greatly rely on computer networks to share information throughout the organization in an efficient and productive manner and their network consists of thousands of work stations.

- These workstations on company network are directly connected to the Internet.
- This sort of unsecured network becomes a target for an attack which holds valuable information and displays vulnerabilities.

- A network is defined as two or more computing devices connected together for sharing resources efficiently. Further, connecting two or more networks together is known as **internet working**. Thus, the Internet is just a collection of interconnected networks.

Firewall is a barrier between Local Area Network (LAN) and the Internet. It allows keeping private resources confidential and minimizes the security risks. It controls network traffic, in both directions.

- Firewall management must be addressed by both system managers and the network managers.
- The amount of filtering a firewall varies. For the same firewall, the amount of filtering may be different in different directions.

Cloud Computing provides us means by which we can access the applications as utilities over the internet. It allows us to create, configure, and customize the business applications online.

- **Cloud** means a **Network** or **Internet or** something, which is present at remote location. Cloud can provide services over public and private networks, i.e., WAN, LAN or VPN.
- Applications such as e-mail, web conferencing, customer relationship management (CRM) execute on cloud.
- Cloud Computing refers to **manipulating, configuring,** and **accessing** the hardware and software resources remotely.
- Offers online data storage, infrastructure, and application.
- Offers **platform independency,** as the software is not required to be installed locally on the PC.
- Making our business applications **mobile** and **collaborative.**

Advantages

- Access applications as utilities, over the Internet.
- Manipulate and configure the applications online at any time.
- It does not require to install a software to access or manipulate cloud application.
- Offers online development and deployment tools, programming runtime environment through **PaaS model.**
- Offers on-demand self-service.
- Highly cost effective because it operates at high efficiency with optimum utilization. It just requires an Internet connection.
- Offers load balancing that makes it more reliable.
- Resources are available over the network in a manner that provide platform independent access to any type of clients.

4.22 TRANSMISSION MODES IN COMPUTER NETWORKS

Transmission mode refers to the mechanism of transferring of data between two devices connected over a network. It is also called Communication Mode. These modes direct the direction of flow of information.

4.22.1 Types of Transmission Modes

- Simplex Mode
- Half duplex Mode
- Full duplex Mode

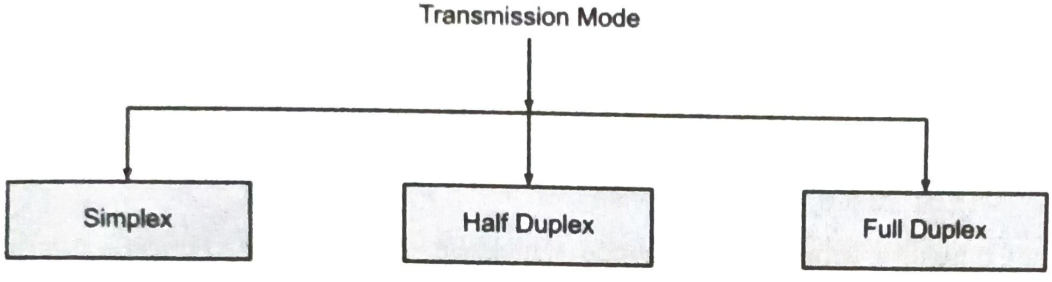


Fig. 4.13 Types of transmission modes

Simplex Mode

In this type of transmission mode, data can be sent only in one direction i.e. communication is unidirectional. We cannot send a message back to the sender. It is used when we just need to send a command/signal, and do not expect any response back. Examples of simplex Mode are loudspeakers, television broadcasting, television and remote, keyboard and monitor etc.

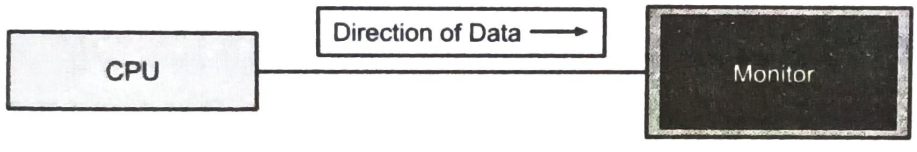


Fig. 4.14 Simplex mode

Half Duplex Mode

Half-duplex data transmission means that data can be transmitted in both directions on a signal carrier, but not at the same time. Hence half-duplex transmission implies a bidirectional line but data can be sent in only one direction at a time. Example of half duplex is a walk i.e.- talkie in which message is sent one at a time but messages are sent in both the directions.

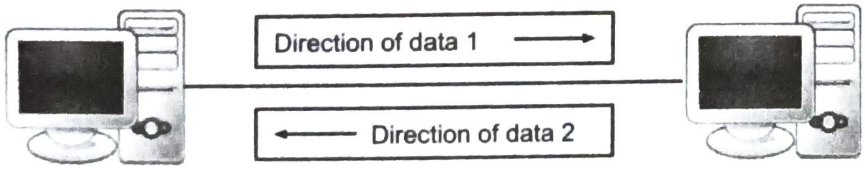


Fig. 4.15 Half duplex mode

Full Duplex Mode

In full duplex system we can send data in both the directions as it is bidirectional at the same time in other words, data can be sent in both directions simultaneously. Example of Full Duplex is a Telephone Network in which there is communication between two persons by a telephone line, using which both can talk and listen at the same time. In full duplex system there can be two lines one for sending the data and the other for receiving data.

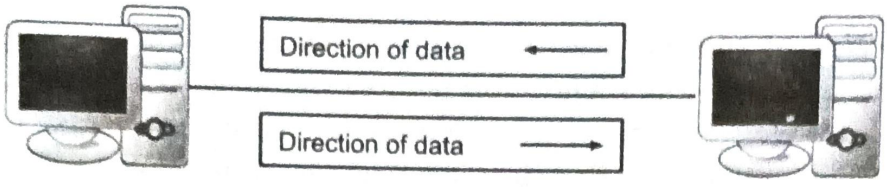


Fig. 4.16 Full duplex mode

Parallel Connection

Parallel connection means simultaneous transmission of N bits. These bits are sent simultaneously over N different channels (a channel being, for example, a wire, a cable, or any other physical medium). These channels may be: N physical lines: in which case each bit is sent on a physical line.

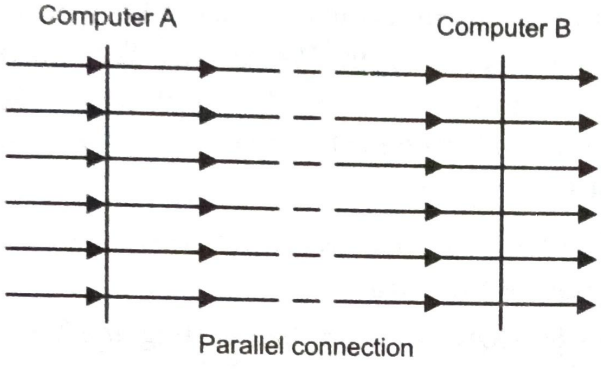


Fig. 4.17 Parallel Connection

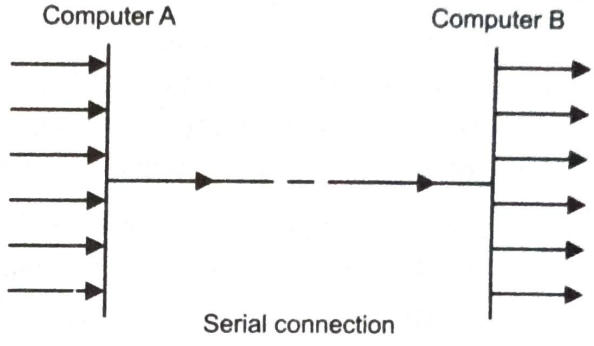


Fig. 4.18 Serial Connection

Serial Connection

In a serial connection, the data is sent one bit at a time over the transmission channel. However, since most processors process data in parallel, the transmitter needs to transform incoming parallel data into serial data and the receiver needs to do the opposite:

These operations are performed by a communications controller (normally a UART, or a Universal Asynchronous Receiver Transmitter, chip. The parallel-serial transformation is performed using a shift register. The shift register, working together with a clock, will shift the register (containing all of the data presented in parallel) by one position to the left and, then, transmit the most significant bit (the leftmost one) and so on. The serial-parallel transformation is done in almost the same way using a shift register. The shift register shifts the register by one position to the left each time a bit is received and, then, transmits the entire register in parallel when it is full.

Asynchronous and Synchronous Transmission

To synchronize the transmitter and receive, there are two types of transmission i.e. an asynchronous connection and a synchronous connection.

In an asynchronous connection, each character is sent at irregular intervals in time. Each character is preceded by some information indicating the start of character transmission (the transmission start information is called a START bit) and ends by sending end-of-transmission information (called STOP bit).

In a synchronous connection, the transmitter and receiver are paced by the same clock. The receiver continuously receives the information at the same rate that the transmitter sent it. This is why the transmitter

and receiver are paced at the same speed. In addition, additional information called handshaking signals is inserted to guarantee that there are no errors during transmission. During synchronous transmission, the bits are sent successively with no separation between each character, so it is necessary to insert synchronization elements; this is called character-level synchronization.

4.23 SEARCH ENGINES

Search engines refers to a program that searches for and identifies items in a database that correspond to keywords or characters specified by the user, used especially for finding particular sites on the World Wide Web. A **search engine** is a software program or script available through the Internet that searches documents and files for keywords and returns the results of any files containing those keywords. Search engine is a service that allows Internet users to search for content via the World Wide Web (WWW). A user enters keywords or key phrases into a search engine and receives a list of Web content results in the form of websites, images, videos or other online data. The list of content returned via a search engine to a user is known as a search engine results page (SERP).

- First search engine ever developed is considered Archie, which was used to search for FTP files and the first text-based search engine is considered Veronica.
- Examples of modern search engines are Google. AOL, Ask.com, Baidu, Bing and Yahoo.

Accessing a search engine

- Search engine is accessed through a browser on their computer, smartphone, tablet, or another device.
- Browsers use an Omnibox, which is a text box at the top of the browser that shows the address and is where you can also search on the Internet.
- You can also visit one of the major search engines home page to perform a search.
- Search engines contain millions and sometimes billions of pages.
- Many search engines not only just search the pages but also display the results depending upon their importance.
- Importance determined by using various algorithms.

4.24 SOCIAL NETWORKING SITES

A social networking site (also social networking service, or SNS) is an online platform which people use to build social networks or social relations with other people who share similar personal or career interests, activities, backgrounds or real-life connections.

- **social network sites** are web-based services that allow individuals to.
- construct a public or semi-public profile within a bounded system.
- articulate a list of other users with whom they share a connection.
- view and traverse their list of connections and those made by others within the system.

Social networking site is a website that enables users to create public profiles within that Web site

and form relationships with other users of the same Web site who access their profile. A social networking site is an online platform that allows users to create a public profile and interact with other users on the website. Social networking sites have different rules for establishing connections, but they often allow users to view the connections of a confirmed connection and even suggest further connections based on a person's established network. Some social networking websites like LinkedIn are used for establishing professional connections, while sites like Facebook straddle the line between private and professional. There are also many networks that are built for a specific user base, such as cultural or political groups within a given area or even traders in financial markets.

What is a social networking site. Name some social networking sites. A social networking site is an online platform which people use to build social networks or social relations with other people who share similar personal or career interests, activities, backgrounds or real-life connections.

- Facebook. This is the biggest social media network on the Internet, both in terms of total number of users and name recognition.
- Twitter.
- LinkedIn.
- Google+ Pinterest.
- Instagram.

4.25 NETWORK TOPOLOGIES

Network Topology is the schematic description of a network arrangement, connecting various nodes (sender and receiver) through lines of connection.

4.25.1 Bus Topology

Bus topology is a network type in which every computer and network device is connected to single cable. When it has exactly two endpoints, then it is called Linear Bus topology.

- transmits data only in one direction.
- Every device is connected to a single cable.

Advantages

- Cost effective.
- Cable required is least compared to other network topology.
- Used in small networks.
- Simple.
- Easy to expand.

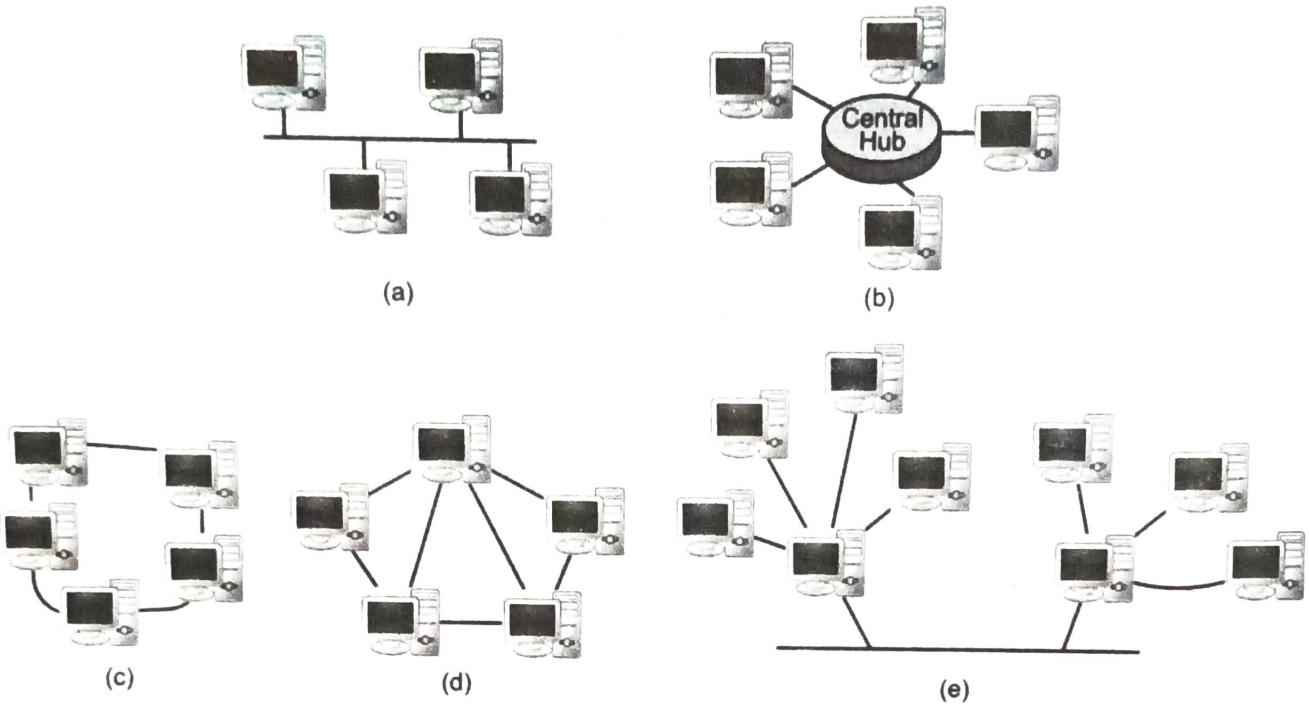


Fig. 4.19 Network topologies (a) bus (b) star (c) ring (d) mesh (e) tree

Limitations

- Cables fails then whole network fails.
- Performance deterirates on heavy traffic.
- Cable has a limited length.
- Slower.

4.25.2 Ring Topology

It is called ring topology because it forms a ring as each computer is connected to another computer, with the last one connected to the first.

- Exactly two neighbours for each device.
- large number of repeaters.
- The transmission is unidirectional.
- Data is transferred in a sequential manner that is bit by bit.

Advantages

- Transmitting network is not affected by high traffic
- Cost effective

Limitations

- Troubleshooting is difficult
- Adding or deleting the computers is tedious.
- Failure of one computer disturbs whole network.

4.25.3 Star Topology

In star topology, every host is connected to a central hub.

Advantages

- If one node or its connection breaks, it doesn't affect the other computers nor their connections.
- Devices can be added or removed without disturbing the network.

Limitations

- An expensive network layout to install because of the number and length of cables needed to wire each host to the central hub.
- Central hub is a single point of failure for the network i.e. if the central hub fails, the whole i.e. entire network will fail.

4.25.4 Mesh Topology

It is a point-to-point connection to other nodes or devices. All the network nodes are connected to each other. Mesh has $n(n-1)/2$ physical channels to link n devices.

- There are two techniques to transmit data over the Mesh topology, i.e. Routing and Flooding.
- Fully connected.
- Robust.
- Not flexible.

Advantages

- Each connection can carry its own data load.
- Robust.
- Easy fault diagonosis.
- Provides security and privacy.

Limitations

- Difficult Installation and configuration.
- High cabling cost.
- Requires bulk wiring.

4.25.5 Tree Topology

It has a root node and all other nodes are connected to it forming a hierarchy. It is also called hierarchical topology.

- I should have at least have three levels to the hierarchy.
- Ideal if workstations are located in groups.
- Used in WANs.

Advantages

- Extension of bus and star topologies.
- Expansion of nodes is possible and easy.
- Easy management and maintenance.
- Easy error detection.

Limitations

- Heavily cabled.
- High cost.
- If more nodes are added maintenance is difficult.
- Central hub fails, network fails.

4.25.6 Hybrid Topology

It is two different types of topologies which is a mixture of two or more topologies:

- It is a combination of two or more topologies, hence the name hybrid technology.
- Inherits the advantages and disadvantages of the topologies included.

Advantages

- Reliable.
- Error detecting and troubleshooting is easy.
- Effective.
- Scalable.
- Flexible.

Limitations

- Complex design.
- Costly.

4.26 SOME IMPORTANT QUESTIONS AND ANSWERS

Q. What is a web browser?

Ans. A web browser is a software program that allows a user to locate, access, and display web pages

- Primarily for displaying and accessing websites on the internet, as well as other content created using languages such as Hypertext Markup Language (HTML) and Extensible Markup Language (XML).
- Browsers translate web pages and websites delivered using Hypertext Transfer Protocol (HTTP) into human-readable content.
- Have the ability to display other protocols and prefixes, such as secure HTTP (HTTPS), File Transfer Protocol (FTP), email handling (mailto:), and files (file:).

- Also support external plug-ins required to display active content, such as in-page video, audio and game content. Variety of web browsers are available with different features, and are designed to run on different operating systems.
- Common browsers include Internet Explorer from Microsoft, Firefox from Mozilla, Google Chrome, Safari from Apple, and Opera.

Q. What do you mean by URL, URI, URN WWW, FTP, HTTP, RDC, TELNET, E-MAIL, MAC ADDRESS, IP ADDRESS?

Ans.
- Uniform Resource Identifier (URI) is a string of characters used to identify a name or a resource on the Internet.
- URI identifies a resource either by location, or a name, or both. **A URI has two specializations known as URL and URN.**
- Uniform Resource Locator (URL) is a subset of the Uniform Resource Identifier (URI) that specifies where an identified resource is available and the mechanism for retrieving it.
- URL defines how the resource can be obtained.
- Uniform Resource Name (URN) is a Uniform Resource Identifier (URI) that uses the URN scheme, and **does not imply availability of the identified resource.**
- Both URNs (names) and URLs (locators) are URIs, and a particular URI may be both a name and a locator at the same time.
- The URNs are part of a larger Internet information architecture which is composed of URNs, URCs and URLs.
- URI stands for Uniform Resource Identifier. URI is a text which is used to identify any resource or name on Internet. URI has two specializations in the form of URL (Uniform Resource Locator) and URN (Uniform Resource Name) to identify resource and name.
- URL standards for Uniform resource locator and it is a subset of URI or Uniform Resource Identifier. URL includes location as well as the protocol to retrieve the resource:
  - Every URL and URN is URI because URI is the superset of both URL and URN.
  - URL includes protocol e.g. http://, ftp:// along with location to identify resource e.g. http://www.blogspot.com/abc.html.
  - URN are the unambiguous way to identify a resource. ISBN numbers are best examples of URN.

WWW: The Web, or World Wide Web (W3), is basically a system of Internet servers that support specially formatted documents. The documents are formatted in a markup language called HTML (*HyperText Markup Language*) that supports links to other documents, as well as graphics, audio, and video files.

This means you can jump from one document to another simply by clicking on hot spots. Not all Internet servers are part of the World Wide Web.

FTP: File Transfer Protocol (FTP) is a client/server protocol used for transferring files to or exchanging files with a host computer.

- It may be authenticated with user names and passwords
- FTP is a protocol designed for transferring files over the Internet.

- Files stored on an FTP server can be accessed using an FTP client, such as a web browser, FTP software program, or a command line interface.
- An FTP server can be configured to enable different types of access.

HTTP: HTTP means **H***yper***T***ext* **T***ransfer* **P***rotocol*. HTTP is the underlying protocol used by the World Wide Web and this protocol defines how messages are formatted and transmitted, and what actions:

- Web servers and browsers should take in response to various commands. For example, when you enter a URL in your browser, this actually sends an HTTP command to the Web server directing it to fetch and transmit the requested Web page.
- Other main standard that controls how the World Wide Web works is HTML, which covers how Web pages are formatted and displayed.
- HTTP is an application layer protocol in TCP/IP suite used for transfer files that make up the web pages from the web servers.
- These transfers are done in plain text and an intruder can easily read the data packets exchanged between the server and a client.
- ***HTTP*** (Hypertext Transfer Protocol) is the set of rules for transferring files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web.
- As soon as a Web user opens their Web browser, the user is indirectly making use of ***HTTP***.

RDC: Remote Desktop Connection (RDC) is a Microsoft technology that allows a local computer to connect to and control a remote PC over a network or the Internet.

- Done through a Remote Desktop Service (RDS) or a terminal service that uses the company's proprietary Remote Desktop Protocol (RDP). RDC requires the remote computer to enable the RDS and to be powered on.
- Connection is established when a local computer requests connection to a remote computer using an RDC-enabled software.
- On authentication, the local computer has full or restricted access to the remote computer. Besides desktop computers, servers and laptops, RDC also supports connecting to virtual machines.

TELNET: Telnet is a protocol used on the Internet or local area network to provide a bidirectional interactive text-oriented communication facility using a virtual terminal connection.

- Telnet is a user command and an underlying TCP/IP protocol for accessing remote computers. Through Telnet, an administrator or another user can access someone else›s computer remotely.
- On the Web, HTTP and FTP protocols allow you to request specific files from remote computers, but not to actually be logged on as a user of that computer.

E-MAIL: ***E-mail*** (***electronic mail***) is the exchange of computer-stored messages by telecommunication.

- Electronic mail (email) is a digital mechanism for exchanging messages through Internet or intranet communication.
- Allows you to send and receive messages to and from anyone with an ***email*** address, anywhere in the world.
- Uses multiple protocols within the TCP/IP suite.
- Means or system for transmitting messages electronically (as between computers on a network).

MAC ADDRESS: A media access control **address** (**MAC address**) of a device is a unique identifier assigned to a network interface controller (NIC) for communications at the data link layer of a network segment.

- **MAC addresses** are used as a network **address** for most IEEE 802 network technologies, including Ethernet and Wi-Fi. In a local area network (LAN) or other network, the MAC (Media Access Control) address is your computer's unique hardware number.
- ***MAC address*** is a hardware identification number that uniquely identifies each device on a network.

IP ADDRESS: An Internet Protocol ***address*** (***IP address***) is a numerical label assigned to each device connected to a computer network that uses the Internet Protocol for communication.

- An ***IP address*** serves two principal functions: host or network interface identification and location addressing.
- An ***IP address*** is an identifier for a computer or device on a TCP/***IP*** network. Networks using the TCP/***IP*** protocol route messages based on the ***IP address*** of the destination.

DNS: The Domain Name System (DNS) is the phonebook of the Internet. Humans access information online through domain names, like nytimes.com or espn.com.

- Web browsers interact through Internet Protocol (IP) addresses. DNS translates domain names to IP addresses so browsers can load Internet resources.
- The process of DNS resolution involves converting a hostname (such as www.kaumdi.com) into a computer-friendly IP address (such as 458.646.2.3).
- An IP address is given to each device on the Internet, and that address is necessary to find the appropriate Internet device.
- **Domain Name System** (DNS) is used to resolve host domain names to IP addresses.
- Network users depend on DNS functionality mainly during browsing the Internet by typing a URL in the web browser.

Q. What is a social networking site? Name some social networking sites.

Ans. A **social networking** service (**social networking site**, SNS or **social** media) is an online platform which people use to build **social networks** or **social** relations with other people who share similar personal or career interests, activities, backgrounds or real-life connections.

- Facebook. This is the biggest **social media network** on the Internet, both in terms of total number of users and name recognition.
- Twitter.
- LinkedIn.
- Google+
- Pinterest.
- Instagram.

Q. What is a modem? What is the role of modem in accessing the internet?

Ans. A **modem** (modulator–demodulator) is a network hardware device that modulates one or more carrier wave signals to encode digital information for transmission and demodulates signals to decode the transmitted information.

- Modem is short for Modulator/Demodulator.
- Hardware component that allows a computer or other device, such as a router or switch, to connect to the Internet.
- Converts or "modulates" an analog signal from a telephone or cable wire to a digital signal that a computer can recognize.
- Converts outgoing digital data from a computer or other device to an analog signal.
- Modern modems are typically DSL or cable modems, which are considered "broadband" devices.
- DSL modems operate over standard telephone lines, but use a wider frequency range.
- Allows for higher data transfer rates than dial-up modems and enables them to not interfere with phone calls. Cable modems send and receive data over standard cable television lines, which are typically coaxial cables.
- Most modern cable modems support DOCSIS (Data Over Cable Service Interface Specification), which provides an efficient way of transmitting TV, cable Internet, and digital phone signals over the same cable line.

Q. What do you mean by internet security? What are firewall and cloud computing?

Ans. In modern times, organizations greatly rely on computer networks to share information throughout the organization in an efficient and productive manner and their network consists of thousands of work stations.

- These workstations on company network are directly connected to the Internet.
- This sort of unsecured network becomes a target for an attack which holds valuable information and displays vulnerabilities.
- A network is defined as two or more computing devices connected together for sharing resources efficiently. Further, connecting two or more networks together is known as **internet working**. Thus, the Internet is just a collection of interconnected networks.

Firewall is a barrier between Local Area Network (LAN) and the Internet. It allows keeping private resources confidential and minimizes the security risks. It controls network traffic, in both directions.

- Firewall management must be addressed by both system managers and the network managers.
- The amount of filtering a firewall varies. For the same firewall, the amount of filtering may be different in different directions.

Cloud Computing provides us means by which we can access the applications as utilities over the internet. It allows us to create, configure, and customize the business applications online.

- Cloud means a Network or Internet or something, which is present at remote location. Cloud can provide services over public and private networks, i.e., WAN, LAN or VPN.
- Applications such as e-mail, web conferencing, customer relationship management (CRM) execute on cloud.
- Cloud Computing refers to manipulating, configuring, and accessing the hardware and software resources remotely.
- Offers online data storage, infrastructure, and application.

- Offers platform independency, as the software is not required to be installed locally on the PC.
- Making our business applications mobile and collaborative.

Advantages

- Access applications as utilities, over the Internet.
- Manipulate and configure the applications online at any time.
- It does not require to install a software to access or manipulate cloud application.
- Offers online development and deployment tools, programming runtime environment through **PaaS model.**
- Offers on-demand self-service
- Highly cost effective because it operates at high efficiency with optimum utilization. It just requires an Internet connection
- Offers load balancing that makes it more reliable.
- Resources are available over the network in a manner that provide platform independent access to any type of clients.

EXERCISES

1. What is a computer Network? Explain Client Server Model and Peer to Peer Model
2. What are Networking Devices? Explain Switch, Router, Hub, Bridge, Gateway.
3. What are networking topologies? Explain LAN, MAN and WAN.
4. Describe the differences between Internet, Intranet, Extranet.
5. What are microsoft internal explorer and google?
6. What is internet service provider and its relevance?
7. What is the role of the modem in accessing the internet?
8. What is installation procedure of a modem using control panel?
9. What is the purpose of web browser software?
10. What are url, uri, urn, www, ftp, http, rdc (remote desktop connection), telnet?
11. What is email? Explain the process of sending and receiving e-mail.
12. What are transmission modes?
13. What is an IP address and its format?
14. What is a MAC address?
15. What is DNS?
16. What do you mean by search engines?
17. Explain social network sites and their role in modern society.
18. What is internet security?
19. Explain about firewall.
20. Explain about cloud computing and its services

❑❑❑

5 Chapter

MEMORIES

THINK ABOUT IT

When you look closely to the path you have travel on, you will realise that God was always with you, directing every step you took.
When you are truly comfortable with who you are, not everybody will like you. But you won't care about it one bit.
Be thankful for what you have. You have no idea how many people would love to have what you've got.

— Lailah Gifty Akita

5.1 INTRODUCTION

The memory of a computer is where the program and data are stored before the calculations begin. The memory is therefore one of the most active parts of the computer. The memory is equivalent to thousands of registers, each storing a binary word.

The memory cell (or a flip flop) is the fundamental building block of computer memory. The memory cell is an electronic circuit that stores one bit of binary information and it must be set to store a logic 1 (high voltage level) and reset to store a logic 0 (low voltage level). The value in the memory cell can be accessed by reading it.

A memory is just like a human brain. It is used to store data and instructions. Computer memory is the storage space in computer where data is to be processed and instructions required for processing are stored. The memory is divided into large number of small parts called cells. Each memory location has a unique address which varies from zero to memory size minus one. For example, if computer has 1024 words, then this memory unit has 1024 memory locations. The address of these locations varies from 0 to 1023.

Bit (Binary Digit)	A binary digit is a logical 1 or 0.
Nibble	A group of 4 bits is called nibble.
Byte	A group of 8 bits is called byte.
Word	A computer word, like a byte, is a group of fixed number of bits processed as a unit which varies from computer to computer but is fixed for each computer. The length of a computer word is called word-size or word length and it may be as small as 8 bits or may be as long as 96 bits. A computer stores the information in the form of computer words.

5.2 MEMORY RELATED TERMINOLOGY

Memory Cell

A device or electrical circuit used to store a single bit is called a memory cell for example a flip flop, a charged capacitor and a single spot on a magnetic tape or disk.

Memory Word

A group of bits in a memory that represents instruction or data of same type is called a memory word.

Byte

A group of 8-bits is termed as byte.

Memory Capacity or Density

By capacity of memory we mean the number of bits which can be stored in the memory, for example, if a memory can store 512 words of 8 bits each then its size will be 512 × 8 bits. Here, the first number indicates the number of words and the second number indicates the word size (number of bits in each word). For memories of bigger size, Kilo and Mega are used where 1 K = 2^{10} = 1024, 1 M = 2^{10} = 1,048,576, so by 2 K × 8 memory we mean 2 × 1024 × 8 memory or 2048 × 8 memory. The block diagram of a M × K memory is shown in Fig. 5.1.

"By memory capacity, we mean that how can we specify the number of bits that can be stored in the memory."

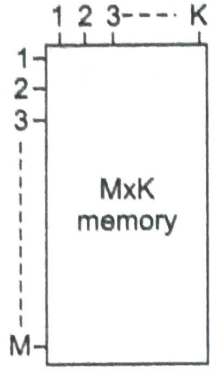


Fig. 5.1 Memory of M × K capacity

Address

"Address is a number that identifies the location of word in the memory. Each word stored in the memory has a unique binary address."

Every word stored in the memory has a unique address. This address is expressed in binary although it can also be expressed in octal or hexadecimal. From Fig. 5.2, it becomes that to store 8 words, the address size will be of three bits (because it need at least 3 bits to generate eight unique addresses (i.e.

000, 001, 010, 011, 100, 101, 110, 111). Similarly, to generate 16 unique addresses 4 bits will be needed. Hence, if the memory has to store to 2^n words then each address size will be of n bits.

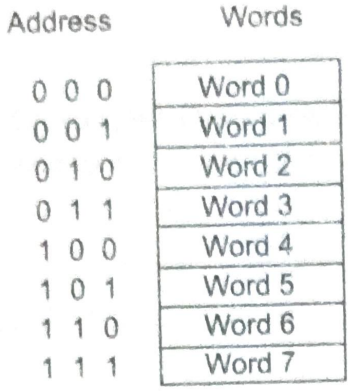


Fig. 5.2 Unique address of every word location

If the number of stored words in the memory is M then the number of address bits needed (n) is the smallest number which satisfies the equation $2^n \geq M$. The size of the address bus is equal to the number of address bits. Table 5.1 can be used to calculate the size of address bus (note that K = Kilo, M = Mega, G = Giga, T = Tera). For example, if the memories size is 4 K × 8 then the number of words stored in the memories will be 4 K. As 4 K = 4 × 1024 = 4096 = 2^{12}. So, the width of the bus will be twelve i.e. there will be 12 address lines.

Table 5.1 Calculation of width of address bus for a given memory size

$2^1 = 2$	$2^{11} = 2$ K	$2^{21} = 2$ M	$2^{31} = 2$ G
$2^2 = 4$	$2^{12} = 4$ K	$2^{22} = 4$ M	$2^{32} = 4$ G
$2^3 = 8$	$2^{13} = 8$ K	$2^{23} = 8$ M	$2^{33} = 8$ G
$2^4 = 16$	$2^{14} = 16$ K	$2^{24} = 16$ M	$2^{34} = 16$ G
$2^5 = 32$	$2^{15} = 32$ K	$2^{25} = 32$ M	$2^{35} = 32$ G
$2^6 = 64$	$2^{16} = 64$ K	$2^{26} = 64$ M	$2^{36} = 64$ G
$2^7 = 128$	$2^{17} = 128$ K	$2^{27} = 128$ M	$2^{37} = 128$ G
$2^8 = 256$	$2^{18} = 256$ K	$2^{28} = 256$ M	$2^{38} = 256$ G
$2^9 = 512$	$2^{19} = 512$ K	$2^{29} = 512$ M	$2^{39} = 512$ G
$2^{10} = 1024$	$2^{20} = 1024$ K	$2^{30} = 1024$ M	$2^{40} = 1024$ G
1 K = 2^{10} = 1024	1 M = 1024 K = 2^{10} K	1 G = 2^{10} M = 1024 M	1 T = 2^{10} G = 1024 G

Read Operation

Read operation is the operation by which the binary word stored in a specific memory location is sensed and then transferred to another device.

Write Operation

The operation where a new word is placed or stored into a particular memory location is called a write operation.

Access Time

It is a measure of operating speed of the memory. It is amount of time required to perform a read operation. It is the time between memory receiving a new address input and data becoming available at the memory output.

Volatile and Non-Volatile Memories

Volatile memories need electrical power to retain the stored data. If the power supply becomes off, the data stored in the volatile memory gets lost. However, non-volatile memories can retain the data even if the power supply fails.

Non-volatile memories can retain information without electrical power. All magnetic memories are non-volatile.

Random Access and Sequential Access Memories (RAM and SAM)

"RAM is a type of memory in which the access time is same for any address in the memory. SAM is a type of memory in which the access time is not constant but varies depending on address location."

In sequential access memory, the access time for any memory location is not same but depends on the address location i.e. how far from the starting point the location is situated. Hence, to locate any address, the addresses are sequenced one by one to reach the desired address. Hence, it is clear that to reach the desired address (sequencing process), the access time will be different for every address. The example of SAM is magnetic tape disk, magnetic bubble memory etc. An audio tape cassette is also an example of SAM because to reach any song are have to fast forward or rewind the tape until you reach the desired song. In the same way, you can compare RAM with the Jukebox in which to select a song it is only needed to punch the code and it takes same time to select any song.

Read/Write Memory and Read Only Memory (RWM and ROM)

Any memory that can be read from or write into with equal ease is called a Read/Write Memory. In a ROM, the data is written into only once, and this operation is performed at the factory (or by programmer). Thereafter, the information can only be read from the memory.

Static and Dynamic Memory

"Semiconductor memory devices in which the stored data will remain permanently stored as long as the power is applied, without the need for periodically rewriting the data into the memory, are called static memories.

Semiconductor memory devices in which the stored data will not remain permanently stored, even with power applied, unless the data are periodically rewritten (re-freshed) into the memory are called dynamic memories."

Dynamic RAM memory are made using MOS and CMOS transistor gates and the bits are stored in the form of a charge. This charge is stored in the capacitor formed between source and gate of the MOS. The limitation of this memory is that the stored charge leaks and hence to prevent the information from getting lost, it is necessary to rewrite the data at regular intervals (about 1 to 2 milli seconds). This is called the refreshing of dynamic memory and it needs additional circuit to refresh memory which increases the cost of this memory.

Internal and Auxilliary Memory

Internal memory stores instructions and data CPU is currently working on. Auxiliary memory stores massive amount of information external to internal memory.

Semiconductor and Non-semiconductor Memories

Semiconductor memory is made of semiconductor materials while non-semiconductor memory is made of magnetic materials. The examples of magnetic memory are Floppy disc, Cassette, Hard disk, Magnetic tapes, Magnetic core and Magnetic drums.

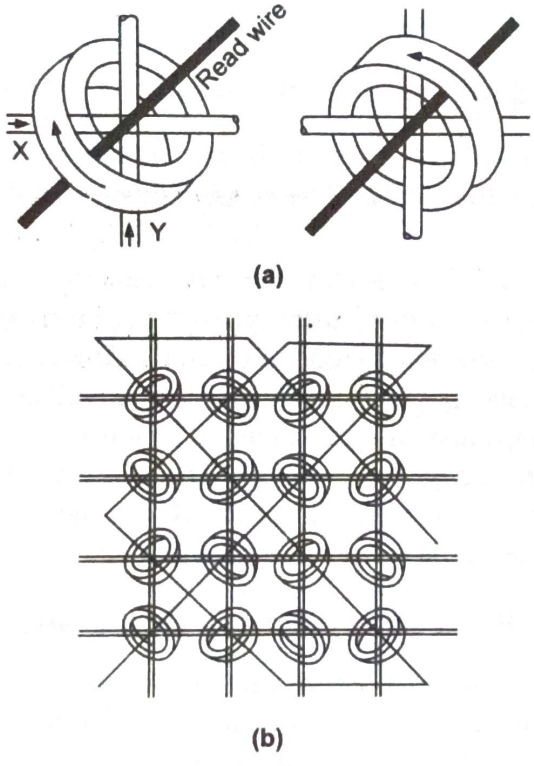


Fig. 5.3 (a) Magnetic core (b) Magnetic memory core configuration

Destructive and Non-destructive Memory

During read operation, if data is lost from the memory, than the read out is called a destructive read out. Memories with destructive read out are called destructive memories.

Memories having a non destructive read out i.e., data remains intact during a readout are termed non destructive memories.

Practice Questions

(i) The size of a memory chip is 4 K × 8. How many words can be stored in this memory? How many bits can be stored in this memory? What is the number of address bits (address bus size) for this memory?

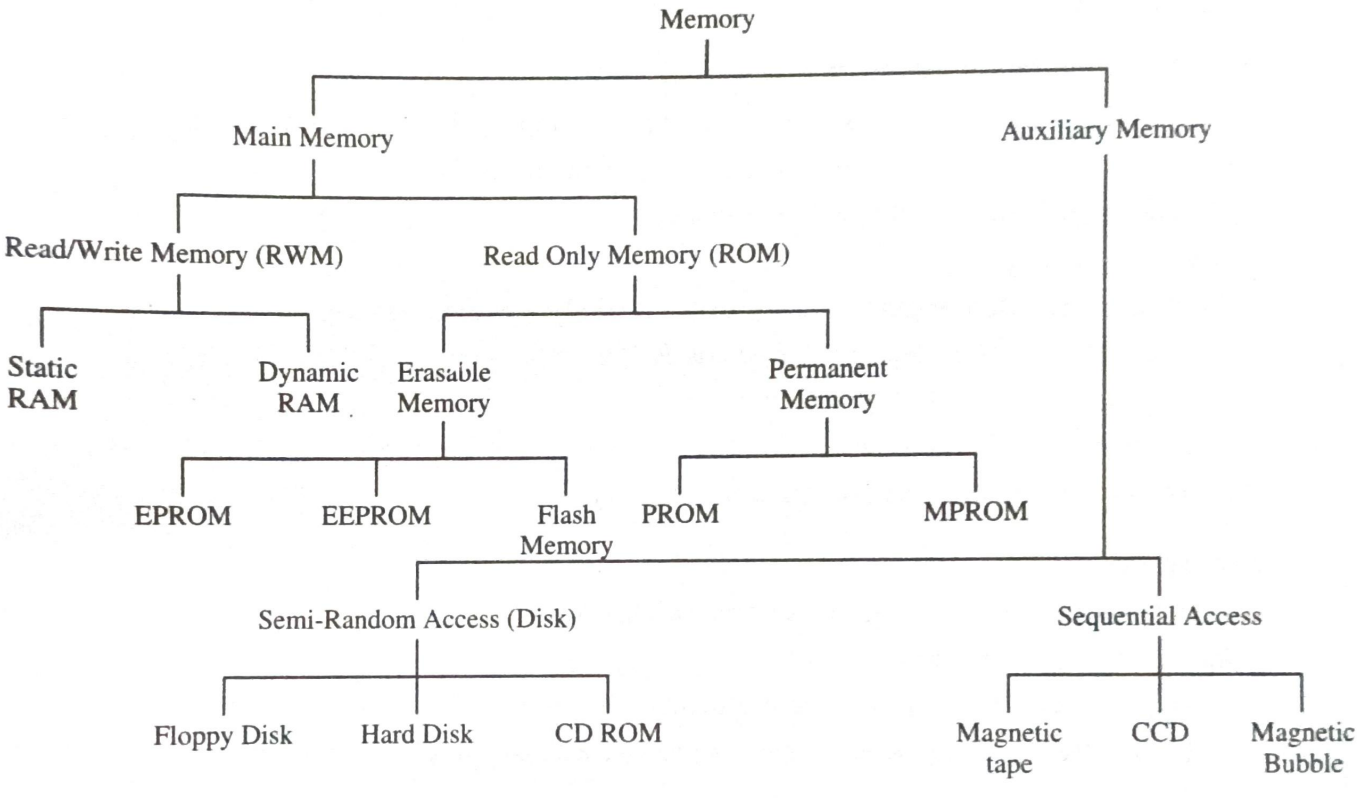
(ii) Which memory will address more bits—5 M × 4 or 100 K × 16?

(iii) If the memory size is 64 K × 8, then what will be the size of address bus and data bus.

5.3 MEMORY CLASSIFICATION

Classification of memory is shown in Table 5.2—

Table 5.2



Memory is primarily of three types:

- Cache Memory.
- Primary Memory/Main Memory.
- Secondary Memory.

Cache Memory

- A very high speed semiconductor memory which can speed up CPU.
- Acts as a buffer between the CPU and main memory.
- Used to hold those parts of data and program which are most frequently used by CPU.

- Parts of data and programs are transferred from disk to cache memory by operating system, from where CPU can access them.

Advantages

- Faster than main memory.
- Consumes less access time as compared to main memory.
- Stores the program that can be executed within a short period of time.
- Stores data for temporary use.

Limitations

- Limited capacity.
- Very expensive.

Primary Memory (Main Memory)

- Holds only those data and instructions on which computer is currently working.
- Limited capacity and data is lost when power is switched off.
- Generally made up of semiconductor device.
- Not as fast as registers.
- Data and instruction required to be processed reside in main memory.
- Divided into two subcategories RAM and ROM.
- It is working memory of the computer.
- Faster than secondary memories.
- A computer cannot run without primary memory.

Secondary Memory

- Also known as external memory or non-volatile memory.
- Slower than main memory.
- Used for storing data/Information permanently.
- CPU directly does not access these memories, instead, they are accessed via input-output routines.
- Contents of secondary memories are first transferred to main memory, and then CPU can access it.
- Examples : disk, CD-ROM, DVD, pen drives etc.
- Magnetic and optical memories.
- Known as backup memory.
- It is non-volatile memory i.e., data is permanently stored even if power is switched off.
- Used for storage of data in a computer.
- Computer may run without secondary memory.
- Slower than primary memories.

RAM (Random Access Memory)

- Internal memory of the CPU for storing data, program and program result.
- Read/write memory which stores data until the machine is working.
- As soon as the machine is switched off, data is erased.
- Access time in RAM is independent of the address, that is, access to each storage location inside the memory takes the same amount of time.
- Expensive.
- RAM is volatile, i.e. data stored in it is lost when we switch off the computer or if there is a power failure.
- Hence a backup uninterruptible power system (UPS) is often used with computers.
- RAM is small, both in terms of its physical size and in the amount of data it can hold.

RAM is of Two Types

- Static RAM (SRAM)
- Dynamic RAM (DRAM)

Static RAM (SRAM)

- Memory retains its contents as long as power is being supplied.
- Data is lost when the power gets down due to volatile nature.
- SRAM chips use a matrix of 6-transistors and no capacitors.
- Transistors do not require power to prevent leakage, so SRAM need not have to be refreshed on a regular basis.
- It has long life, there is no need to refresh.
- Faster. Used as cache memory.

Dynamic RAM (DRAM)

- Must be continually refreshed in order to maintain the data.
- Done by placing the memory on a refresh circuit that rewrites the data several hundred times per second.
- Used for most system memory because it is cheap and small.
- Made up of memory cells which are composed of one capacitor and one transistor.
- It has short data lifetime.
- Need to be refreshed continuously.
- Slower as compared to SRAM.
- Less power consumption.

Read Only Memory (ROM)

- Memory from which we can only read but cannot write on it.
- Non-volatile i.e., the information is stored permanently in such memories during manufacture or during burning process.
- Stores such instructions that are required to start a computer. This operation is referred to as bootstrap.
- ROM chips are not only used in the computer but also in other electronic items like washing machine and microwave oven.

Various Types of ROM

MROM (Masked ROM)

- Very first ROMs were hard-wired devices that contained a pre-programmed set of data or instructions.
- Known as masked ROMs which are inexpensive.

PROM (Programmable Read only Memory)

- Can be modified only once by a user.
- User buys a blank PROM and enters the desired contents using a PROM program.
- Inside the PROM chip there are small fuses which are burnt open during programming(the process is known as burning of the ROM).
- Can be programmed only once and is not erasable.

EPROM (Erasable and Programmable Read Only Memory)

- Can be erased by exposing it to ultra-violet light for a duration of up to 30-40 minutes.
- EPROM eraser achieves this function.
- During programming, an electrical charge is trapped in an insulated gate region.
- Charge is retained for more than ten years because the charge has no leakage path.
- For erasing this charge, ultra-violet light is passed through a quartz crystal window (lid).
- Exposure to ultra-violet light dissipates the charge.
- During normal use the quartz lid is sealed with a sticker.

EEPROM (Electrically Erasable and Programmable Read Only Memory)

- Programmed and erased electrically.
- Can be erased and reprogrammed about ten thousand times.
- Both erasing and programming take about 4 to 10 milli seconds.
- Any location can be selectively erased and programmed.

- Can be erased one byte at a time, rather than erasing the entire chip.
- Process of re-programming is flexible but slow.

Advantages of ROM

- Non-volatile in nature.
- Cannot be accidentally changed.
- Cheaper than RAMs.
- Easier to test.
- More reliable than RAMs.
- These are static and do not require refreshing.
- Contents are always known and can be verified.

5.4 READ ONLY MEMORIES

Read only memory or ROM is a type of semiconductor memory designed to hold such data which is either permanent or does not need to be frequently changed. Generally, new data can be written on the ROM i.e., once written, the data can be only read. In some ROMs, data is stored during manufacturing process while in some other ROMs, data is entered electrically. The process of entering the data is called programming or burning-in process. In some ROMs, data can not be changed while in other ROMs data can be erased and reprogrammed.

Masked Programmed ROM

"The mask programmed ROM has its storage location written into (programmed) by manufacturer according to customers specification. A photographic negative called mask is used to control the interconnection on the chip. The major disadvantage of this type of ROM is that they cannot be reprogrammed in the event of design change requiring a modification of stored data."

In mask programmable ROM, the data is stored according to the specifications of the customer during manufacturing process. A photo negative called mask controls the connection on the chip. So, to store different information, different masks are needed. Since these masks are costly, so, MROM is suitable only when large quantity of the same ROM is needed like mathematical tables, CRT displays, character codes etc. The main limitation of this ROM is that once the data is stored it cannot be changed i.e. ROM can not be reprogrammed.

Figure 5.4 shows a small circuit of bipolar ROM. It has 16 memory cells and 4 cells are arranged in each cell row. Each cell has NPN bipolar transistor and the transistors are connected in common collector (i.e. emitter follower) arrangement (i.e. input at the base and output at the emitter). Each row forms four bit words. Notice that the base of some transistors are connected to the enable line while some of them are not connect to the row. If one has to be stored in the memory cell connection will be made and if 0 has to be stored, connection will not be made.

Hence from Fig. 5.4(b), it is clear that in 1010 is stored in row-0, 1001 in row-1, 1110 in row-2 and 0111 in row-3.

The address input A_1A_0 can be decoded using 1-of-4 decoded and row from which data has to be read is selected.

For example, if the data of row-2 has to read then $A_1 = 1$ and $A_0 = 0$. Hence, row-2 line will become high, and Q_8, Q_9, Q_{10} will become ON (Q_{11} will not become ON because its base is not connected i.e. opened to row-2).

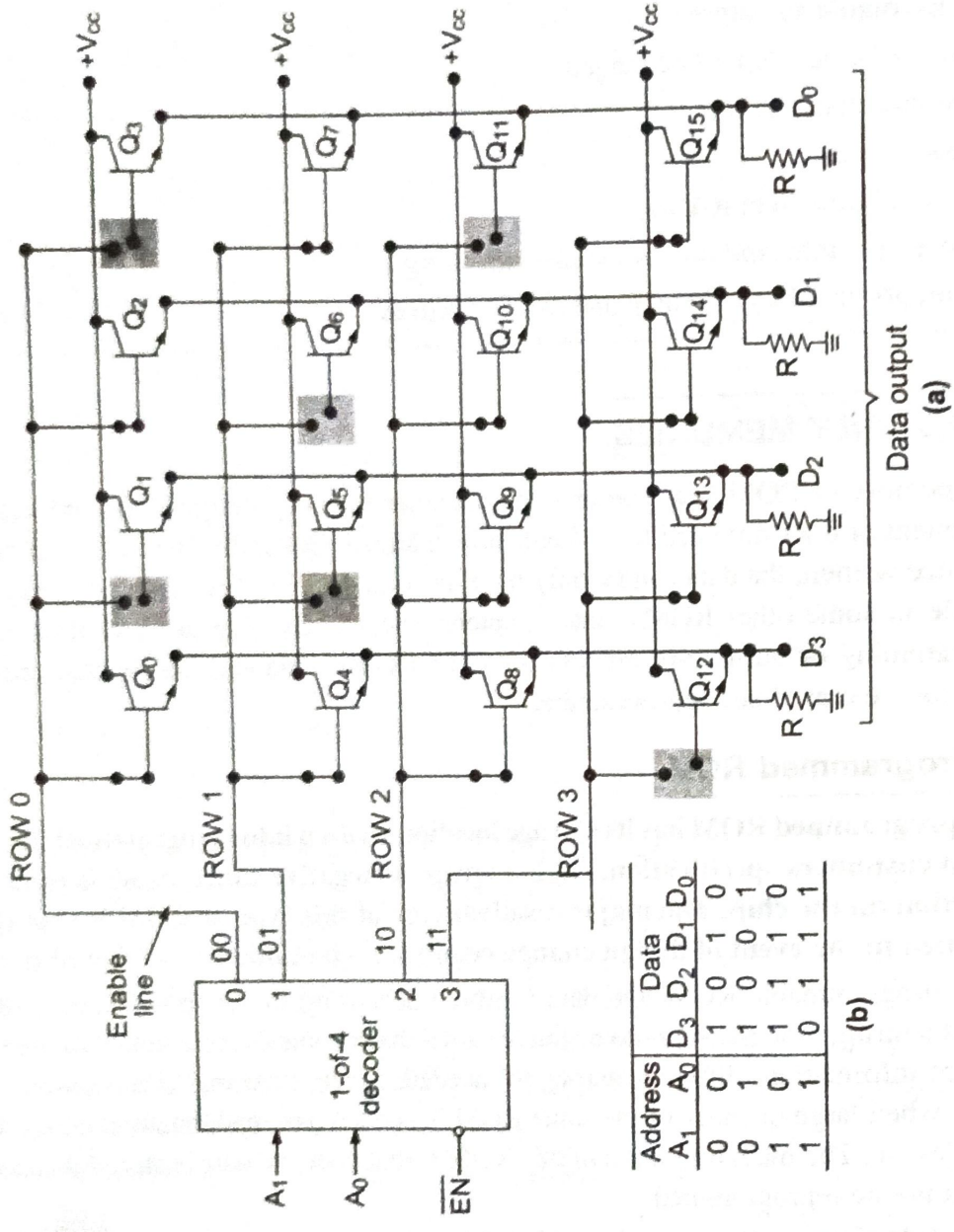


Fig. 5.4 (a) Structure of bipolar MROM, in which one bipolar transistor is used for each memory cell (b) Binary word stored on each address

Hence the data output D_3, D_2, D_1 will be high and D_0 will be low i.e. output will be 1110. Similarly, any row can be selected and its data can be read.

Note that to read any row, the $\overline{EN}$ signal should be made low. If $\overline{EN}$ is high then output of the decoder will become inactive and all transistors will remain OFF. It is also to be noted that at one time, only one row can be activated.

Bipolar MROMs are available for low capacity memories. IC 74187 is an example of MROM IC with a capacity of 256 × 4. Its access time is 40 ns. IC 7488 is also bipolar MROM IC with access time 45 ns and capacity 32 × 8.

Practice Questions

(*i*) Design an MROM for the data shown in Table 5.3 and draw its circuit.

Table 5.3

Address			Data			
A_2	A_1	A_0	D_3	D_2	D_1	D_0
0	0	0	0	0	0	1
0	0	1	1	0	1	0
0	1	0	1	1	0	1
0	1	1	1	1	1	1
1	0	0	0	0	1	1
1	0	1	1	0	1	0
1	1	0	1	0	1	1
1	1	1	0	0	0	1

(*ii*) Design the MROM shown in Fig. 5.3 to store the mathematical function $y = x^2 + 3$. Input x is binary input of two bit A_1A_0. Draw the circuit diagram of MROM also.

Programmable ROMs or PROMs

PROMs are user programmable ROMs, and have fusible links. They are not programmed during manufacturing process but are custom-programmed by the user. Once programmed, the PROM cannot be erased and the data cannot be changed. Hence, they are one-time programmable ROMS. To store the data on the PROMS, the user can selectively blow off the fuse links. The process of programming PROM in done by a special apparatus called a PROM programmer.

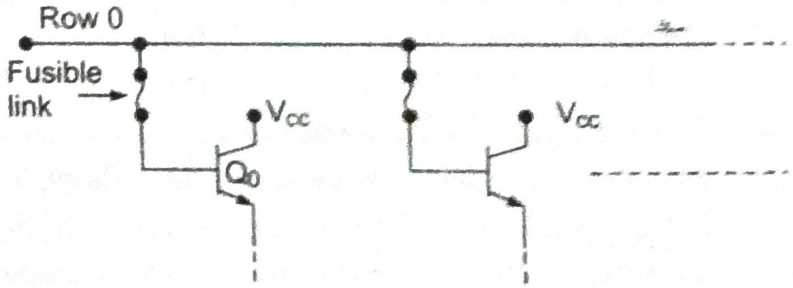


Fig. 5.5 PROM have Fusible link on each connection

PROM (Programmable Read Only Memory)

- Can be modified only once by a user.
- User buys a blank PROM and enters the desired contents using a PROM program.
- Inside the PROM chip there are small fuses which are burnt open during programming (the process is known as burning of the ROM).
- Can be programmed only once and is not erasable.

- A method of allowing a user to tailor a microcode program using a special machine called a PROM programmer .
- Machine supplies an electrical current to specific cells in the ROM that effectively blows a fuse in them.
- Process is known as burning the PROM .
- Since this process leaves no margin for error, most ROM chips designed to be modified by users use erasable programmable read-only memory (EPROM) or electrically erasable programmable read-only memory (EEPROM).
- Key difference between MROM and PROM is that the data is written into a MROM during manufacture, while with a PROM the data is programmed into them after manufacture.
- MROMs tend to be used only for large production runs with well-verified data, while PROMs are used to allow companies to test on a subset of the devices in an order before burning data into all of them.
- PROMs are manufactured blank and, depending on the technology, can be programmed at wafer, final test, or in system.
- Blank PROM chips are programmed by plugging them into a device called a PROM programmer.
- Used in microcontrollers, video game consoles, mobile phones, radio-frequency identification (RFID) tags, implantable medical devices, high-definition multimedia interfaces (HDMI) and in many other consumer and automotive electronics products.
- PROM comes with all bits reading as "1".
- Burning a fuse bit during programming causes the bit to read as "0".
- Can be programmed just once after manufacturing by blowing the fuses, which is an irreversible process.
- The bit cell is programmed by applying a high-voltage pulse not encountered during normal operation across the gate and substrate of the thin oxide transistor (around 6 V for a 2 nm thick oxide, or 30 MV/cm) to break down the oxide between gate and substrate.
- Positive voltage on the transistor's gate forms an inversion channel in the substrate below the gate, causing a tunneling current to flow through the oxide.
- Current produces additional traps in the oxide, increasing the current through the oxide and ultimately melting the oxide and forming a conductive channel from gate to substrate.

Erasable Programmable ROM or EPROM

A EPROM can be programmed by the user and it can also be erased and reprogrammed as often as desired. The process of programming an EPROM involves the application of special voltage levels for specified amount of time. The programming is done in a separate apparatus and takes several minutes.

The storage cells in an EPROM are MOS transistors with a floating silicon gate. In normal state, each transistor is off hence storing a 1. A transistor can be turned on by application of high voltage programming pulse that injects high energy electrons in the floating gate. The electrons remained trapped

in this region once the pulse is terminated, since there is no discharge path. This keeps the transistor permanently on thereby storing a 0.

The EPROM cell can be erased by exposing it to ultraviolet light applied through a window on the chip. This erasing time takes 15 to 20 minutes of exposure to UV rays. All the chip is erased at the same time.

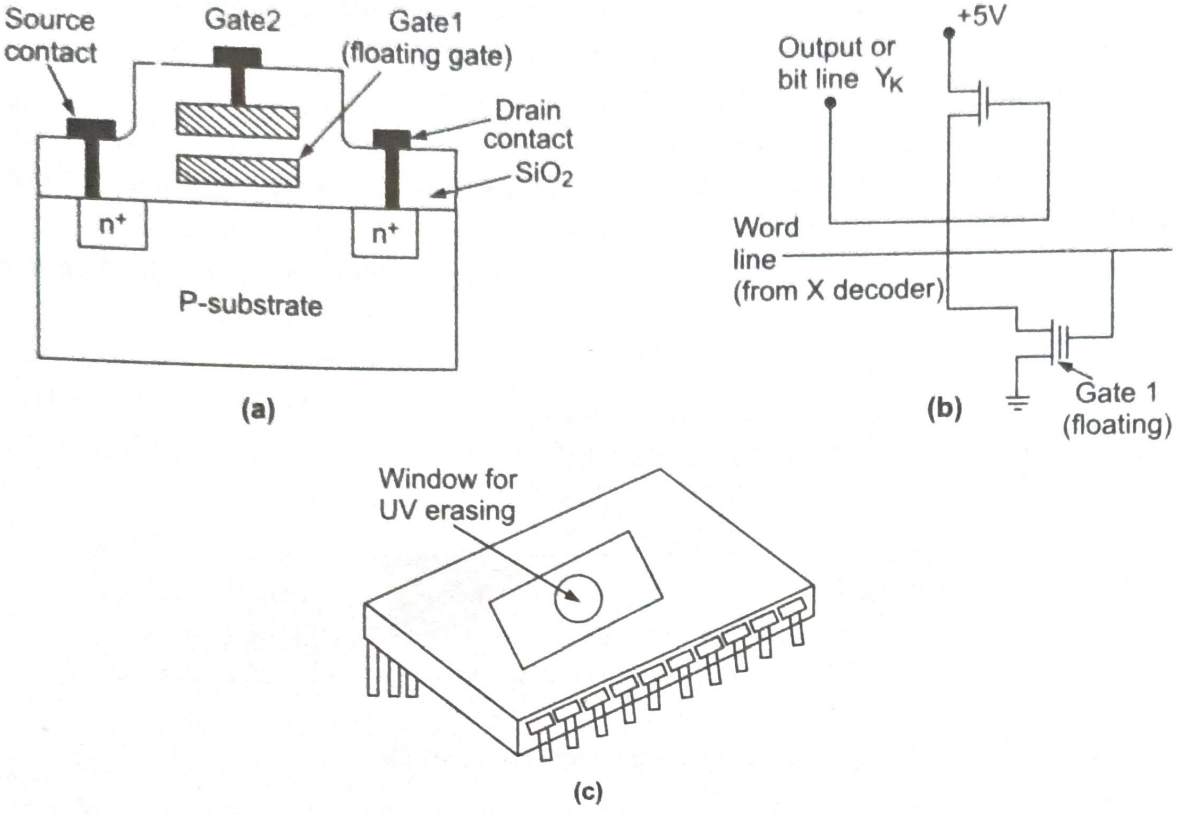
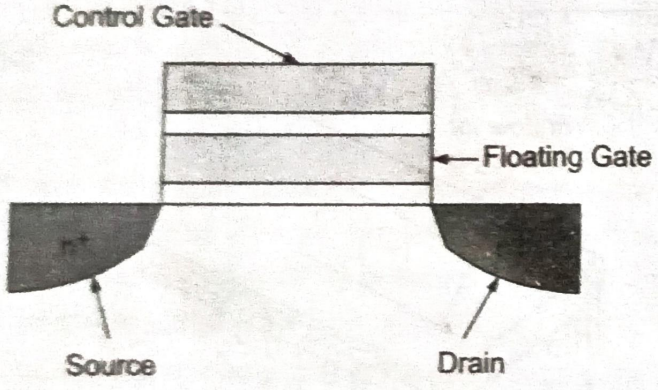


Fig. 5.6 (a) Realizing EPROM with the help of Floating Polysilicon Gate Structure (FAMOS) (b) Circuit of EPROM cell (c) Window in EPROM IC to apply UV light

EPROM (Erasable Programmable Read-Only Memory)

- Programmable read-only memory (programmable ROM) that can be erased and re-used.
- Erasure caused by shining an intense ultraviolet light through a window that is designed into the memory chip.
- An array of floating-gate transistors individually programmed by an electronic device that supplies higher voltages than those normally used in digital circuits.
- Once programmed, an EPROM can be erased by exposing it to strong ultraviolet light source (such as from a mercury-vapor light).
- Easily recognizable by the transparent fused quartz window in the top of the package, through which the silicon chip is visible, and which permits exposure to ultraviolet light during erasing (see the cover page of this book and find the EPROM).
- Each storage location of an EPROM consists of a single field-effect transistor.
- Each FET consists of a channel in the semiconductor body of the device.

- Source and drain contacts are made to regions at the end of the channel.
- Insulating layer of oxide is grown over the channel, then a conductive (silicon or aluminum) gate electrode is deposited, and a further thick layer of oxide is deposited over the gate electrode.
- Floating gate electrode has no connections to other parts of the integrated circuit and is completely insulated by the surrounding layers of oxide.
- A control gate electrode is deposited and further oxide covers it.
- To retrieve data from the EPROM, the address represented by the values at the address pins of the EPROM is decoded and used to connect one word of storage to the output buffer amplifiers.
- Each bit of the word is a 1 or 0, depending on the storage transistor being switched on or off, conducting or non-conducting.



A cross-section of a floating-gate transistor

- Switching state of the field-effect transistor is controlled by the voltage on the control gate of the transistor.
- Presence of a voltage on this gate creates a conductive channel in the transistor, switching it on.
- Stored charge on the floating gate allows the threshold voltage of the transistor to be programmed.
- Storing data in the memory requires selecting a given address and applying a higher voltage to the transistors.
- Creates an avalanche discharge of electrons, which have enough energy to pass through the insulating oxide layer and accumulate on the gate electrode.
- When the high voltage is removed, the electrons are trapped on the electrode.
- Because of the high insulation value of the silicon oxide surrounding the gate, the stored charge cannot readily leak away and the data can be retained for decades.
- Programming process is not electrically reversible.
- To erase the data stored in the array of transistors, ultraviolet light is directed onto the die.
- Photons of the UV light cause ionization within the silicon oxide, which allow the stored charge on the floating gate to dissipate.

- Since the whole memory array is exposed, all the memory is erased at the same time.
- Process takes 20-30 minutes for UV lamps of convenient sizes
- EPROMs must be removed from equipment to be erased, since it is not usually practical to build in a UV lamp to erase parts in-circuit.
- Erasure can also be accomplished with X-rays.

Electrically Erasable PROM or EEPROM or E^2PROM

EPROM has an important characteristics namely its electrical erasability. Since it can be erased at very low currents, the erasing and programming of an EEPROM can be done in-circuit. Another advantage of EEROM is the ability to electrically erase and rewrite individual bytes.

Electrically Erasable Programmable Read-Only Memory or EEPROM (Pronounced double-ee-prom or e-e-prom)

- EEPROM is a special type of PROM that can be erased by exposing it to an electrical charge.
- Similar to flash memory (sometimes called *flash EEPROM*).
- Principal difference is that E^2PROM requires data to be written or erased one byte at a time whereas flash memory allows data to be written or erased in blocks(fast erasure).
- A type of non-volatile memory used in computers and other electronic devices to store relatively small amounts of data but allowing individual bytes to be erased and reprogrammed.
- Organized as arrays of floating-gate transistors.
- Can be programmed and erased in-circuit, by applying special programming signals.
- Modern EEPROMs allow multi-byte page operations.
- EEPROM chips can be reprogrammed without removing them from the computer
- A localized charge from an electrical field is all that is needed in order to erase the EEPROM chip.
- Entire EEPROM chip does not need to be erased at one time, which therefore allows specific changes to be made.
- Constructed as arrays of floating-gate transistors.

Comparison with EPROM and EEPROM/Flash

The difference between EPROM and EEPROM lies in the way that the memory programs and erases. EEPROM can be programmed and erased electrically using field electron emission (also known in the industry as Fowler–Nordheim tunneling).

EPROMs can't be erased electrically, and are programmed via hot carrier injection onto the floating gate. Erase is via an ultraviolet light source.

Flash Memory

- A non-volatile computer storage medium that can be electrically erased and reprogrammed.
- Two main types of flash memory are named after the NAND and NOR logic gates.
- Individual flash memory cells exhibit internal characteristics similar to those of the corresponding gates.
- Whereas EPROMs had to be completely erased before being rewritten, NAND-type flash memory may be written and read in blocks which are generally much smaller than the entire device.
- NOR-type flash allows a single byte to be written—to an erased location—or read independently.
- Applications of flash memory are personal computers, **PDAs**, digital audio players, digital cameras, mobile phones, synthesizers, video games, scientific instrumentation, industrial robotics, and medical electronics.
- Flash memory offers fast read access times,
- Although not as fast as static RAM or ROM.
- Mechanical shock resistance
- Hence, useful over hard disks in portable devices,
- High durability, ability to withstand high pressure, temperature and immersion in water, etc.
- Stores information in an array of memory cells made from floating-gate transistors.
- In single-level cell (SLC) devices, each cell stores only one bit of information.
- In multi-level cell (MLC) devices, including triple-level cell (TLC) devices, can store more than one bit per cell.
- Floating gate may be conductive (polysilicon) or non-conductive (as in *SONOS* flash memory).
- Each memory cell resembles a standard MOSFET, except that the transistor has two gates instead of one.

Comparison of Different ROMs

The comparison of various ROMs is given in Table 5.4.

Table 5.4 Comparison of Different ROMs

Type of ROM	Main Features	Type Number
MROM	(i) ROM programmed by manufacturer (ii) Suitable for high volume operation (iii) Use of bipolar transistor or MOSFET for basic memory cell (iv) Reprogramming not possible	74187, 7488A, TMS47256
PROM	(i) ROM programmed by user (ii) Reprogramming not possible (iii) Basic structure same as MROM (iv) Use of fusible links for programming	74186, TBB285166, TMS27PC256

Type of ROM	Main Features	Type Number
EPROM	(i) Floating gate structure	2732
	(ii) Facility of erasing and reprogramming	273512
	(iii) It is necessary to apply UV light upto 20-30 minutes for erasing	27C512
	(iv) On-circuit erasing not possible	
	(v) Erased all memory location at one time i.e. selective erasure not possible	
EEPROM	(i) Floating gate structure same as EPROM, but thin oxide layer	2864
	(ii) On-circuit erasibility is possible	
	(iii) Electric erasibility is possible	
	(iv) Individual byte erasibility is possible	
	(v) Integration of support circuitry in memory chip is possible	
	(vi) Erasing and programming time is less	
	(vii) More cost	
	(viii) Low density	
Flash Memory	(i) Structure same as EPROM	28F256A
	(ii) Due to thin gate oxide layer, electrical erasability is possible	
	(iii) More density in comparison to EEPROM	
	(iv) Less cost in comparison to EEPROM	
	(v) Less erasure time	
	(vi) Facility of sector erasing	

ROM Application

Firmware: Data and program codes, which are available as soon as the power of a microprocessor system is switched ON are stored in ROMs.

Bootstrap Memory: The Bootstrap program which comes to action when a computer is switched ON and executes instructions to initialize the CPU hardware, and loads the operating system from the disk to main memory is stored in ROM. After the operating system is loaded, it is executed and prepares the computer to take the commands from the user.

Look-up Tables: ROMs can be used to create look-up tables for routine calculations such as trigonometric functions, logarithm, exponential, square root, etc. A look-up table for $Y = \tan \theta$ is a code-conversion system between the input code representing θ in binary and the output code giving the corresponding values of the tangent function. Similarly, any calculation for which a truth table can be written may be implemented with a ROM.

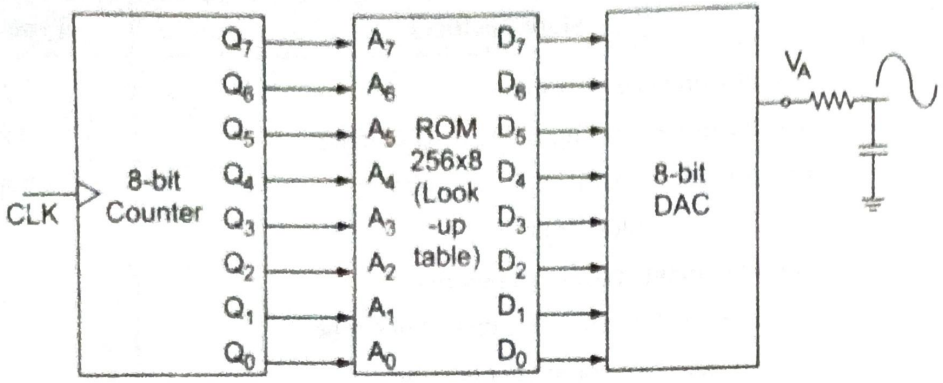


Fig. 5.7 Function generation with the help of ROM

Sequence Generators: If in a digital system, P pulse trains are required for testing or control purposes, then they can be generated by using ROM with P outputs and to change the address by means of a counter.

Waveform Generator: If the output of the digital sequence generator is converted into an analog voltage, then a waveform generator is used. Consider a 256 × 8-bit ROM sequenced by means of an 8-bit counter. Each step of the counter represents $111 \approx 1.4°$ of the waveform. The ROM is programmed so the output gives the digital number corresponding to the analog amplitude at each step. The ROM outputs feed into a DAC, and the output gives the analog waveform desired.

Seven Segment Visible Display: The BCD inputs can be converted to seven segments outputs for display using a ROM.

Combinational Logic: If N logic equations of M variables are given in the sum-of-products canonical form, these equations may be implemented with an M-input, N-output ROM.

Character Generator: Alphanumeric characters may be written on the face of a cathode-ray with the help of a ROM.

5.5 CHARGE COUPLED DEVICE OR CCD

A Charge-Coupled Device (CCD) is a device for the movement of electrical charge, usually from within the device to an area where the charge can be manipulated, for example conversion into a digital value. This is achieved by shifting the signals between stages within the device one at a time. CCDs move charge between capacitive bins in the device, with the shift allowing for the transfer of charge between bins. An image is projected through a lens onto the capacitor array causing each capacitor to accumulate an electric charge proportional to the light intensity at that location. A one-dimensional array, used in line-scan cameras, captures a single slice of the image, whereas a two-dimensional array, used in video and still cameras, captures a two-dimensional picture corresponding to the scene projected onto the focal plane of the sensor. Once the array has been exposed to the image, a control circuit causes each capacitor to transfer its contents to its neighbour (operating as a shift register). The last capacitor in the array dumps its charge into a charge amplifier, which converts the charge into a voltage. By repeating this process, the controlling circuit converts the entire contents of the array in the semiconductor to sequence of voltages. In a digital device, these voltages are then sampled, digitized, and usually stored in memory; in an analog device , they are processed into a continuous analog signal, which is then processed and fed out to other circuits for transmission, recording, or other processing.

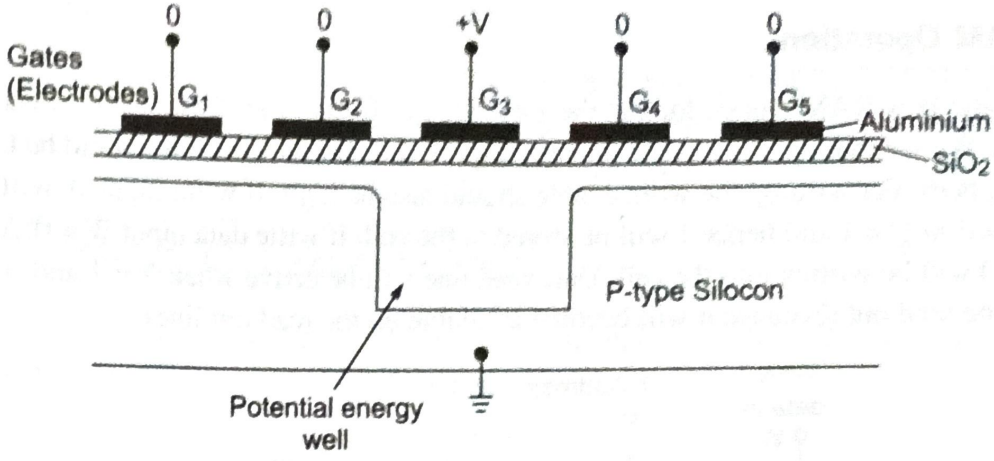


Fig. 5.8 Simplified structure of n-channel CCD

5.6 RANDOM ACCESS MEMORY OR RAM

In a digital system, data needs to be stored and read back whenever desired. In semi-conductor memories, data is stored in form of bits in matrices or arrays of storage cells and each cell stores one bit. In RAMs, data can be read or written randomly and access time to reach any of the cell of the memory is same and does not depends on location from the top. So, these are called random access memories. Since the data can both be read or written, hence they are also known as read/write memory and hence they are different from ROM in which data can be only read. MOS and bipolar technology can be used to fabricated RAMs. RAMs are volatile i.e. the stored data gets lost if power supply goes OFF.

Basic RAM Cell

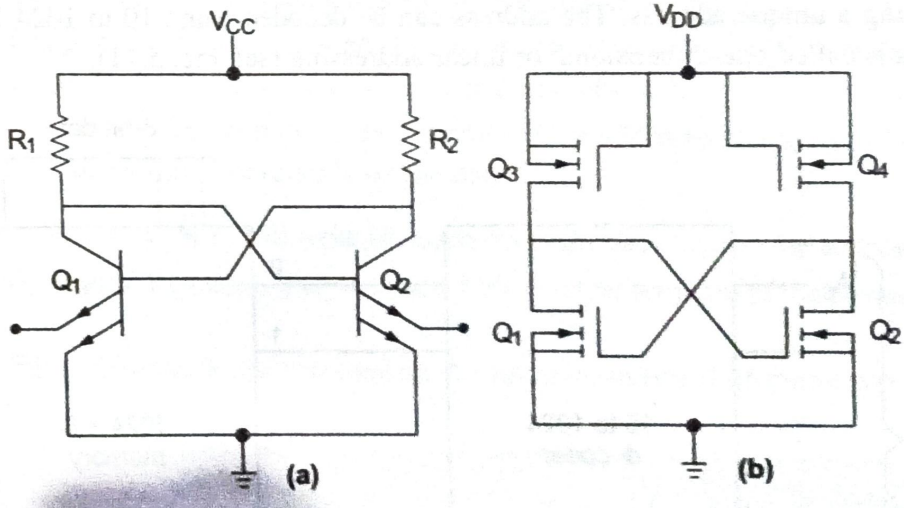


Fig. 5.9 (a) Basic bipolar static RAM cell (b) Basic NMOS static RAM cell

Figure 5.9 shows the bipolar static RAM cell and NMOS static RAM cell. In bipolar cell, two transistors and two resistors are used while an NMOS cell uses four and channel MOSFET. Bipolar cell needs more chip area because resistors also need to be fabricated, but in MOS cells, MOSFET themselves can act as resistances.

Basic RAM Operation

To understand how RAM works, look at the 1-bit SR filp-flop of Fig. 5.10. This shows input data and data output. We see that for writing and reading respectively, the address line should be high for reading and writing both. For writing, the write enable should also be high. If write input W will be one, then $S = 1$ and $R = 0$ so $Q = 1$ and hence 1 will be stored in the cell. If write data input $W = 0$, $S = 0$, $R = 1$, so, $Q = 0$ and 0 will be written into the cell. Data read line will be active when $X = 1$ and whatever data is stored can be read out (because it will become available on the read out line).

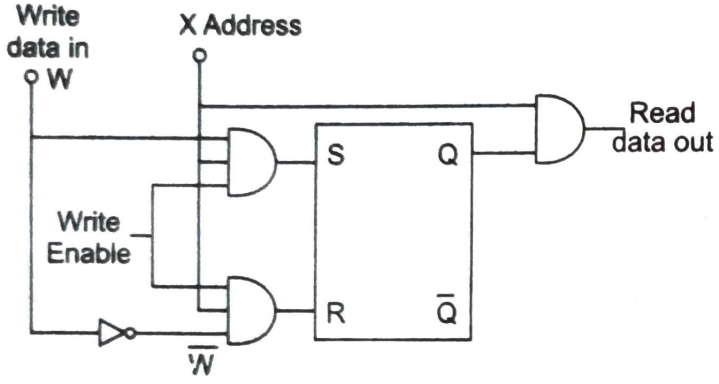


Fig. 5.10 One-bit memory cell

Basic RAM organisation

Suppose there is a 1024 × 8 RAM. It needs 10 address line and 8 data input line and output line. It will have 1024 × 8 = 8192 cells which will be arranged in form of matrix. 8-cells will be arranged in a horizontal line and they all will become active by a single address line. Similarly, there will be 1024 lines each having a unique address. The address can be decoded using 10 to 1024 line decoder. This type of address is called one-dimensional or linear addressing (see Fig. 5.11).

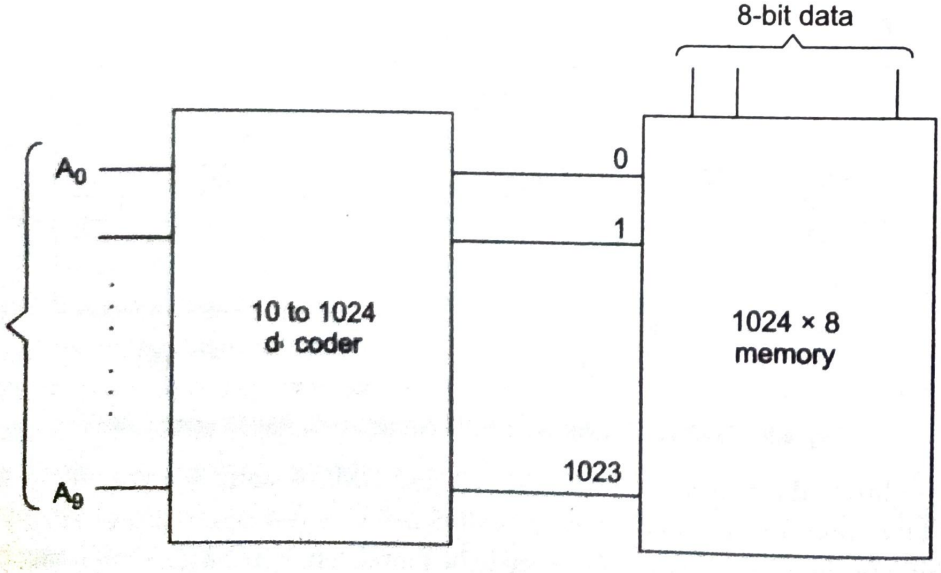


Fig. 5.11

Practice Question

128 words needs to stored in a 1024 bit RAM. If linear selection is used draw the block diagram (Note: Show each 1 bit cell by a rectangle having three terminals—X: address input, W: write input and R: read input).

5.7 PIN STRUCTURE OF A MEMORY CHIP

A memory chip (IC) contains many pins, like address pins, data pins, $\overline{RD}$, $\overline{WR}$, chip enable, power supply and ground pins. The description is given below:

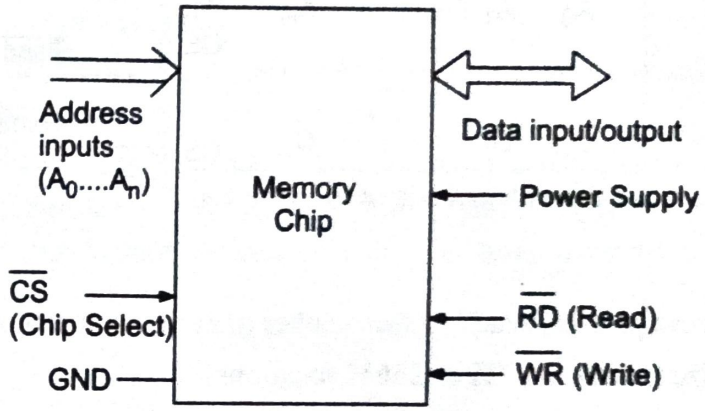


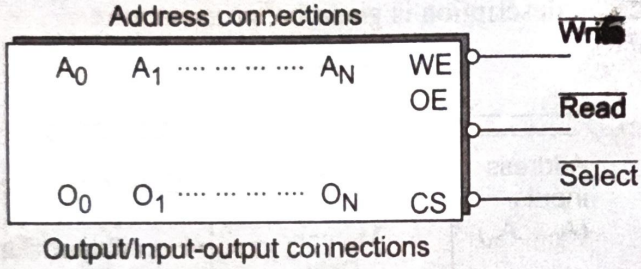
Fig. 5.12 Logic diagram of memory chip

1. **Address Inputs:** The number of pins depend on the size of memory. If the memory size is $2^n \times$ K, then the number of address inputs will be n.
2. **Chip Select ($\overline{CS}$):** A low signal on this pin will select the memory.
3. **Data Input/Output:** These pins are used to read data from or write data into the memory. If the size of memory is $2^n \times$ K, then the number of data lines will be K.
4. **Read ($\overline{RD}$):** A low on $\overline{RD}$ will make the contents of the addressed location (whose address is applied on the address inputs) available on the data lines.
5. **Write ($\overline{WR}$):** A low on $\overline{WR}$ will write the contents of the data lines at the addressed locations.
6. **Power Supply Input:** This pin is used to connect the positive terminal of the power supply to the chip.
7. **Ground (GND):** This pin is used to connect the negative terminal of the power supply to the chip.

A memory chip

- An integrated circuit made out of millions of capacitors and transistors that can store data or can be used to process code.
- Memory chips can hold memory either temporarily through random access memory (RAM), or permanently through read only memory (ROM).

- Read only memory contains permanently stored data that a processor can read but cannot modify.
- Comes in different sizes and shapes.
- Some can be connected directly while some need special drives
- Essential components in computer and electronic devices in which memory storage plays a key role.
- *Generic pin configuration:*



Memory Chips

- number of address pins is related to the number of memory locations.
  - Common sizes today are **1K** to **256M** locations.
  - Therefore, between 10 and 28 address pins are present.
- The data pins are typically bi-directional in read-write memories.
  - The number of data pins is related to the size of the memory location.
  - For example, an 8-bit wide (byte-wide) memory device has **8** data pins.
- Each memory device has at least one chip select (CS) or chip enable (CE) or select (S) pin that enables the memory device.
  - This enables read and/or write operations.
  - If more than one are present, then all must be 0 in order to perform a read or write.
- Each memory device has at least one control pin.
  - For ROMs, an output enable (OE) or gate (G) is present.
    - The OE pin enables and disables a set of tristate buffers.
  - For RAMs, a read-write (R/W) or write enable (WE) and read enable (OE) are present.
    - For dual control pin devices, it must be hold true that both are not 0 at the same time.

5.8 MOTHERBOARD

The motherboard serves as a single platform to connect all of the parts of a computer together. A motherboard connects CPU, memory, hard drives, optical drives, video card, sound card, and other ports and expansion cards directly or via cables. It can be considered as the backbone of a computer.

Features of Motherboard: A motherboard comes with following features:

- Motherboard varies greatly in supporting various types of components.
- Normally a motherboard supports a single type of CPU and few types of memories.
- Video Cards, Hard disks, Sound Cards have to be compatible with motherboard to function properly.
- Motherboards, cases and power supplies must be compatible to work properly together.

The motherboard is mounted inside the case and is securely attached via small screws through pre-drilled holes. Motherboard contains ports to connect all of the internal components. It provides a single socket for CPU whereas for memory, normally one or more slots are available. Motherboards provide ports to attach floppy drive, hard drive, and optical drives via ribbon cables. Motherboard carries fans and a special port designed for power supply.

There is a peripheral card slot in front of the motherboard using which video cards, sound cards and other expansion cards can be connected to motherboard.

On the left side, motherboards carry a number of ports to connect monitor, printer, mouse, keyboard, speaker, and network cables. Motherboards also provide USB ports which allow compatible devices to be connected in plug-in/plug-out fashion for example, pen drive, digital cameras etc.

EXERCISES

1. (*a*) What is a memory?

(*b*) Explain the difference between:

(*i*) Volatile and non-volatile memories.

(*ii*) Random access and sequential access memories.

(*iii*) Semiconductor and non-semiconductor memories.

(*iv*) Destructive and non-destructive memories.

(*v*) ROM and RAM.

(*vi*) Static and dynamic memories.

(*c*) Explain the following:

(*i*) ROM (*ii*) PROM

(*iii*) EPROM (*iv*) EEPROM

(*v*) SRAM (*vi*) DRAM

(*d*) Explain the basic structure and working of ECDs.

(*e*) What is the difference between RWM and ROM?

❑❑❑

6 Chapter

BINARY CODES

THINK ABOUT IT

Be careful what you water your dreams with. Water them with worry and fear and you will produce weeds that choke the life from your dreams. Water them with optimism and solutions and you will cultivate success. Always be on the lookout for ways to turn a problem into an opportunity for success. Always be on the lookout for ways to nurture your dream.

— Lao Tzu

6.1 INTRODUCTION

"When numbers, letters or words are represented by special group of symbols, this process is called encoding and the group of symbols is called a code".

We saw in the last chapter that how decimal numbers can be converted into binary. Binary numbers are in group of 1's and 0's and hence binary number is also a type of code. If a decimal number is expressed in its binary form, it is called straight binary form. It is called straight binary coding or a binary code.

All digital systems use binary number for their internal operations while in practice mainly we use decimal numbers. So interconversion becomes necessary between binary and decimal system. So that the data can be used by digital systems.

In the previous chapter we saw that if the decimal number is large then its conversion to binary becomes long and complicated. Hence, some other codes are also popular which provide a direct conversion of decimal numbers in binary form (1's and 0's) and these are used in different conditions.

6.2 8421 CODE OR BINARY CODED DECIMAL (BCD) CODE

If 4 bit binary equivalent number is placed (written) in place of each decimal digit then the code obtained is called binary coded decimal or *BCD*. The table 6.1 can be use for binary conversion.

For example, to convert $(649)_{10}$ to *BCD* form we write the binary equivalent of each of the digit.

6	4	9	(decimal)
↓	↓	↓	
0110	0100	1001	(BCD)

Hence, $(649)_{10} = 0110\ 0100\ 1001$ (BCD)

Table 6.1 BCD conversion from Decimal

Decimal	BCD code
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

Example 6.1. Convert the *BCD* number 0111 0100 0011 to decimal.

Solution: Grouping the numbers in four from right, we get

$$\underbrace{0111}_{\downarrow 7}\ \underbrace{0100}_{\downarrow 4}\ \underbrace{0011}_{\downarrow 3} \qquad \text{(From Table 6.1)}$$

Hence, $011101000011\ (BCD) = (743)_{10}$

BCD is Also Called 8421 Code

Look at Table 6.1 you see that every bit of the BCD code has a weight attached to it. The rightmost bit has weight 1, the next bit has weight 2, the next one has weight 4 and the leftmost has the weight 8. So, to find the equivalent decimal digit of a four bit BCD add weights of all the positions having 1.

For example in 0110 the weights of position having is are 2 and 4 so its equivalent decimal will be 4 + 2 = 6. Similarly, for 1001 the weights of the two high bits in the code are 8 and 1. So, its decimal equivalent will be 1 + 8 = 9. So, the BCD code is called an 8421 code or a weighted binary code.

Thought Question:

The zeroes to the left of any number have no significance and can be discarded. But is the same things hold for BCD code also? For example, the BCD code of $(23)_{10}$ is it $(0010\ 0011)_{BCD}$. Can we write it as $(10\ 0011)_{BCD}$ by discarding the two leftmost zeroes? Is it correct? Comment.

Comparison of BCD and Binary

It is necessary to understand that BCD code is not a number system like binary, octal, hexadecimal. This is just a way to represent a decimal digit directly in a digital form. It is also very important to appericate that methods of BCD conversion and binary conversion are different. For converting decimal number to binary, a complete number is taken and repeatedly divided by two and numbers are written in reverse order. If the decimal number has fractional part also, then fraction is taken separately and repeatedly multiplied by 2 and integer of product written in direct order.

However, the conversion of decimal number into BCD is quite simple. Each of the digit is taken separately and binary equivalent of each digit is written.

Example 6.2. Convert $(473)_{10}$ into binary and BCD.

Solution: (*i*) Binary conversion

2	473	1
2	236	0
2	118	0
2	59	1
2	29	1
2	14	1
2	7	1
2	3	1
2	1	1
	0	

$(473)_{10} = (111011001)_2$

(*ii*) BCD Conversion

4 7 3
↓ ↓ ↓
0100 0111 0011

$(473)_{10} = 0100\ 0111\ 011$ (BCD)

(*i*) You saw that for expressing 473 in binary code only 9 bits are required while expressing 473 in BCD 12 bits are required. The BCD code requires larger number of bits because in BCD only 10 of the 16 possible four bit configurations are used and remaining 6 are left unused and hence BCD is a less efficient code compared to binary.

(*ii*) The advantage of BCD code is that the code conversion is easy. Hence BCD to decimal and decimal to BCD code conversion circuits are simple.

Example 6.3. Convert $(12)_{10}$ into binary and *BCD*.

Solution: (*i*) Binary Conversion

2	12	0
2	6	0
2	3	1
2	1	1
	0	

$(12)_{10} = (1100)_2$

(*ii*) BCD Conversion

1 2
↓ ↓
0001 0010

$(12)_{10} = 0001\ 0010$ (*BCD*)

"The binary-coded decimal (BCD) 8421 code is not a number system but a code to facilitate the handling of decimal and binary numbers. Once you have memorized the binary equivalent of decimal numbers 0 through 9, conversion between these two systems can be done instantly. However, arithmetic operations using the BCD 8421 code and the required additional circuitry in equipment is a little more complex. The BCD 8421 code uses 4 bits to represent each of the 10 decimal digits and each digit is converted separately."

Limitations of BCD Code 8421

In the last article you saw that in 8421 or BCD code every digit of the decimal number is expressed in binary form. From Table 6.5, it is also clear that in BCD code only 10 combinations (0000 to 1001) are used of the total 16 possible combinations (0000 to 1111). This means that 1010, 1011, 1100, 1101,1110 and 1111 are invalid BCD codes because there is no decimal digit equivalent to these codes. So, there is a problem in obtaining the complements of BCD codes.

In the last chapter, you saw that complements are used for subtraction in the digital number systems and for subtraction the complement of subtrahend is added to the minuend. The complement is obtained by changing 1 to 0 and 0 to 1. For exampless the 1's complement of binary number 0010 (2 decimal) is 1101. But the problem is that there is no decimal equivalent to 1101 because this is not a valid BCD code. To overcome this problem some other codes are used. Excess-3 code is example of such a code.

Practice Question

Write the BCD codes

(*i*) 75.76 (*ii*) 233.59 (*iii*) 1.23 (*iv*) 0.56

6.3 EXCESS-3 CODE

As it clear from its name, excess-3 means 3 more. So, for obtaining the excess-3 code of any decimal digit just add 3 to that digit and write the binary equivalent of the sum. For example, to write excess-3 code of a decimal digit 4 add 3 to it, hence, we get 7 and the binary of 7 is 0111. So, the excess-3 code of decimal 4 is 0111. Similarly, the excess-3 code of all the decimal digit can be written as shown in Table 6.2. If you want to write excess-3 code of any decimal number then write the individual code of each digit using Table 6.2.

Table 6.2 Excess-3 code

Decimal Digit	Excess-3 Code
0	0011
1	0100
2	0101
3	0110

Decimal Digit	Excess-3 Code
4	0111
5	1000
6	1001
7	1010
8	1011
9	1100

Example 6.4. Write the BCD code and Excess-3 code for 732.

Solution: (*i*) BCD Code (Table 6.1)

7 3 2
↓ ↓ ↓
0111 0011 0010

Hence $(732)_{10}$ = 0111 0011 0010 (BCD)

(*ii*) Excess-3 Code (Table 6.2)

7 3 2
↓ ↓ ↓
1010 0110 0101

Hence $(732)_{10}$ = 1010 0110 0101 (Excess-3)

Excess-3 Code is not a Weighted Code

Excess-3 code is not a weighted code because there is no local value or weight attached to the bits.

Excess-3 Code is a Self-Complementary Code

The main advantage of excess-3 code is that it is a self-complementary code. By self-complementary code we mean that code in which if we change 1 to 0 or 0 to 1 of the code of any decimal number then we obtain the code for the 9's complement of that decimal number. As in computers subtraction is done using complementary method, so, being a self complementary code, excess-3 code proves very useful in subtraction process. BCD or 8421 is not a self- complementary code while excess-3 is a self-complementary code. For example, the excess-3 code for 2 is 0101 and if we complement this we get 1010 which is a excess-3 code of 7. So, we see that on complementing excess-3 code of any decimal number we get the excess-3 code of 9's complement of that number and hence excess-3 is a self-complementary code.

In the same way, the 9's complement of any decimal number in excess-3 code can be found by changing all its ones and zeroes to zeroes and ones respectively. For example, the excess-3 code of 593 decimal is 1000 1100 0110. The 9's complement of this decimal is 406 whose excess-3 code is 0111 0011 1001, which can be easily obtained by changing 1's to zeroes and 0's to ones of the Excess-3 code of 593.

Comparison of BCD and Excess-3 Codes

BCD (8421)	Excess-3
1. In this code the binary equivalent number for every decimal number is written.	In this code 3 is added to every decimal digit and then binary code for every digit is written.
2. It is a weighted code.	It is not a weighted code.
3. It is not a self-complementary code.	It is a self-complementary code.
4. Not useful in the process of computer subtraction.	Being self-complementary code, it is useful for computer subtraction.

Practice Question

Write the binary equivalence BCD codes and X-3 codes for the given decimal numbers:

(*i*) 75 (*ii*) 25.73 (*iii*) 2.34 (*iv*) 0.59

6.4 ADDITION OF 8421 (BCD) CODED NUMBERS

Let us take some examples to understand *BCD* addition

Example 6.5.

Decimal	BCD
5	0101
+ 2	+ 0010
7	0111 → BCD sum (7)

Example 6.6.

Decimal		BCD
6		0110
+ 7		+ 0111
13		1101 → Not BCD (sum greater than 9)
	Add Six	+ 110
		1 0011 → BCD 13

From the above examples, it is clear that:

(*i*) If the sum of two decimal digit is less than or equal to 9 then this is the correct sum.

(*ii*) If the sum of BCD codes two decimal digits is greater than 9 then 6 (0110) is to be added to make the sum correct. Addition of 6 is known as BCD correction.

Example 6.7. Convert $(67)_{10}$ and $(21)_{10}$ in BCD code and add them.

Solution: $(67)_{10} = 0110\ 0111$ (BCD)

$(21)_{10} = 0010\ 0001$ (BCD)

On adding, we get

0110	0111	(BCD)
+ 0010	0001	(BCD)
1000	1000	(BCD)
↓	↓	
8	8	(Decimal)

Hence $(67)_{10} + (21)_{10} = (88)_{10}$

Example 6.8. Convert $(25)_{10}$ and $(38)_{10}$ in BCD and add them.

Solution: $(25)_{10} = 0010\ 0101$ (BCD)

$(38)_{10} = 001\ 1000$ (BCD)

On adding, we get

	0010	0101	(BCD)
	0011	1000	(BCD)
	0101	1101 →	(greater than 9)
Applying BCD correction to the lower nibble		+ 0110	
	0110	0011	(BCD)
	↓	↓	
	6	3	(Decimal)

Hence $(25)_{10} + (38)_{10} = (63)_{10}$

Note that only one of the result is greater than 9, hence BCD correction is applied to that digit only.

Example 6.9. Convert $(76)_{10}$ and $(58)_{10}$ to BCD code and add them.

Solution: $(76)_{10} = 0111\ 0110$ (BCD)

$(58)_{10} = 0101\ 1000$ (BCD)

On adding, we get

	0111	0110	(BCD)
	0101	1000	(BCD)
	1100	1110	
		→	(Both greater than 9)
Applying BCD correction to both digits	+ 0110	0110	
	1 0011	0100	(BCD)
	↓ ↓	↓	
	1 3	4	(BCD)

Hence $(76)_{10} + (58)_{10} = (134)_{10}$

In the above example, both the sums were greater than 9. So, the BCD correction of +6 is applied at both the nibbles (group of four bits).

6.5 REFLECTED CODES OR GRAY CODES

The number in the gray code changes by only one bit as it proceeds from one number to the next.

They gray code for decimal numbers 0 to 15 is shown is Table 6.3

Table 6.3 Gray Codes

Decimal	Binary	Gray Code
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0010
4	0100	0110
5	0101	0111
6	0110	0101
7	0111	0100
8	1000	1100
9	1001	1101
10	1010	1111
11	1011	1110
12	1100	1010
13	1101	1011
14	1110	1001
15	1111	1000

It is clear from Table 6.3 that in gray code only one bit changes as we move from one code to the consecutive code, so gray code is also called a unit distance code. Gray code is not a weighted code. Since there is no local weight is attached to any bit position. So, grey code is not a weighted code.

Interconversion of Binary or Gray code

The process of converting gray code to binary and vice versa will be explained in Chapter 4 (after study of EX-OR Gate).

Applications of Gray Code

Gray codes are used in input-output devices and analog to digital converters. However, they are not suitable for arithmetic operations.

6.6 2421 CODE

2421 is weighted code in which the weights of four bit is 2, 4, 2 and 1 respectively from the left. Hence, to calculate the decimal value of any 2421 code add the positional value of all the bits of the code which are 1. The 2421 code from 0 to 9 is shown in Table 6.4

Table 6.4

Decimal	2421 code
0	0000
1	0001
2	0010
3	0011
4	0100
5	1011
6	1100
7	1101
8	1110
9	1111

It is dear from this table that every bit position has a weight attached to it. For example, 2421 code of decimal 8 is 1110 and the weights at high position bits are 2, 4 and 2 and their sum is 2 + 4 + 2 = 8.

2421 is a Self-Complementary Code

2421 is a self-complementary code because after changing 1's to 0's of 2421 code of any decimal number, the 2421 code of its 9's complement is obtained. Hence being self-complementary 2421 code is useful in computer subtraction.

Conversion of a Decimal Number into its 2421 Code

To convert any decimal number to its 2421 code put the 2421 code of every digit in place of that digit using Table 6.4.

Example 2.5. Find 2421 code of decimal 734.

Solution: From Table 6.4

$$\begin{array}{ccc} 7 & 3 & 4 \\ \downarrow & \downarrow & \downarrow \\ 1101 & 0011 & 0100 \end{array}$$

Hence $(734)_{10} = 1101\ 0011\ 0100\ (2421)$

Practice Question

Write the 2421 of the given decimal numbers.

(i) 75.9 (ii) 25.56

6.7 ALPHANUMERIC CODES

To store the data in computers, alphabets, and special characters (like brackets, full stop, comma, space, equal to etc.) are also to be used. Hence, to feed alphabets and special characters into the computers, binary codes are needed so that computer can understand these alphabets, and special characters. The codes which comprises of alphabets (capital and small), numbers and special characters are called alphanumeric code. One such code is ASCII code (American Standard Code for Information Interchange). It is a seven bit code (see Table 6.5) and is used in keyboards, video terminals, printers for transferring information. For example, looking out Table 6.5, we find that ASCII code for A is 100 0001.

Table 6.5 ASCII Codes

$X_3X_2X_1X_0$	$X_6X_5X_4$					
	010	**011**	**100**	**101**	**110**	**111**
0000	SP	0	@	P		p
0001	!	1	A	Q	a	q
0010	"	2	B	R	b	r
0011	#	3	C	S	c	s
0100	$	4	D	T	d	t
0101	%	5	E	U	e	u
0110	&	6	F	V	f	v
0111	'	7	G	W	g	w
1000	(	8	H	X	h	x
1001	)	9	I	Y	i	y
1010	*	:	J	Z	j	z
1011	+	;	K		k	
1100	,	<	<	L	l	
1101	–	=	M		m	
1110	*	>	N		n	
1111	/	?	O		o	

Example 6.11. The given information is in ASCII code. Write it in alphanumeric form.

100 0111 100 1111 100 0100 010 0000
100 1001 101 0011 010 0000 100 0111
101 0010 100 0101 100 0001 101 0100
010 1110

Solution: Converting the information to hexadecimal form, we get,

47 4F 44 20 49 53 20 47 52 45 41 54 2E

Now writing the alphanumeric character for each alphanumeric code (using Table 6.5) we get the result.

GOD IS GREAT.

"Most applications of digital computer require handling of data that consists of not only numbers, but also of letters. An alphanumeric code is a binary code of a group of elements consisting of ten decimal digits, 26 letters of alphabet (usually both in lowercase and uppercase) and certain number of special symbols. One such code is ASCII (American Standard Code for Information Interchange.)"

6.8 COMPARISON OF VARIOUS BINARY CODES

Various binary codes for decimal numbers 0 to 15 are shown in Table 6.6.

Table 6.6 Different binary codes

Decimal	Binary	BCD	Excess-3	Gray	2421
0	0000	0000	0011	0000	0000
1	0001	0001	0100	0001	0001
2	0010	0010	0101	0011	0010
3	0011	0011	0110	0010	0011
4	0100	0100	0111	0110	0100
5	0101	0101	1000	0111	1011
6	0110	0110	1001	0101	1100
7	0111	0111	1010	0100	1101
8	1000	1000	1011	1100	1110
9	1001	1001	1100	1101	1111
10	1010	0001 0000	0100 0011	1111	0001 0000
11	1011	0001 0001	0100 0100	1110	0001 0001
12	1100	0001 0010	0100 0101	1010	0001 0010
13	1101	0001 0011	0100 0110	1011	0001 0011
14	1110	0001 0100	0100 0111	1001	0001 0100
15	1111	1001 0101	0100 1000	1000	0011 1011

The comparison for different binary codes is illustrated in Table 6.7.

6.9 PARITY

When digital data is transferred from one place to other, errors may get introduced into the data due to noise and other factors.

"Noise is defined as any unwanted signal, tending to interfere with the proper and easy reception and reproduction of wanted signal."

Table 6.7 Comparison of Various Binary Codes

Code	Features	Weighted or Not?	Self-complementary or Not?	Merits	Limitations
Binary	The whole decimal number is converted to binary.	Yes	Yes	• Efficient • Binary addition to this code	• Becomes complex (larger) for big numbers
BCD C8421	4-bit binary number is written for every decimal digit.	Yes	No	• Simple • Weighted	• Not efficient • Not self-complementary
Excess-3	4-bit binary number is written for every decimal digit after adding 3 to each decimal digit.	No	Yes	• Self-complementary • Can be used for subtraction in computers	• Not weighted
Gray	The gray code for two decimal numbers differs by only one bit. Hence called unit distance code.	No	No	• Appropriate for A/D converters being a unit distance code.	• Not weighted • Not self-complementary
2421	Weights attached to 4-bits are 2421 respectively (starting from MSB).	Yes	Yes	• Self-complementary	• Not efficient

The errors in the digital signal may change the status of some bits from 0 to 1 or 1 to 0. In high speed systems, where lakhs of bits are transferred per second, even a lower error rate may have an adverse effect on the system. So, digital systems have provisions for error detection and correction. Parity method is used for error detection while Hamming codes can detect as well as correct the errors.

Parity Bit

Parity bit is an additional bit attached to the code group so as to make total number of 1's even or odd.

Even Parity

In even parity, the parity bit is added so as to make total number of 1's in the group (including parity bit) even. For example, the even parity bit (the 8^{th} bit) for A and C in their ASCII code is added as follows:

1100 0011 (C)
↑ added parity bit (for even parity)

0100 0001 (A)
↑ added parity bit (for even parity)

Odd Parity

In odd parity, the parity bit is added so as to make total number of 1's in the group (including the parity bit) odd. For example, the ASCII codes of A and C can be added the parity bit (the 8th bit) as follows:

```
0100    0011        (C)
↑
└────────────────── parity bit (for odd parity)

1100    0001        (A)
↑
└────────────────── parity bit (for odd parity)
```

Error Detection at the Receiver

The receiver checks at the receiving end that for even parity generated at the transmitter, the parity of received bits of the group should also be even. If it is not, means the error has taken place.

Parity Method Does Not Work if Two Bits are in Error

For even parity, if one bit error take place, then the number of 1's will become odd and the parity checker at the receiver will be able to detect the error. However, if two bit errors take place, the number of 1's will again become even, and the detection circuit will not be able to detect the error. So, we see that a parity detector will detect an error if the number of errors taken place is odd.

Parity Generation and Detection Circuits

Parity generation and detection circuits will be discussed in chapter 4 (After the study of XOR gate).

Example 6.12. A trasmitter is sending ASCII coded message with an even parity to the receiver. Add the even parity bit with the message : GOD IS GREAT.

Solution: Adding even parity with the message, the result is an follows:

```
        ┌──────────────── even parity bit
        ↓
G       0100    0111
O       1100    1111
D       0100    0100
        1010    0000
I       1100    1001
S       0101    0011
        0010    0100
G       0100    0111
R       1101    0010
E       1100    0101
A       0100    0001
T       1101    0100
.       0010    1110
```

EXERCISES

1. (a) What is a code? Mention 8421 and Excess-3 code.
   (b) What is a BCD code? How is it different from binary number? Explain using examples.
   (c) How are BCD numbers added? What is BCD correction?
   (d) What is a Gray code? Explain the interconversion of binary number to gray code and vice ver
   (e) What is parity? What is even and odd parity? What is single and double parity? What is error det
   (f) What are the advantages and limitations of BCD and X-3 codes.
   (g) Explain the difference between weighted and self-complementary codes.
   (h) What are alphanumeric and ASCII codes?
2. Convert the following decimal numbers to Excess-3, binary, BCD, 2421 code:
   (a) 723 (b) 496 (c) 73
3. Convert to BCD code:
   (a) 32.96 (b) 4.19 (c) 19.7
4. Convert 101010111 to gray code.
5. Convert binary number $(110101111)_2$ to BCD and X-3 codes.
6. Convert:
   (i) $(1010\ 1011)_{X\text{-}3}$ (ii) $(1001\ 1001)_2$ (iii) $(1001\ 1001)_{BCD}$
7. Conver to BCD codes:
   (i) $(99)_{10}$ (ii) $(99)_{16}$ (iii) $(99)_{11}$
8. Convert to Excess-3 code
   (i) $(1001)_2$ (ii) $(1001)_8$ (iii) $(1001)_{10}$
   (iv) $(1001)_{16}$ (v) $(1001)_{BCD}$ (vi) $(101)_7$
   (vii) $(1001)_9$ (viii) $(1001)_{gray}$

7 Chapter

PRACTICALS

THINK ABOUT IT

You have to grow from the inside out. None can teach you, none can make you spiritual. There is no other teacher but your own soul.

— Swami Vivekananda

EXPERIMENT-1

AIM: Familiarization with Computer System and Its Peripheral Devices

A **computer peripheral** is a device that is connected to a computer but is not part of the core computer architecture. The core elements of a computer are the central processing unit, power supply, motherboard and the computer case that contains those three components. Technically speaking, everything else is considered a peripheral device. However, this is a somewhat narrow view, since various other elements are required for a computer to actually function, such as a hard drive and random-access memory (or RAM).

Types of Peripheral Devices

There are many different peripheral devices, but they fall into three general categories:

1. **Input devices**, such as a mouse and a keyboard
2. **Output devices**, such as a monitor and a printer
3. **Storage devices**, such as a hard drive or flash drive

Some devices fall into more than one category. Consider a CD-ROM drive; you can use it to read data or music (input), and you can use it to write data to a CD (output).

Peripheral devices can be **external** or **internal peripheral** is a device that is used to put information into or get information out of the computer

There are three different types of peripherals:

- Input, used to interact with, or send data to the computer (mouse, keyboards, etc.)
- Output, which provides output to the user from the computer (monitors, printers, etc.)
- Storage, which stores data processed by the computer (hard drives, flash drives, etc.)

EXPERIMENT-2

AIM: Familiarization with Operating System

An operating system (OS) is the program that, after being initially loaded into the computer by a boot program, manages all the other programs in a computer. The other programs are called *applications* or application programs. The application programs make use of the operating system by making requests for services through a defined application program interface (API). In addition, users can interact directly with the operating system through a user interface such as a command line or a graphical user interface (GUI).

An operating system performs these services for applications:

- In a multitasking operating system where multiple programs can be running at the same time, the operating system determines which applications should run in what order and how much time should be allowed for each application before giving another application a turn.
- It manages the sharing of internal memory among multiple applications.
- It handles input and output to and from attached hardware devices, such as hard disks, printers, and dial-up ports.
- It sends messages to each application or interactive user (or to a system operator) about the status of operation and any errors that may have occurred.
- It can offload the management of what are called *batch* jobs (for example, printing) so that the initiating application is freed from this work.
- On computers that can provide parallel processing, an operating system can manage how to divide the program so that it runs on more than one processor at a time.

All major computer platforms (hardware and software) require and sometimes include an operating system, and operating systems must be developed with different features to meet the specific needs of various form factors.

Common Desktop Operating Systems

Windows is Microsoft's flagship operating system, the de facto standard for home and business computers. Introduced in 1985, the GUI-based OS has been released in many versions since then. The user-friendly Windows 95 was largely responsible for the rapid development of personal computing.

Mac OS is the operating system for Apple's Macintosh line of personal computers and workstations.

Linux is a Unix-like operating system that was designed to provide personal computer users a free or very low-cost alternative. Linux has a reputation as a very efficient and fast-performing system.

Windows operating systems have long dominated the market and continue to do so. As of August 2016, Windows systems had a market share of over 85 percent. In contrast, Mac OS was at a little over 6 percent and Linux was just over 2 percent. Nevertheless, Windows is losing market share from a long-held 90 percent and higher.

A mobile OS allows smartphones, tablet PCs and other mobile devices to run applications and programs. Mobile operating systems include Apple iOS, Google Android, BlackBerry OS and Windows 10 Mobile.

An embedded operating system is specialized for use in the computers built into larger systems, such as cars, traffic lights, digital televisions, ATMs, airplane controls, point of sale (POS) terminals, digital cameras, GPS navigation systems, elevators, digital media receivers and smart meters.

EXPERIMENT-3

AIM: Practice of Internal and External Commands of DOS

In DOS systems, an internal command is any command that resides in the COMMAND.COM file. This includes the most common DOS commands, such as COPY and DIR. Commands that reside in other COM files, or in EXE or BAT files, are called external commands.

SOME INTERNAL COMMANDS

DATE

This command is used to display the system current date setting and prompt you to enter a new date. The syntax is: **DATE [/T | date]**

TIME

This command is used to displays or set the system time. The syntax is: **TIME [/T | time]**

COPY CON

It is used to create a file in the existing directory. Here CON is a DOS reserved word which stands for console. Syntax is: **COPY CON filename** after that press Enter and start typing your text and after you're done typing your text, to save and exit hit F6 key.

TYPE

This command is used to display the contents of a text file or files. **The syntax is: TYPE [drive:][path]filename**

CLS

It is used to clear the screen. Syntax is **CLS**

SOME EXTERNAL COMMANDS

XCOPY

This command is used to copy files and directory trees from one disk to another disk. Syntax is **XCOPY source [destination]**

DISKCOPY

This command copies the contents of one floppy from the source drive to a formatted or un-formatted floppy disk in the destination drive. This command copies the data from particular position on the source disk to exactly the same position on the destination disk. Syntax **Diskcopy A: B:**

TREE

This command is very useful to view the list of directories and subdirectories present on the disk in graphical form. If you wanted to include files also with directories and subdirectories, then you'll have to give the command line as tree/f which presents the tree view of all the content on your disk. Here is the syntax for this command with allowed switches: **TREE [drive:path] [/F] [/A]**

DELTREE

This command is used to remove a directory along with its contents. Syntax is **deltree [drive:path]**

EXPERIMENT-4

AIM: Working Practice on Windows Operating System: Creating File, Folder, Copying, Moving, Deleting File, Folder

Copy a File or Folder

- Open the drive or folder containing the file or folder you want to copy.
- Select the files or folders you want to copy.
- Click the **Organize** button on the toolbar, and then click **Copy**.
- Display the destination folder where you want to copy the files or folder.
- Click the **Organize** button on the toolbar, and then click **Paste**.

Move a File or Folder

- Open the drive or folder containing the file or folder you want to move.
- Select the files or folders you want to move.
- Click the **Organize** button on the toolbar, and then click **Cut**.
- Display the destination folder where you want to move the files or folder.
- Click the **Organize** button on the toolbar, and then click **Paste**.

Copy or Move a File or Folder Using Drag and Drop

- Open the drive or folder containing the file or folder you want to copy or move.
- Select the files or folders you want to copy or move.
- In the Navigation pane, point to a folder list to display the expand and collapse arrows.
- Click the arrows to display the destination folder, and then click the destination folder.
- Right-click the selected files or folders, drag to the destination folder, and then click **Copy Here** or **Move Here**.

EXPERIMENT-5

AIM: Installing and Uninstalling of New Software Using Control Panel

Installation (or **setup**) of a computer program (including device drivers and plugins), is the act of making the program ready for execution. Because the process varies for each program and each computer, programs (including operating systems) often come with an *installer*, a specialized program responsible for doing whatever is needed for their installation. Installation may be part of a larger software deployment process.

Installation typically involves code being copied/generated from the installation files to new files on the local computer for easier access by the operating system. Because code is generally copied/generated in multiple locations, uninstallation usually involves more than just erasing the program folder. For example, registry files and other system code may need to be modified or deleted for a complete uninstallation.

Some computer programs can be executed by simply copying them into a folder stored on a computer and executing them. Other programs are supplied in a form unsuitable for immediate execution and therefore need an installation procedure. Once installed, the program can be executed again and again, without the need to reinstall before each execution.

Common operations performed during software installations include:

- Making sure that necessary system requirements are met.
- Checking for existing versions of the software.
- Creating or updating program files and folders.
- Adding configuration data such as configuration files, Windows registry entries or environment variables.
- Making the software accessible to the user, for instance by creating links, shortcuts or bookmarks.
- Configuring components that run automatically, such as daemons or Windows services.
- Performing product activation.
- Updating the software versions.

These operations may require some charges or be free of charge. In case of payment, installation costs means the costs connected and relevant to or incurred as a result of installing the drivers or the equipment in the customers' premises.

An *installation program* or *installer* is a computer program that installs files, such as applications, drivers, or other software, onto a computer. Some installers are specifically made to install the files they contain; other installers are general-purpose and work by reading the contents of the software package to be installed.

EXPERIMENT-6

AIM: Installation and Uninstallation of New Hardware Drivers using Control Panel

Double-click the folder that has the same name as the downloaded file. Click Start, then right-click My Computer (or Computer) and click Manage. In the Computer Management window, on the left, click Device Manager. Click the + sign in front of the device category for which you wish to **install** the **driver**.

The downloaded driver file will be an executable file (File name ends in ".exe".) or a zip file (File name ends in ".zip".).

For executable file, to install the driver, you just need to double-click on the file and follow the on-screen instructions.

For zip file, you need to unzip it and find the executable file in the archive. If you cannot find an executable file, you need to install the driver step by step using the ".inf" file. Following steps are for your reference how to install the driver in this way.

Go to Device Manager

Find the device that need to install a driver. (Here let's take video card for example.)

- Right-click on the device and select **Update Driver Software...**
- Select **Browse my computer for driver software.**
- Select **Let me pick from a list of device drivers on my computer.**
- Click **Have Disk...** button.
- Click **Browse...** button. Navigate to the folder where you saved the downloaded driver file and browse the .inf driver file.
- Click **OK** button then **Next** button to finish the installation. You might be asked for an admin password or to confirm your choice.

EXPERIMENT-7

AIM: Disk Defragmentation using System Tool

Defragmentation is like cleaning house for your PC, it picks up all of the pieces of data that are spread across your hard drive and puts them back together again. Why is ***defragmentation*** important? Because every computer suffers from the constant growth of *fragmentation* and if you don't clean house, your PC suffers.

Disk *fragmentation* occurs when a file is broken up into pieces to fit on the disk. Because files are constantly being written, deleted and resized, *fragmentation* is a natural occurrence. When a file is spread out over several locations, it takes longer to read and write. But the effects of *fragmentation* are far more widespread: Slow PC performance, long boot-times, random crashes and freeze-ups – even a complete inability to boot up at all. Many users blame these problems on the operating system or simply think their computer is "old", *when hard disk fragmentation is most often the real culprit.*

EXPERIMENT-8

AIM: Procedure of Disk Partition and Its Operation (Shrinking, Extending, Delete, Format)

In order to use a hard drive, or a portion of a hard drive, in Windows you need to first partition it and then format it. This process will then assign a drive letter to the partition allowing you to access it in order to use it to store and retrieve data.

If you are using Windows 8, type Disk Management at the start screen, click on **Settings**, and then click on the **Create and format hard disk partitions** option. Then skip to step 3. Otherwise, click on the **Start** button and select the **Control Panel** option.

If in Classic control panel mode, double-click on the **Administrative Tools** icon and then double-click on **Computer Management** icon.

If your control panel is in the Category view, click on **Performance and Maintenance**, then click on **Administrative Tools,** and finally double-click on the **Computer Management** icon.

When the Computer Management screen opens, click on the **Disk Management** option under the **Storage** category.

To make a partition from the unused space you would do the following.

- Right click on the space listed as unallocated.
- At the menu that comes up, click on the **New Partition** option.

- You will now be presented with a wizard as to how you would like the partition to be created. At the first screen press **Next**.
- At the following screen, determine if you need a primary or extended partition. For more information about these partitions you can read our partition tutorial listed above. Most people will be fine selecting **Primary Partition**. Select **Primary Partition** and press **Next**.
- At the next screen you will be prompted to type in how much of the unallocated space you would like used for the new partition. In my example, my unallocated space is 26.43 GB, so I can choose to make a partition of that entire amount of only use half and save the rest for another partition. Regardless, of what you decide, you need to enter a size in the **Partition size in MB:** field, or stick with the default size, and press the **Next** button.
- At the next screen select the drive letter you would like assigned to it, or use the default one given. When done, press the **Next** button. The drive letter that you assign here will be how you access the partition later.
- In this step you will determine how you would like the new partition to be formatted. For the most part you are advised to use the **NTFS** file system. If you need a file system that can be readable by older operating systems like DOS, Windows 95, Windows 98, or Windows ME, then you should instead choose the **FAT32** file system.
- Type a name in the **Volume Label** field that will be associated with this partition or leave it blank.
- Finally press the **Next** button and you will come to a summary screen. Review how the partition will be created, and if you are satisfied, press the **Finish** button to complete the creation and formatting of your new hard disk partition.

When the computer finishes creating and formatting the new partition you will be presented with the Disk Management screen again and will see that you have a new partition and drive letter on your computer. Now you can use that drive to start storing your data.

To delete a partition please follow these steps:

- Click on the **Start** button and select the **Control Panel** option.
- If in Classic control panel mode, double-click on the **Administrative Tools** icon and then double-click on **Computer Management** icon.
- If your control panel is in the Category view, click on **Performance and Maintenance**, then click on **Administrative Tools,** and finally double-click on the **Computer Management** icon.
- When the Computer Management screen opens, click on the **Disk Management** option under the **Storage** category.
- Right-click on the partition you would like to delete and choose the **Delete Partition** option.
- A confirmation box will come up asking if you are sure you would like to continue. If you press the yes button, all data on this partition will be deleted. If you are sure about deleting this partition, press the **Yes** button.

EXPERIMENT-9

AIM: Installation of Operating Systems

- **Insert the installation disk or flash drive.** To install a new operating system on Windows, you must have the operating system's install tool on a DVD or flash drive, and the disk or flash drive must be inserted into your computer.
- **Restart your computer.** Press and hold your computer's Power button to turn it off, wait for a few seconds, and then press the Power button again to turn the computer back on.
- **Wait for the computer's first startup screen to appear.** Once the startup screen appears, you'll have a very limited window in which you can press the setup key.
- **Press and hold Del or F2 to enter the BIOS page.** The key you're prompted to press might also be different; if so, use that key instead. This will load your computer's BIOS page, from which point you can select your installation disk or drive.

You'll typically use the "F" keys to access the BIOS.

- **Locate the "Boot Order" section.** This section is normally on the main page of the BIOS, though you may need to use the arrow keys to navigate over to the "Boot" or "Advanced" tab.
- **Select the location from which you want to start your computer.** In this case, you'll be starting your computer either from the disk drive or from an external drive, such as a flash drive. The disk drive option is usually labeled **CD-ROM Drive**, while external drives will show up as **Removable Devices**.
- **Move your selected location to the top of the list.** Typically, you'll press the + key with the boot location you want to use selected until it's at the top of the "Boot Order" list.
- **Save your settings and exit the BIOS.** There should be a "Save and Exit" key listed in the BIOS' key legend; press the key listed there to save your settings and exit the BIOS.
- **Restart your computer.** Once your computer begins to start up again, it will select your disk or flash drive as the boot location, which means that it will begin installing the operating system.
- **Follow the on-screen prompts.** Each operating system will have different steps to take when installing it, so just follow the on-screen directions to complete the installation.

EXPERIMENT-10

AIM: Changing Resolution, Colour, Appearances, and Screen Saver Option of the Display

To **change** the size of text and windows, click Medium or Larger, then click Apply. Right-click the desktop and click **Screen resolution**. Click the image of the **monitor** that you want to **adjust**. To **change** the **screen** size for the selected **monitor**, select a **resolution** from the menu, then click Apply.

Some of the very first shareware programs written for Windows were "wallpaper changers." These would change your desktop wallpaper everyday or ever week, depending on what you wanted. To change your wallpaper yourself, here's what you do. Using the standard Start menu that comes with Windows XP you'd click:

Start ... Control Panel...Appearance and Themes...Change the Desktop Background

You can also right-click on the desktop and select *Properties*. This is the most direct way to change things like wallpaper no matter what version of Windows you have.

Appearance

Another tab is labeled *Appearance* and it lets you change the way Windows appears. You can pick from the "style" of windows and buttons that you want **and** you can pick a color scheme. Color schemes range through a variety of colors — from red to green to blu. Pick the one you want. Note that you also change the "Font Size" if you want. You can pick from Normal, Large, or Extra Large. On this same tab there area couple of extra buttons — Advanced and Effects. If you click on the Effects button you'll see you can elect to have shadows under menus, show the content of windows while dragging, select a transition effect, and more. The "Advanced" button lets you change the appearance in a variety of areas, like icons, desktop, active title bar, icon spacing, and many more.

Screen Saver and Themes

Using the *Screen Saver* tab, You can select one of the screen savers that comes with Windows, or one that you've downloaded an installed. Decide how long you want the computer to be idle before the screen saver comes on and preview it. In the early days of computers screen savers were very important. Many simply turned the screen black, but this stopped a process called *burn-in* where an image could become a permanent part of the screen. Today screen savers are somewhat less important because many monitors will turn themselves off, but screen savers come in a huge variety. The other tab is for *Themes*. Themes are available for download or you can purchase a product like Microsoft Plus! that delivers themes.

EXPERIMENT-11

AIM: Changing System Date and Time

Right-click on the **time** in the bottom-right of the screen and select Adjust **Date/Time**. Click on the **Change date and time**... button. Use the arrows to the left and right of the month/year and the arrows to the right of the clock to **change** the **time** to the correct **time**.

1. Right-click or tap on the date and time in the Windows Notification Area in the bottom right corner of the screen.
2. Click **Adjust date/time**.
3. Make sure your **Time zone** is set properly if your computer is displaying the wrong time.
4. To manually adjust the time, **turn off the Set time automatically** option and then click the **Change** button.

EXPERIMENT-12

AIM: User Account Creation and its Feature on Windows Operating System

This includes all of **the** permissions that are granted to a standard **user account** plus **the** ability to make major **operating system** changes, install new software, and **create** and modify other **user accounts**. Administrator **accounts** also have **the** ability to set permissions for other **users** on **the system**.

If the PC is on a domain, the password can only be created by the administrator. Open the Control Panel and Select **User Accounts** and then choose Manage another **account**. Select the **account** you want to **create** a password for and press **Create** a password. Type in the password, confirm it and then press **Create** password.

EXPERIMENT-13

AIM: Email Account Creation, Reading, Writing and Sending emails with Attachments

Follow the steps below to create email account:

- Click on the Sign Up Button
- Enter all mandatory fields (First Name, Last Name, Gender, etc.)
- Type in your desired Email Address
- Choose a secure Password (at least 8 characters, mixing letters, numbers, lower and upper case, and using special characters)
- Select your Security Question, type in your Answer
- Verify your registration by typing the numbers in the captcha picture
- Click the "Accept" - Button underneath
- Once you have an email account, an Internet connection and an email program, you are ready to start.
- When your email program is open, you can create a new (blank) message.
- In order to send the message you must click on the *"Send"* button (you must also be connected to the Internet). Clicking the *"Send"* button more than once will mean that the recipient will receive multiple copies of your email message (and attachments if you have sent any).
- "Checking your mail" means checking if any messages have been left on your mail server for you. It's like looking in the letterbox. If you have received mail, an email program will transfer it to your hard drive (like bringing the mail into your house for you).

EXPERIMENT-14

AIM: Internet Browsing using Browsers

A **web browser** (or **browser**) is a software application for accessing information on the World Wide Web. Each individual web page, image, and video is identified by a distinct URL, enabling browsers to retrieve and display them on the user's device.

Note that a web browser is not the same thing as a search engine, though the two are often confused. For a user, a search engine is just a website, such as google.com, that stores searchable data about other websites. But in order to connect to and display websites on their device, a user needs to have a web browser installed

The most popular web browsers are Chrome, Firefox, Safari, Internet Explorer, and Edge.

EXPERIMENT-15

AIM: Using of Search Engine to get Information from Internet

Web Search Engine is a program that searches for and identifies items in a database that correspond to keywords or characters specified by the user, used especially for finding particular sites on the World Wide Web.)

- Search engine is a service that allows Internet users to search for content via the World Wide Web (WWW).
- user enters keywords or key phrases into a search engine and receives a list of Web content results in the form of websites, images, videos or other online data.
- list of content returned via a search engine to a user is known as a search engine results page (SERP).
- A search engine is a web site that collects and organizes content from all over the internet.
- Those wishing to locate something would enter a query about what they'd like to find and the engine provides links to content that matches what they want.
- Example of search engines are Google.com, Yahoo.com,Dogpile.com, Ask.com, Bing.com etc.

❑❑❑

8 Chapter

TAIRTE KO NAAV KA SAHAARA

THINK ABOUT IT

The best preparation for tomorrow is doing your best today.

— H. Jackson Brown, Jr.

➢ WHAT IS A COMPUTER?

A **computer** is a device that can be instructed to carry out sequences of arithmetic or logical operations automatically via computer programming. Modern computers have the ability to follow generalized sets of operations, called *programs.* These programs enable computers to perform an extremely wide range of tasks.

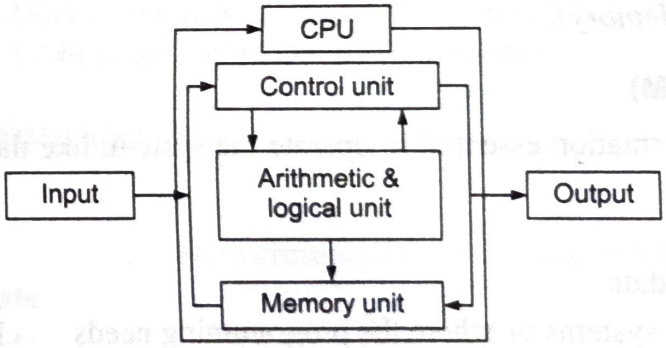


Fig. 8.1 Block diagram of computer

➢ LIST SOME COMPUTER INPUT DEVICES

Input Devices

- Keyboard
- Mouse (pointing device)
- Webcam
- Cameras
- Trackballs
- Digital camera
- Joystick
- Microphone
- Scanner
- Touchpads Graphics Tablets
- Video Capture Hardware
- Barcode reader
- Gamepad

➢ LIST SOME COMPUTER OUTPUT DEVICES

- Monitor (LED, LCD, CRT etc)
- Plotters.
- LCD Projection Panels.
- Speakers
- Printers (all types)
- Projector.
- **Computer Output** Microfilm (COM)
- Head Phone.

➢ LIST THE TYPES OF MEMORIES IN COMPUTER

Computer memory is any physical device capable of storing information temporarily or **permanently.** For example, Random Access **Memory** (RAM), is a volatile **memory** that stores **information on an** integrated circuit used by the operating system, software, and hardware.. Computer **memory is of two** basic type – Primary memory/Volatile memory and Secondary memory/non-volatile **memory. Random** Access Memory (RAM) is volatile memory and Read Only Memory (ROM) is **non-volatile memory.**

Random Access Memory (RAM)

- Also called as *read write memory* or the *main memory* or the *primary memory.*
- Programs and data that the CPU requires during execution of a program **are stored in this** memory.
- Volatile memory as the data loses when the power is turned off.
- Further classified into two types- *SRAM (Static Random Access Memory)* and ***DRAM (Dynamic*** *Random Access Memory).*

Read Only Memory (ROM)

- Stores crucial information essential to operate the system, like the program **essential to boot** the computer.
- Not volatile.
- Always retains its data.
- Used in embedded systems or where the programming needs no change.
- Used in calculators and peripheral devices.
- ROM is further classified into 4 types- *ROM, PROM. EPROM,* and *EEPROM.*

Types of Read Only Memory (ROM)

PROM (Programmable read-only memory): Can be programmed by user. Once **programmed, the** data and instructions in it cannot be changed.

- **EPROM (Erasable Programmable read only memory):** Can be reprogrammed. **To erase** data from it, it is exposed to ultra violet light. To reprogram it, all the previous **data has to be** erased.
- **EEPROM (Electrically erasable programmable read only memory):** The data **can be erased** by applying electric field, no need of ultra violet light. We can erase only portions **of the chip.**

➢ WHAT IS HARDWARE AND SOFTWARE?

A computer system consists of two major elements:

Hardware and Software

- Computer **hardware** is the collection of all the parts you can physically touch.
- Computer **software** is not something you can touch
- **Software** is a set of instructions for a computer to perform specific operations.

➢ WHAT IS GUI AND CUI?

- The **graphical user interface** (**GUI** is a type of user interface that allows users to interact with electronic devices through graphical icons and visual indicators such as secondary notation, instead of text-based user interfaces, typed command labels or text navigation.
- **GUI** stands for **graphical user interface**
- Interface we are using now a days on windows operating system, smartphones, ATM machine and more
- Attractive and easy to use
- **CUI** is Command line user interface or character user interface
- Means that we have to type commands to interact with the computer

➢ WHAT ARE INTERNAL AND EXTERNAL COMMANDS OF DOS?

In DOS systems, an internal command is any command that resides in the COMMAND.COM file. This includes the most common DOS commands, such as COPY and DIR. Commands that reside in other COM files, or in EXE or BAT files, are called external commands.

➢ SOME INTERNAL COMMANDS

date

This command is used to display the system current date setting and prompt you to enter a new date. The syntax is: **date [/T | date]**

time

This command is used to displays or set the system time. The syntax is: **time [/T | time]**

COPY CON

It is used to create a file in the existing directory. Here CON is a DOS reserved word which stands for console. Syntax is: **COPY CON filename** after that press Enter and start typing your text and after you're done typing your text, to save and exit hit F6 key.

TYPE

This command is used to display the contents of a text file or files. The syntax is: **TYPE [drive:][path]filename**

CLS

It is used to clear the screen. Syntax is **CLS**

➢ SOME EXTERNAL COMMANDS

xcopy

This command is used to copy files and directory trees from one disk to another disk. Syntax is **xcopy source [destination]**

diskcopy

This command copies the contents of one floppy from the source drive to a formatted or un-formatted floppy disk in the destination drive. This command copies the data from particular position on the source disk to exactly the same position on the destination disk. Syntax **diskcopy A: B:**

tree

This command is very useful to view the list of directories and subdirectories present on the disk in graphical form. If you wanted to include files also with directories and subdirectories, then you'll have to give the command line as tree/f which presents the tree view of all the content on your disk. Here is the syntax for this command with allowed switches: **tree [drive:path] [/F] [/A]**

deltree

This command is used to remove a directory along with its contents. Syntax is **deltree [drive:path]**

➢ EXPLAIN THE PROCESS OF CREATING FILE, FOLDER. COPYING, MOVING, DELETING FILE, FOLDER IN WINDOWS.

Copy a File or Folder

- Open the drive or folder containing the file or folder you want to copy.
- Select the files or folders you want to copy.
- Click the **Organize** button on the toolbar, and then click **Copy**.
- Display the destination folder where you want to copy the files or folder.
- Click the **Organize** button on the toolbar, and then click **Paste**.

Move a File or Folder

- Open the drive or folder containing the file or folder you want to move.
- Select the files or folders you want to move.
- Click the **Organize** button on the toolbar, and then click **Cut**.
- Display the destination folder where you want to move the files or folder.
- Click the **Organize** button on the toolbar, and then click **Paste**.

Copy or Move a File or Folder Using Drag and Drop

- Open the drive or folder containing the file or folder you want to copy or move.
- Select the files or folders you want to copy or move.
- In the Navigation pane, point to a folder list to display the expand and collapse arrows.
- Click the arrows to display the destination folder, and then click the destination folder.
- Right-click the selected files or folders, drag to the destination folder, and then click **Copy Here** or **Move Here**.

➤ EXPLAIN THE USES OF COMPUTERS IN VARIOUS FIELDS

Computers are used in so many fields in our daily life. From Engineers to Doctors, Students, Teachers, Government Organization they all use computers to perform specific tasks, for entertainment or just to finish office work. Computers have made our life easier. With greater precision and accuracy and less time taking computers can do a lot in short time while that task can take a lot of time while doing manually. Computers have taken industries and businesses to a whole new level.

People can find any type of information on the internet. Educational and informative websites are available to download books, tutorials etc. to improve their knowledge and learn new things.

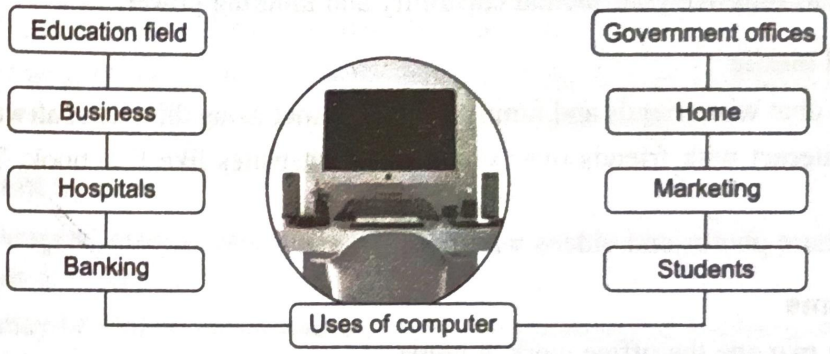


Fig. 8.2

➤ BANKING

Banks are using computers daily to faster and accurate the customer demands.

- Banks are using a computer to deposit customer money in their account.
- Providing ATM to withdraw and cash deposit ATM's for their customer.
- Whenever we deposit, withdraw money we get messages on our mobile number.
- We can see and print our transaction records without visiting banks.
- The whole process of banking is done by computer.

Marketing and E-commerce

- Use of computer with the internet is creating new ways to do the product and services marketing online.
- Digital marketing services, products, websites, and businesses are growing.
- Businesses can use a computer to type marketing content, to publish content marketing article on websites and social media.
- They can sell and market their product on portals or such as Amazon.

Government offices

- Office Automation.
- Consumers are getting a solution with high speed and accuracy because of the uses of computer in official works.
- Applications that speed the process and quality of official works.
- Microsoft Office package, email, video conferencing tools etc. are few applications that speed the work of government offices with accuracy.

Entertainment

- People can find entertainment on the internet.
- Watch movies, listen to songs, and watch videos download different stuff. They can also watch live matches on the internet.

Computer Games

- Different types of games are available.
- Source of entertainment and recreation.
- Developed to improve your mental capability and thinking power.

Chatting & Social Media

- People can chat with friends and family on the internet using different software like Skype etc.
- One can interact with friends over social media websites like Facebook, Twitter & Google Plus.
- Can also share photos and videos with friends.

Working from Home

- People can manage the office work at home.
- Owner of a company can check the work of the employees from home. He can control his office while sitting at home.

Computer Aided Learning (CAL)

- Computer aided learning is the process of using information technology to help teaching and enhance the learning process.
- Use of computer can reduce the time that is spent on preparing teaching material. It can also reduce the administrative load of teaching and research.
- Use of multimedia projector and PowerPoint presentations has improved the quality of teaching.
- Also helped the learning process.

Distance Learning

- Distance learning is a new learning methodology
- Computer plays the key role in this kind of learning.
- Many institutes are providing distance learning programs.
- Student can attend the lecture at home by connecting to a network.
- Student can also ask questions to the teacher.

Online Examination

- The trend of online examination is becoming popular.
- Different examination like GRE, GMAT and SAT are conducted online all over the world
- Minimizes the chance of mistakes.
- Enables to announce the result in time.

Marketing

- An organization can use computers for marketing their products
- Marketing applications provide information about the products to customers. Computer is also used to manage distribution system, advertising and selling activities
- Companies can know more about their customers and their needs and requirements etc.

Stock Exchange

- Stock Exchange is the most important place for businessmen.
- Stockbrokers perform all trading activities electronically.
- They connect with the computer where brokers match the buyers with sellers. It reduces cost as no paper or special building is required to conduct these activities.

Hospital Management System

- Specialized hospital management softwares are used to automate the day to day procedures and operations at hospitals.
- These tasks may be Online appointments, payroll admittance and discharge records etc.
- Hospital management systems can store data about patients.
- Computers are used to store data about patients, their diseases & symptoms, the medicines that are prescribed.
- Monitoring systems are installed in medical wards and Intensive care units to monitoring patients continuously.
- These systems can monitor pulse, blood pressure and body temperature and can alert medical staff about any serious situations.
- Specialised devices are used to help impaired patients like hearing aids.

Engineering

- ***Engineers*** rely on ***computers*** for much of the process. Using ***computers*** and specialty ***computer*** software, ***engineers*** can design, test and make changes to products in minimal time.
- ***Computer-aided design/computer-aided manufacturing***, computer systems used to design and manufacture products
- ***Engineering*** designers can find effective means of collecting, storing, retrieving, processing, communicating, distributing, displaying, plotting and printing large quantities of information.

Thought Question

A digital computer, analog computer and now the use of hybrid computers are growing in our daily life. Computer is doing our work faster and accurately and save our time. But then why people do not have any time today for their family. You can say the computer has changed our lives because today we want to use air purifier inside the home rather than planting new trees outside. Do you agree?

➢ EXPLAIN THE RELEVANCE OF SPEED AND WORD LENGTH FOR CPU PERFORMANCE

The factors Affecting CPU performance are:

- Multiple cores
- Clock speed
- Address bus width
- Cache memory
- Word length
- Data bus width.

Word size refers to the number of bits processed by a computer's CPU in one go (typically **32 bits** or **64 bits**). Data bus size, instruction size, address size are usually multiples of the word size.

The length of the important registers like Program counter, Accumulator are defined by the word size. 16 bit word size means the register can store 16 ones and zeros in it, and the biggest number is the decimal equivalent of that binary number.

The number of bits in a word (the *word size*, *word width*, or *word length*) is an important characteristic of any specific processor design or computer architecture.

- The 8088 processor has a clock speed of 4.77 MHz and has an 8-bit word length.
- The 80486 has a clock speed of 50 to 80 MHz and has a word length of 32 bits.
- The Pentium 4 as a clock speed of 1.5 gigahertz to 3.2 gigahertz and has a word length of 64 bits.

CPUs with Speed and Word Length

CPU	*Clock Speed (Mhz)*	*Word Length (Bits)*
8088	4.77	8
80286	6-12	16
80386	25-40	32
80486	50-80	32
Pentium (80586)	96-200	64
Pentium Pro	100-200	64
Pentium II	233-300	64
Pentium III	350 MHz-1.13 GHz	64
Pentium IV	1.5 GHz-3.2 GHz	64

➢ WHAT IS THE DIFFERENCE BETWEEN DATA AND INFORMATION?

Data are simply facts or raw figures. When **data** are processed, interpreted, organized, structured or presented so as to make them meaningful or useful, they are called information. **Information** provides context for **data**.

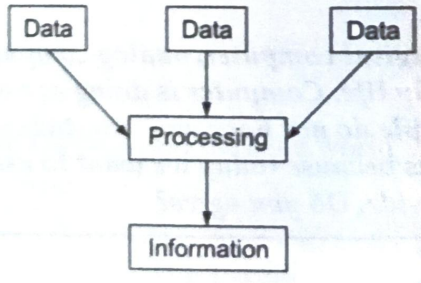


Fig. 8.3: Information is created from data

➢ WHAT IS A NUMBER SYSTEM?

A **number system** is a **system** for expressing **numbers**; that is, a mathematical notation for representing numbers of a given set, using digits or other symbols in a consistent manner.

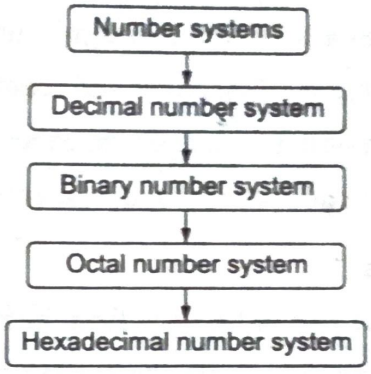


Fig. 8.4

➢ WHAT IS MEMORY ADDRESSING?

A **memory address** is a reference to a specific **memory** location used at various levels by software and hardware. **Memory addresses** are fixed-length sequences of digits conventionally displayed and manipulated as unsigned integers. It is a number that is assigned to each byte in a computers ***memory*** that the CPU uses to track where data and instructions are stored in ***RAM***. Each byte is assigned a ***memory address*** whether or not it is being used to store data. A ***memory address*** is a unique identifier used by a device or CPU for data tracking. This binary ***address*** is defined by an ordered and finite sequence allowing the CPU to track the location of each ***memory*** byte.

➢ WHAT ARE ASCII AND EBCDIC CODING SYSTEMS?

ASCII stands for American Standard Code for Information Interchange. Computers can only understand numbers, so an ASCII code is the numerical representation of a alphanumeric characters (alphabets and numeric characters). ASCII (American Standard Code for Information Interchange) is the most common format for text files in computers and on the Internet. In an ASCII file, each alphabetic, numeric, or special character is represented with a 7-bit binary number (a string of seven 0s or 1s). 128 possible characters are defined. UNIX and DOS-based operating systems use ASCII for text files. Windows NT and 2000 uses a newer code, Unicode. IBM's S/390 systems use a proprietary 8-bit code called EBCDIC. Conversion programs allow different operating systems to change a file from one code to another. ASCII was developed by the American National Standards Institute (ANSI).

➢ NAME THE TYPE OF OPERATING SYSTEMS

- Simple Batch System
- Multiprocessor System
- Distributed Operating System
- Realtime Operating System
- Multiprogramming Batch System
- Desktop System
- Clustered System
- Handheld System

Simple Batch Systems

- **No direct interaction between user and the computer.**
- The user has to submit a job (written on cards or tape) to a computer operator.
- Then computer operator places a batch of several jobs on an input device.
- Jobs are batched together by type of languages and requirement.
- Then a special program, the monitor, manages the execution of each program in the batch.
- The monitor is always in the main memory and available for execution.

Multiprogramming Batch Systems

- Picks up and begins to execute one of the jobs from memory.
- Once this job needs an I/O operation operating system switches to another job (CPU and OS always busy).
- Jobs in the memory are always less than the number of jobs on disk (Job Pool).
- If several jobs are ready to run at the same time, then the system chooses which one to run through the process of **CPU Scheduling**.
- In Non-multiprogrammed system, there are moments when CPU sits idle and does not do any work.
- In Multiprogramming system, CPU will never be idle and keeps on processing.

Time Sharing Systems are very similar to Multiprogramming batch systems. In fact time sharing systems are an extension of multiprogramming systems.

In Time sharing systems the prime focus is on **minimizing the response time**, while in multiprogramming the prime focus is to maximize the CPU usage.

➢ WHAT IS BIOS

- The BIOS (basic input/output system) is a program pre-installed on Windows-based computers that the computer uses to start up.
- The CPU accesses the BIOS even before the operating system is loaded.
- BIOS then checks all your hardware connections and locates all your devices. If everything is OK, the BIOS loads the operating system into the computer's memory and finishes the boot-up process.
- BIOS is the program a personal computer's microprocessor uses to get the computer system started after you turn it on.
- Manages data flow between the computer's operating system and attached devices such as the hard disk, video adapter, keyboard, mouse and printer.
- Integral part of your computer
- Program that is made accessible to the microprocessor on an erasable programmable read-only memory (EPROM) chip.
- When you turn on your computer, the microprocessor passes control to the BIOS program, which is always located at the same place on EPROM.

- When BIOS boots up (starts up) your computer, it first determines whether all of the attachments are in place and operational and then it loads the operating system into your computer's random access memory (RAM) from your hard disk or diskette drive.
- With BIOS, your operating system and its applications are freed from having to understand exact details about the attached input/output devices.
- When device details change, only the BIOS program needs to be changed. Sometimes this change can be made during your system setup. In any case, neither your operating system or any applications you use need to be changed.

➢ WHAT ARE SYSTEM UTILITIES?

- Utility software is system software designed to help analyze, **configure**, optimize or maintain a computer.
- Used to support the computer infrastructure in contrast to application software, which is aimed at directly performing tasks that benefit ordinary users.

➢ EXPLAIN EDITOR, LINKER, LOADER, FILE MANAGER.

A computer system is made of hardware and software. We write programs in high-level language, which are then fed into a series of tools and OS components to get the desired code that can be used by the machine. This is known as Language Processing System.

The high-level language is converted into binary language in various phases. A **compiler** is a program that converts high-level language to assembly language. Similarly, an **assembler** is a program that converts the assembly language to machine-level language.

- User writes a program in C language (high-level language).
- The C compiler, compiles the program and translates it to assembly program (low-level language).
- An assembler then translates the assembly program into machine code (object).
- A linker tool is used to link all the parts of the program together for execution (executable machine code).
- A loader loads all of them into memory and then the program is executed.

Preprocessor

- A tool that produces input for compilers.
- Deals with macro-processing, augmentation, file inclusion, language extension, etc.

Interpreter

- Translates high-level language into low-level machine language.
- Difference between compiler and interpreter lies in the way they read the source code or input.
- Compiler reads the whole source code at once, creates tokens, checks semantics, generates intermediate code, executes the whole program and may involve many passes.
- However, an interpreter reads a statement from the input, converts it to an intermediate code, executes it, then takes the next statement in sequence.

- If an error occurs, an interpreter stops execution and reports it, whereas a compiler reads the whole program even if it encounters several errors.

Assembler

- Translates assembly language programs into machine code.
- Output of an assembler is called an object file, which contains a combination of machine instructions as well as the data required to place these instructions in memory.

Linker

- Computer program that links and merges various object files together in order to make an executable file.
- All these files might have been compiled by separate assemblers.
- Major task of a linker is to search and locate referenced module/routines in a program and to determine the memory location where these codes will be loaded, making the program instruction to have absolute references.

Loader

- Part of operating system and is responsible for loading executable files into memory and execute them.
- Calculates the size of a program (instructions and data) and creates memory space for it.
- Initializes various registers to initiate execution.

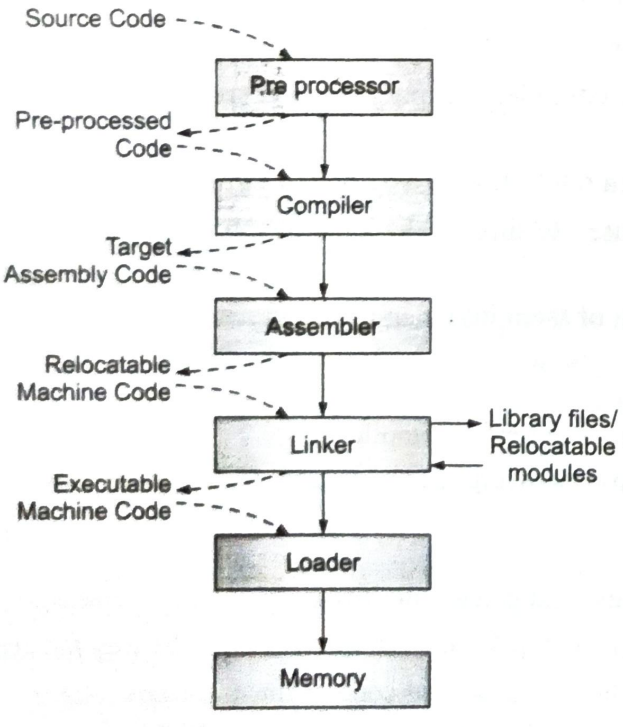


Fig. 8.5

➢ WHAT ARE WILD CARDS?

- **Wildcard** is a symbol used to replace or represent one or more characters.
- Wildcards are typically either an asterisk (*), which represents one or more characters or question mark(?), which represents a single character.
- Wildcard refers to a character that can be substituted for zero or more characters in a string. Wildcards are commonly used in computer programming, database SQL search queries, and when navigating through DOS or Unix directories via the command prompt.
- An asterisk (*) matches zero or more characters, while a question mark (?) matches a single character.
- An **asterisk** (*) may be used to specify any number of characters. It is typically used *at the end of a root word*, when it is referred to as "**truncation**."
- ***Example:*** searching for *INTER** would tell the database to look for all possible endings to that root like INTERNAL, INTERVIEW, INTERMEDIATE etc.
- A **question mark** (?) may be used to represent a single character, anywhere in the word. It is most useful when there are *variable spellings* for a word, and you want to search for all variants at once.
- For example, searching for ***c?r*** would return both ***car*** and ***cover***.

➢ EXPLAIN AUTOEXEC.BAT AND CONFIG.SYS

- Autoexec.bat is a file containing Disk Operating System commands that are executable when the computer is booted (started).
- The commands in autoexec.bat tell the operating system which application programs are to be automatically started, how memory is to be managed, and initialize other settings.
- Each command in autoexec.bat could be typed in manually after the computer is started, but that would take too long. The autoexec.bat file is command script that is written beforehand so that it can be automatically executed when the operating system is started.
- The bat suffix stands for batch, indicating that this is a file containing a sequence of commands entered from a file rather than interactively by a user.
- **config.sys** is a system file used with MS-DOS and OS/2 that is loaded each time the computer first boots up.
- This file controls components connected to the computer such as memory and other hardware devices with early computers.

➢ EXPLAIN THE DIFFERENCE BETWEEN CLIENT-SERVER AND PEER-TO-PEER NETWORK.

- The main difference between the Client-Server and Peer-to-Peer network model is that in **Client-Server** model, the data management is centralised whereas, in **Peer-to-Peer** each user has its own data and applications. In Client-Server network model **Server** is a powerful system that stores the data or information in it. **Client** is the machine which let the users access the data on the remote server.

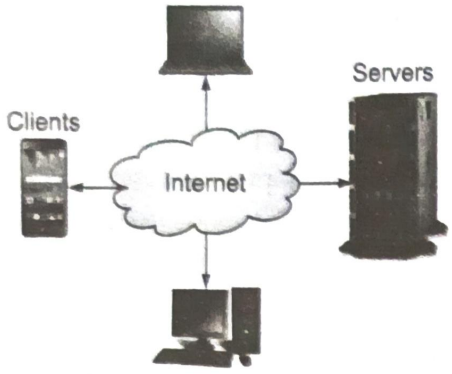


Fig. 8.6 Client-Servers Network Model

- **System administrator** manages the data on the server.
- Client machines and the server are connected through a **network**.
- Allows the clients to access data even if the client machine and server are far apart from each other.
- Client process on the client machine sends the **request** to the server process on the server machine.
- When the server receives the client request, it lookouts for the requested data and **send** it back with the reply.

Peer-to-Peer model does not distinguish between client and server instead each **node** can either be a client or a server depending on the whether the node is **requesting** or **providing** the services. Each node is considered as a **peer**.

- To become a part of peer-to-peer, a node must initially **join** the network.
- After joining it must start to provide services to and must request the services from other nodes in the peer-to-peer system.
- ***Two ways*** to know which node provides which services:
- When a node enters the peer-to-peer system, it must register the services it will be providing, into a centralized lookup service on the network. When a node desires for any specific service it must contact centralized lookup services to check out which node will provide the desired services. Now, Rest of the communication is done by the desiring node and the service providing node.

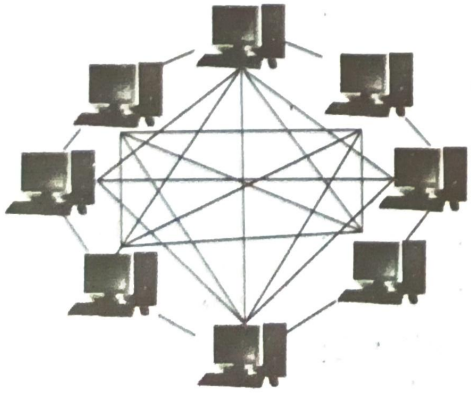


Fig. 8.7 Peer-to-Peer Network Model

- A node desiring for the specific services must broadcast the request for services to all other nodes in the peer-to-peer system. The node providing the requested service will respond to the node making the request.

Characteristics	*Client-server*	*Peer-to-peer*
Basic	Specific server and specific clients connected to the server.	Clients and server are not distinguished; each node act as client and server.
Service	Client request for service and server respond with the service.	Each node can request for services and can also provide the services.
Data	The data is stored in a centralized server.	Each peer has its own data.
Server	When several clients request for the services simultaneously, a server can get bottlenecked.	As the services are provided by several servers distributed in the peer-to-peer system, a server in not bottlenecked.
Expense	The client-server are expensive to implement.	Peer-to-peer are less expensive to implement.
Stability	More stable and scalable.	Less

➢ EXPLAIN THE INSTALLING AND UNINSTALLING OF NEW SOFTWARE USING CONTROL PANEL

Installation (or **setup**) of a computer program (including device drivers and plugins), is the act of making the program ready for execution. Because the process varies for each program and each computer, programs (including operating systems) often come with an *installer*, a specialized program responsible for doing whatever is needed for their installation. Installation may be part of a larger software deployment process.

Installation typically involves code being copied/generated from the installation files to new files on the local computer for easier access by the operating system. Because code is generally copied/generated in multiple locations, uninstallation usually involves more than just erasing the program folder. For example, registry files and other system code may need to be modified or deleted for a complete uninstallation.

Some computer programs can be executed by simply copying them into a folder stored on a computer and executing them. Other programs are supplied in a form unsuitable for immediate execution and therefore need an installation procedure. Once installed, the program can be executed again and again, without the need to reinstall before each execution.

Common Operations Performed During Software Installations Include

- Making sure that necessary system requirements are met.
- Checking for existing versions of the software.
- Creating or updating program files and folders.
- Adding configuration data such as configuration files, Windows registry entries or environment variables.

- Making the software accessible to the user, for instance by creating links, shortcuts or bookmarks.
- Configuring components that run automatically, such as daemons or Windows services.
- Performing product activation.
- Updating the software versions.

These operations may require some charges or be free of charge. In case of payment, installation costs means the costs connected and relevant to or incurred as a result of installing the drivers or the equipment in the customers' premises.

An *installation program* or *installer* is a computer program that installs files, such as applications, drivers, or other software, onto a computer. Some installers are specifically made to install the files they contain; other installers are general-purpose and work by reading the contents of the software package to be installed.

➢ EXPLAIN LAN, MAN AND WAN

A **LAN** (local area network) is a group of computers and network devices connected together, usually within the same building.

- Connections must be high speed and relatively inexpensive (e.g., token ring or Ethernet).
- A **MAN** (metropolitan area network) is a larger network that usually spans several buildings in the same city or town.
- A **WAN** (wide area network), in comparison to a MAN, is not restricted to a geographical location, although it might be confined within the bounds of a state or country. A WAN connects several LANs, and may be limited to an enterprise or accessible to the public.
- The technology is high speed and relatively expensive.
- Internet is an example of a worldwide public WAN.

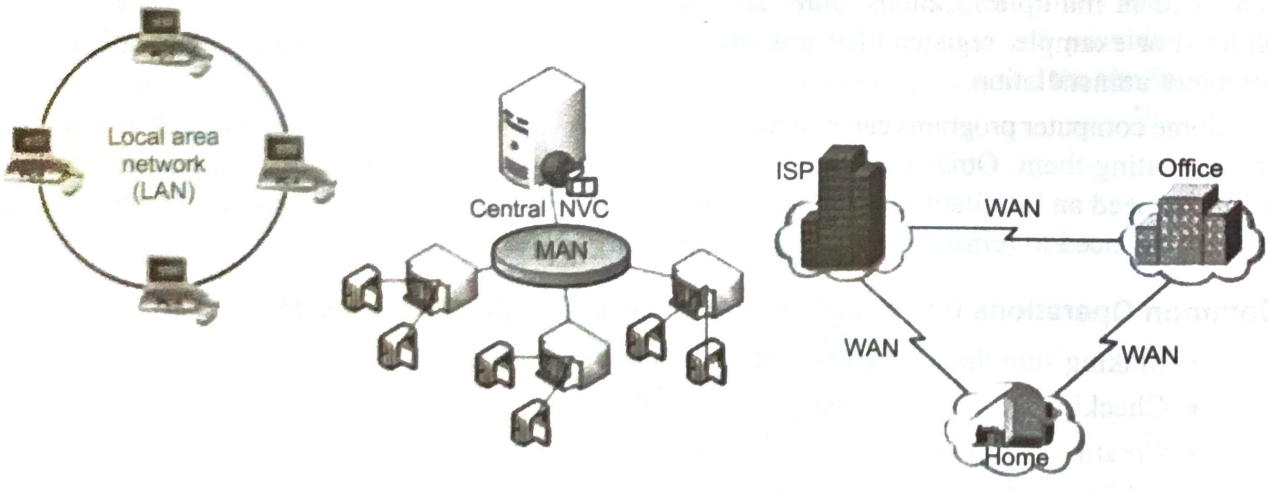


Fig. 8.8 Define LAN, MAN and WAN.

➢ EXPLAIN VARIOUS NETWORK DEVICES LIKE HUB, REPEATER, BRIDGE, SWITCH, ROUTER, GATEWAYS ETC.

Repeater

A repeater operates at the physical layer.

- Its job is to regenerate the signal over the same network before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network.
- Do not amplify the signal.
- When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength.
- It is a 2 port device.

Hub

A hub is basically a multiport repeater.

- Connects multiple wires coming from different branches, for example, the connector in star topology which connects different stations. Hubs cannot filter data, so data packets are sent to all connected devices.
- Collision domain of all hosts connected through Hub remains one.
- Do not have intelligence to find out best path for data packets which leads to inefficiencies and wastage.

Types of Hub

- **Active Hub:** These are the hubs which have their own power supply and can clean , boost and relay the signal along the network. It serves both as a repeater as well as wiring center.
- used to extend maximum distance between nodes.
- **Passive Hub:** These are the hubs which collect wiring from nodes and power supply from active hub.
- Relay signals onto the network without cleaning and boosting them and can't be used to extend distance between nodes.

Bridge

A bridge operates at data link layer.

- Bridge is a repeater, with add on functionality of filtering content by reading the MAC addresses of source and destination. It is also used for interconnecting two LANs working on the same protocol. It has a single input and single output port, thus making it a 2 port device.

Types of Bridges

- **Transparent Bridges:** These are the bridge in which the stations are completely unaware of the bridge's existence i.e. whether or not a bridge is added or deleted from the network , reconfiguration of the stations is unnecessary.
- Bridges makes use of two processes i.e. bridge forwarding and bridge learning.

- **Source Routing Bridges:** Routing operation is performed by source station and the frame specifies which route to follow:

Switch

A switch is a multi port bridge with a buffer and a design that can boost its efficiency.

- Data link layer device.
- Perform error checking before forwarding data, that makes it very efficient as it does not forward packets that have errors and forward good packets selectively to correct port only.

Routers

A router is a device like a switch that routes data packets based on their IP addresses.

- **Network Layer device:** connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets.

Gateway

A gateway is a passage to connect two networks together that may work upon different networking models.

- They basically works as the messenger agents that take data from one system, interpret it, and transfer it to another system.
- Protocol converters and can operate at any network layer.
- More complex than switch or router.

➢ WHAT IS THE DIFFERENCE BETWEEN THE INTERNET, INTRANET AND EXTRANET?

Parameter	*Internet*	*Intranet*	*Extranet*
Type of network	Public	Private	Private/VPN
Size	Large number of connected devices	Limited number of connected devices	Limited number of connected devices over internet
Security	Depends on the device connected to the device	Firewall protected	Firewall separates internet and extranet
Policy	Internet Communication Protocols	Organizational Policies	Organizational policies, contractual policies and internet policies
Assessibility	Anyone	Authorized people	Authorized people
Information sharing	Information can be shared across the world	Information can be shared securely within an Organization	Information can be shared between employees and external people
Owner	Not owned by anyone		Owned by one or more Organizations
Example	World Wide Web, Email, Chat, Social Media		Network of Collaboration between two Corporations

➢ WHAT IS A SOCIAL NETWORKING SITE. NAME SOME SOCIAL NETWORKING SITES

A **social networking** service (**social networking site**, SNS or **social** media) is an online platform which people use to build **social networks** or **social** relations with other people who share similar personal or career interests, activities, backgrounds or real-life connections.

- Facebook. This is the biggest **social media network** on the Internet, both in terms of total number of users and name recognition.
- Twitter.
- LinkedIn.
- Google+
- Pinterest.
- Instagram.

➢ WHAT IS A MODEM? WHAT IS THE ROLE OF MODEM IN ACCESSING THE INTERNET?

A **modem** (modulator–demodulator) is a network hardware device that modulates one or more carrier wave signals to encode digital information for transmission and demodulates signals to decode the transmitted information.

- Modem is short for Modulator/Demodulator.
- Hardware component that allows a computer or other device, such as a router or switch, to connect to the Internet.
- Converts or "modulates" an analog signal from a telephone or cable wire to a digital signal that a computer can recognize.
- Converts outgoing digital data from a computer or other device to an analog signal.
- Modern modems are typically DSL or cable modems, which are considered "broadband" devices.
- DSL modems operate over standard telephone lines, but use a wider frequency range.
- Allows for higher data transfer rates than dial-up modems and enables them to not interfere with phone calls. Cable modems send and receive data over standard cable television lines, which are typically coaxial cables.
- Most modern cable modems support DOCSIS (Data Over Cable Service Interface Specification), which provides an efficient way of transmitting TV, cable Internet, and digital phone signals over the same cable line.

➢ WHAT IS A WEB BROWSER?

A web browser is a software program that allows a user to locate, access, and display web pages

- Primarily for displaying and accessing websites on the internet, as well as other content created using languages such as Hypertext Markup Language (HTML) and Extensible Markup Language (XML).
- Browsers translate web pages and websites delivered using Hypertext Transfer Protocol (HTTP) into human-readable content.

- Have the ability to display other protocols and prefixes, such as secure HTTP (HTTPS), File Transfer Protocol (FTP), email handling (mailto:), and files (file:).
- Also support external plug-ins required to display active content, such as in-page video, audio and game content. Variety of web browsers are available with different features, and are designed to run on different operating systems.
- Common browsers include Internet Explorer from Microsoft, Firefox from Mozilla, Google Chrome, Safari from Apple, and Opera.

➢ WHAT DO YOU MEAN BY URL, URI, URN WWW, FTP, HTTP, RDC, TELNET, E-MAIL, MAC ADDRESS, IP ADDRESS?

- Uniform Resource Identifier (URI) is a string of characters used to identify a name or a resource on the Internet.
- URI identifies a resource either by location, or a name, or both. **A URI has two specializations known as URL and URN**.
- Uniform Resource Locator (URL) is a subset of the Uniform Resource Identifier (URI) that specifies where an identified resource is available and the mechanism for retrieving it.
- URL defines how the resource can be obtained.
- Uniform Resource Name (URN) is a Uniform Resource Identifier (URI) that uses the URN scheme, and **does not imply availability of the identified resource**.
- Both URNs (names) and URLs (locators) are URIs, and a particular URI may be both a name and a locator at the same time.
- The URNs are part of a larger Internet information architecture which is composed of URNs, URCs and URLs.
- URI stands for Uniform Resource Identifier. URI is a text which is used to identify any resource or name on Internet. URI has two specializations in the form of URL (Uniform Resource Locator) and URN (Uniform Resource Name) to identify resource and name.
- URL standards for Uniform resource locator and it is a subset of URI or Uniform Resource Identifier. URL includes location as well as the protocol to retrieve the resource.
  - Every URL and URN is URI because URI is the superset of both URL and URN.
  - URL includes protocol e.g. http://, ftp:// along with location to identify resource e.g. http://www.blogspot.com/abc.html.
  - URN are the unambiguous way to identify a resource. ISBN numbers are best examples of URN.

WWW

The Web, or World Wide Web (W3), is basically a system of Internet servers that support specially formatted documents. The documents are formatted in a markup language called HTML (*HyperText Markup Language*) that supports links to other documents, as well as graphics, audio, and video files.

This means you can jump from one document to another simply by clicking on hot spots. Not all Internet servers are part of the World Wide Web.

FTP

File Transfer Protocol (FTP) is a client/server protocol used for transferring files to or exchanging files with a host computer.

- It may be authenticated with user names and passwords.
- FTP is a protocol designed for transferring files over the Internet.
- Files stored on an FTP server can be accessed using an FTP client, such as a web browser, FTP software program, or a command line interface.
- An FTP server can be configured to enable different types of access.

HTTP

HTTP means ***HyperText Transfer Protocol.*** HTTP is the underlying protocol used by the World Wide Web and this protocol defines how messages are formatted and transmitted, and what actions.

- Web servers and browsers should take in response to various commands. For example, when you enter a URL in your browser, this actually sends an HTTP command to the Web server directing it to fetch and transmit the requested Web page.
- Other main standard that controls how the World Wide Web works is HTML, which covers how Web pages are formatted and displayed.
- HTTP is an application layer protocol in TCP/IP suite used for transfer files that make up the web pages from the web servers.
- These transfers are done in plain text and an intruder can easily read the data packets exchanged between the server and a client.
- ***HTTP*** (Hypertext Transfer Protocol) is the set of rules for transferring files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web.
- As soon as a Web user opens their Web browser, the user is indirectly making use of ***HTTP***.

RDC

Remote Desktop Connection (RDC) is a Microsoft technology that allows a local computer to connect to and control a remote PC over a network or the Internet.

- Done through a Remote Desktop Service (RDS) or a terminal service that uses the company's proprietary Remote Desktop Protocol (RDP). RDC requires the remote computer to enable the RDS and to be powered on.
- Connection is established when a local computer requests connection to a remote computer using an RDC-enabled software.
- On authentication, the local computer has full or restricted access to the remote computer. Besides desktop computers, servers and laptops, RDC also supports connecting to virtual machines.

TELNET

Telnet is a protocol used on the Internet or local area network to provide a bidirectional interactive text-oriented communication facility using a virtual terminal connection.

- Telnet is a user command and an underlying TCP/IP protocol for accessing remote computers. Through Telnet, an administrator or another user can access someone else's computer remotely.
- On the Web, HTTP and FTP protocols allow you to request specific files from remote computers, but not to actually be logged on as a user of that computer.

E-MAIL

E-mail (***electronic mail***) is the exchange of computer-stored messages by telecommunication.

- Electronic mail (email) is a digital mechanism for exchanging messages through Internet or intranet communication.
- Allows you to send and receive messages to and from anyone with an ***email*** address, anywhere in the world.
- Uses multiple protocols within the TCP/IP suite.
- Means or system for transmitting messages electronically (as between computers on a network)

MAC ADDRESS

A media access control **address** (**MAC address**) of a device is a unique identifier assigned to a network interface controller (NIC) for communications at the data link layer of a network segment.

- **MAC addresses** are used as a network **address** for most IEEE 802 network technologies, including Ethernet and Wi-Fi. In a local area network (LAN) or other network, the MAC (Media Access Control) address is your computer's unique hardware number.
- ***MAC address*** is a hardware identification number that uniquely identifies each device on a network.

IP ADDRESS

An Internet Protocol ***address*** (***IP address***) is a numerical label assigned to each device connected to a computer network that uses the Internet Protocol for communication.

- An ***IP address*** serves two principal functions: host or network interface identification and location addressing.
- An ***IP address*** is an identifier for a computer or device on a TCP/***IP*** network. Networks using the TCP/***IP*** protocol route messages based on the ***IP address*** of the destination.

DNS

The Domain Name System (DNS) is the phonebook of the Internet. Humans access information online through domain names, like nytimes.com or espn.com.

- Web browsers interact through Internet Protocol (IP) addresses. DNS translates domain names to IP addresses so browsers can load Internet resources.
- The process of DNS resolution involves converting a hostname (such as www.kaumdi.com) into a computer-friendly IP address (such as 458.646.2.3).
- An IP address is given to each device on the Internet, and that address is necessary to find the appropriate Internet device.
- Domain Name System (DNS) is used to resolve host domain names to IP addresses.
- Network users depend on DNS functionality mainly during browsing the Internet by typing a URL in the web browser.

➢ WHAT DO YOU MEAN BY INTERNET SECURITY? WHAT ARE FIREWALL AND CLOUD COMPUTING?

In modern times, organizations greatly rely on computer networks to share information throughout the organization in an efficient and productive manner and their network consists of thousands of work stations.

- These workstations on company network are directly connected to the Internet.
- This sort of unsecured network becomes a target for an attack which holds valuable information and displays vulnerabilities.
- A network is defined as two or more computing devices connected together for sharing resources efficiently. Further, connecting two or more networks together is known as **internetworking**. Thus, the Internet is just a collection of interconnected networks.

  Firewall is a barrier between Local Area Network (LAN) and the Internet. It allows keeping private resources confidential and minimizes the security risks. It controls network traffic, in both directions.
- Firewall management must be addressed by both system managers and the network managers.
- The amount of filtering a firewall varies. For the same firewall, the amount of filtering may be different in different directions.

  Cloud Computing provides us means by which we can access the applications as utilities over the internet. It allows us to create, configure, and customize the business applications online.
- **Cloud** means a **Network** or **Internet or** something, which is present at remote location. Cloud can provide services over public and private networks, i.e., WAN, LAN or VPN.
- Applications such as e-mail, web conferencing, customer relationship management (CRM) execute on cloud.

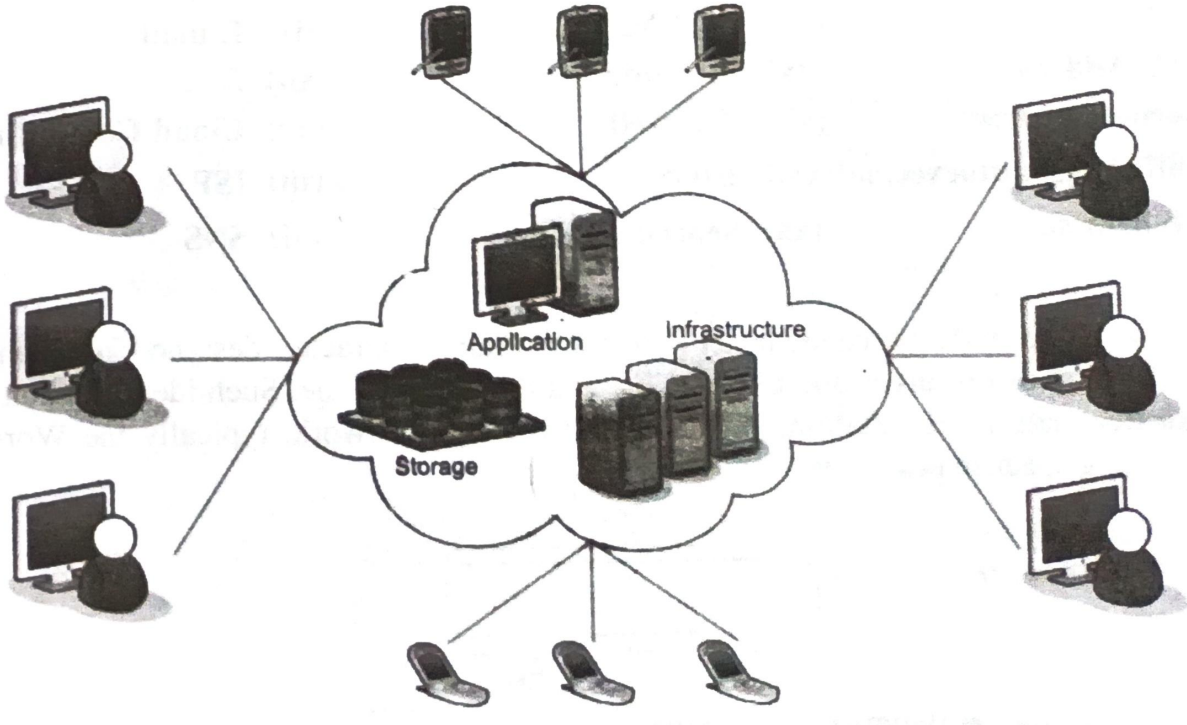


Fig. 8.9

- Cloud Computing refers to **manipulating, configuring,** and **accessing** the hardware and software resources remotely.
- Offers online data storage, infrastructure, and application.
- Offers **platform independency,** as the software is not required to be installed locally on the PC.
- Making our business applications **mobile** and **collaborative.**

Advantages

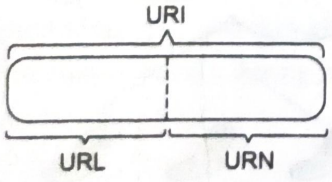
- Access applications as utilities, over the Internet.
- Manipulate and configure the applications online at any time.
- It does not require to install a software to access or manipulate cloud application.
- Offers online development and deployment tools, programming runtime environment through **PaaS model.**
- Offers on-demand self-service
- Highly cost effective because it operates at high efficiency with optimum utilization. It just requires an Internet connection
- Offers load balancing that makes it more reliable.
- Resources are available over the network in a manner that provide platform independent access to any type of clients.

Q. Define following terminology.

(i) URI	**(ii) URL**	**(iii) URN**
(iv) www	**(v) FTP**	**(vi) http**
(vii) RDC	**(viii) TELNET**	**(ix) E-mail**
(x) MAC Address	**(xi) IP Address**	**(xii) DNS**
(xiii) Internet Security	**(xiv) Firewell**	**(xv) Cloud Computing**
(xvi) Config.sys व autoexec.bat	**(xvii) BIOS**	**(xviii) ISP**
(xix) Web browser	**(xx) Search engines**	**(xxi) SNS**

Ans.

(i) **URI**—A Uniform Resource Identifier (URI) is a string of characters designed for unambiguous identification of resources and extensibility via the URI scheme. Such identification enables interaction with representations of the resource over a network, typically the World Wide Web, using specific protocols.



(ii) **URL**—A Uniform Resource Locator (URL), colloquially termed a web address,[1] is a reference to a web resource that specifies its location on a computer network and a mechanism for

retrieving it. A URL is a specific type of Uniform Resource Identifier (URI), although many people use the two terms interchangeably. URLs occur most commonly to reference web pages (http), but are also used for file transfer (ftp), email (mailto), database access (JDBC), and many other applications.

(iii) **URN**—A uniform resource name (URN) is an Internet resource with a static name that remains valid even if its data is moved to another location.

(iv) **www**—The World Wide Web (WWW) is combination of all resources and users on the Internet that are using the Hypertext Transfer Protocol (HTTP). A broader definition comes from the World Wide Web Consortium (W3C): "The World Wide Web is the universe of network-accessible information, an embodiment of human knowledge."

(v) **FTP**—File Transfer Protocol (FTP) is a standard Internet protocol for transmitting files between computers on the Internet over TCP/IP connections.

(vi) **http**—HTTP means HyperText Transfer Protocol. HTTP is the underlying protocol used by the World Wide Web and this protocol defines how messages are formatted and transmitted, and what actions Web servers and browsers should take in response to various commands.

(vii) **RDC**—Remote desktop is a program or an operating system feature that allows a user to connect to a computer in another location, see that computer's desktop and interact with it as if it were local.

(viii) **TELNET**—a network protocol that allows a user on one computer to log into another computer that is part of the same network.

(ix) **E-mail**—Electronic mail (email or e-mail) is a method of exchanging messages ("mail") between people using electronic devices.

(x) **MAC Address**—Stands for "Media Access Control Address," and no, it is not related Apple Macintosh computers. A MAC address is a hardware identification number that uniquely identifies each device on a network.

(xi) **IP Address**—a unique string of numbers separated by full stops that identifies each computer using the Internet Protocol to communicate over a network.

(xii) **DNS**—(Domain Name System) The Internet's system for converting alphabetic names into numeric IP addresses. For example, when a Web address (URL) is typed into a browser, DNS servers return the IP address of the Web server associated with that name.

(xiii) **Internet Security**—a process to create rules and actions to take to protect against attacks over the Internet. An example of Internet security is an online system that prevents credit card numbers from being stolen on a shopping website.

(xiv) **Firewall**—In computing, a firewall is a network security system that monitors and controls incoming and outgoing network traffic based on predetermined security rules. A firewall typically establishes a barrier between a trusted internal network and untrusted external network, such as the Internet.

(xv) **Cloud**—The word "cloud" often refers to the Internet, and more precisely to some datacenter full of servers that is connected to the Internet. However, the term "cloud computing" refers to the software and services that have enabled the Internet cloud to become so prominent in everyday life (see cloud computing).

(xvi) **Config.sys**—DOS CONFIG.SYS CONFIG.SYS is a configuration file made up of DOS commands that DOS looks for in the root directory upon startup. It is used to load drivers and change system settings. ... Any word processor that can import and export ASCII files can also be used.

(xvii) **BIOS**—BIOS is non-volatile firmware used to perform hardware initialization during the booting process, and to provide runtime services for operating systems and programs. The BIOS firmware comes pre-installed on a personal computer's system board, and it is the first software to run when powered on.

(xviii) **ISP**—An Internet service provider (ISP) is an organization that provides services for accessing, using, or participating in the Internet. Internet service providers may be organized in various forms, such as commercial, community-owned, non-profit, or otherwise privately owned.

(xix) **Web browser**—A web browser (commonly referred to as a browser) is a software application for accessing information on the World Wide Web. ... The most popular web browsers are Chrome, Firefox, Safari, Internet Explorer, and Edge.

(xx) **Search Engine**—a program that searches for and identifies items in a database that correspond to keywords or characters specified by the user, used especially for finding particular sites on the World Wide Web.

(xxi) **SNS**—A social networking service (also social networking site, or SNS or social media) is an online platform which people use to build social networks or social relations with other people who share similar personal or career interests, activities, backgrounds or real-life connections. For Example: Facebook, Twitter, Instagram, Youtube, Flickr, WhatsApp, Skype, LinkedIn etc.

❑❑❑

(ODD SEMESTER) DECEMBER-2018 EXAMINATION

FUNDAMENTALS OF COMPUTER AND INFORMATION TECHNOLOGY

[Time : 2:30 Hours] **[Maximum Marks : 50]**

Notes: Attempt **all** questions.

1. Answer any **three** of the following: **[3 × 5 = 15]**

(a) Explain history of Computer. Define Computer generation.

(b) Draw the block diagram of computer. Explain different components of computer.

(c) Explain the following:

(i) Types of Printer (ii) Types of Memory

(d) Explain any two storage devices.

2. Answer any **two** of the following: **[2 × 5 = 10]**

(a) Differentiate between data and information.

(b) Write note on Number system. Convert the following binary number in to Hexadecimal Number.

(c) What is memory addressing? Write its importance.

3. Answer any **two** of the following: **[2 × 2½ = 5]**

(a) What is need of operating system.

(b) Explain wild cards. Write functions of window.

(c) What do you mean by files and directories.

4. Answer any **two** of the following: **[2 × 5 = 10]**

(a) What do you mean by disk defragmentation? Write the purpose of control panel.

(b) Explain the following DOS commands.

(i) Cat (ii) Type (iii) MD (iv) CD (v) Copy

(c) What is BIOS? Differentiate between linker and loader.

5. Write Note on any **two** of the following: **[2 × 5 = 10]**

(a) Networking devices

(b) E-mail and Web browser software

(c) DNS

(ODD SEMESTER) DECEMBER-2019 EXAMINATION

FUNDAMENTALS OF COMPUTER AND INFORMATION TECHNOLOGY

[Time : 2:30 Hours] **[Maximum Marks : 50]**

Notes: Attempt **all** questions.

1. Answer any **two** of the following: **[2 × 5 = 10]**
   (a) What is computer? Explain the architecture of computer using block diagram.
   (b) Differentiate between RAM and ROM in detail.
   (c) List Input and Output devices of computer system. Explain their roles.

2. Answer any **two** of the following: **[2 × 5 = 10]**
   (a) Write short notes on the following:
   (i) Pen drive (ii) Processor
   (iii) Network Card
   (b) What is Modem? What is its role with computer?
   (c) Differentiate between "Data" and "Information". How data communication is done between two computers?

3. Answer any **two** of the following: **[2 × 5 = 10]**
   (a) List the Number System's used with computer. Show data conversion from Decimal to these Number System's with an example.
   (b) What is Memory Addressing? What are different types of memory addressing?
   (c) How character's are represented in computer memory? Explain with example.

4. Answer any **two** of the following: **[2 × 5 = 10]**
   (a) What is operating system? Explain its need and write names of some available operating systems.
   (b) What are the system utilities that exists in ''Windows Operating System''? Explain them.
   (c) Explain the terms ''Directories'', ''Files'' and ''Folders''.

5. Answer any two of the following: **[2 × 5 = 10]**
   (a) What is Network? Explain different network topologies.
   (b) What is IP Address? How is this different from MAC address? Explain.
   (c) List the devices used in Networking. Explain roles of any 3 devices.

(ODD SEMESTER) MARCH-2021 EXAMINATION

FUNDAMENTALS OF COMPUTER AND INFORMATION TECHNOLOGY

[Time : 2:30 Hours] **[Maximum Marks : 50]**

Notes: Attempt **all** questions.

1. Answer any **two** of the following: **[2 × 5 = 10]**

(a) Comment on the generations of computer. Also list various applications of compter.

(b) What are the different perfomance parameters which gives the difference of two computers? Explain.

(c) Briefly describe monitor and its types, with their characteristics.

2. Answer any **two** of the following: **[2 × 5 = 10]**

(a) Write short notes on the following:
(i) Input and output devices (ii) RAM and ROM

(b) What are the storage devices? Give thier detailed classification.

(c) What do you mean by Number system? Which number system's are used in computers? Explain.

3. Answer any **two** of the following: **[2 × 5 = 10]**

(a) How many different ways memory can be addressed or accessed? Explain the siginificance of each.

(b) What is software? What is the difference between 'Application' and 'System' softwares? List softwares in each category.

(c) What is BIOS? Explain its role and working.

4. Answer any **two** of the following: **[2 × 5 = 10]**

(a) List the functions of operating System. Explain them.

(b) Explain the term "CUI", "GUI" and "Desktop".

(c) What is control Panel? What is it used for? Explain.

5. Answer any two of the following: **[2 × 5 = 10]**

(a) Compare LAN, MAN and WAN for their scope and operation.

(b) What is Web Browser? Explain its use, and mention names of any five browsers.

(c) What is Portocol? Write short notes on "FTP" and "Telnet"

Fundamentals of Computer and Information Technology *(With Practicals)*

Once upon a time, a daughter told her father that her life was miserable. She was tired of struggling all the time. As one problem was solved, another one was ready. Her father, a chef, took her to the kitchen. He filled three vessels with water and placed each on fire.

As the three vessels started boiling, he placed potatoes in the first vessel, eggs in the second and ground coffee beans in the third. He then let them boil for sometime. The daughter sat quietly but impatiently waiting, wondering what was happening. After thirty minutes, he turned off the fire. He took the potatoes and eggs in a bowl and the coffee in a cup. Then, he asked her daughter, what she noticed. The daughter shook her head.

He said, "Touch the potatoes." She did and noted that they were soft. Also, she observed the hard-boiled egg. Then, she sipped the coffee. Its rich aroma brought a smile to her face.

"Papa, what does this mean?" she asked.

He then explained, "Beta, the potatoes, the eggs and coffee beans had each faced the same adversity i.e. the boiling water. However, each one reacted in a different way to this tough time. The potatoes went in strong and hard, but in boiling water, they became softer and weaker. The egg was fragile, soft and weak, with the thin outer shell protecting its delicate liquid interior. In the boiling water, the inside of the egg became hard. However, the behaviour of ground coffee beans were unique. After being exposed to the boiling water, they changed the water and created something different.

"Beta, Which one of the three will be your reaction when tough time comes to you?" he asked his daughter. "When adversity tests you, how will you respond?"

He then explained, "Beta, Don't quit when you encounter an obstacle. Adapt a new strategy to conquer it. The harder you fall, the stronger you rise. The gem cannot be polished without friction, nor man can rise in the life without trials."

"Mushkilon se bhaag jaana aasan hota hai,
Har pahlu zindagi ka imtihaan hota hai,
darne waalon ko milta nahi kuchh zindagi mein,
ladne waalon ke qadmon mein jahan hota hai"

With best wishes for success,

RAHUL WADHWA