

**GOVERNMENT OF TAMILNADU
DIRECTORATE OF TECHNICAL EDUCATION
CHENNAI – 600 025**

STATE PROJECT COORDINATION UNIT

**Diploma in Electronics and Communication
Engineering**

Course Code: 1040

M – Scheme

**e-TEXTBOOK
on
COMPUTER HARDWARE SERVICING AND
NETWORKING
for
VI Semester DECE**

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**34061- COMPUTER HARDWARE SERVICING AND NETWORKING
DETAILED SYLLABUS**

UNIT	NAME OF THE TOPIC	HOURS
I	<p><u>MOTHERBOARD COMPONENTS AND MEMORY STORAGE DEVICES</u></p> <p>Introduction: Hardware, Software and Firmware. Mother board, IO and memory expansion slots, SMPS, Drives, front panel and rear panel connectors.</p> <p>Processors: Architecture and block diagram of multicore Processor, Features of new processor(Definition only)-chipsets (Concepts only).</p> <p>Bus Standards: Overview and features of PCI, AGP, PCMCIA</p> <p>Primary Memory: Introduction-Main Memory, Cache memory – DDR2, DDR3 and Direct RDRAM.</p> <p>Secondary Storage: Hard Disk – Construction – Working Principle Specification of IDE, Ultra ATA, Serial ATA; HDD Partition - Formatting.</p> <p>Removable Storage: CD-R,CD-RW,DVD –ROM and DVD –RW: construction and reading & writing operations; Blue-ray – Introduction –Disc Parameters.</p>	16
II	<p><u>I/O DEVICES AND INTERFACE</u></p> <p>Keyboard: Signals – operation of membrane and mechanical keyboards–troubleshooting; wireless Keyboard.</p> <p>Mouse: types, connectors, operation of Optical mouse and Troubleshooting.</p> <p>Printers: Introduction – Types of printers- Dot Matrix, Inkjet Laser, MFP (Multi Function Printer) and Thermal printer – Operation, Construction and Features-Troubleshooting.</p> <p>I/O Ports: Serial, Parallel, USB, Game Port and HDMI.</p> <p>Displays: Principles of LED, LCD and TFT Displays.</p> <p>Graphic Cards: VGA and SVGA card.</p> <p>Modem: Working principle.</p> <p>Power Supply: Servo Stabilizers, online and offline UPS - working principles; SMPS: Principles of Operation and block diagram of ATX Power supply, Connector Specifications.</p>	16
III	<p><u>MAINTENANCE AND TROUBLE SHOOTING OF DESKTOP AND LAPTOPS</u></p> <p>Bios-setup: Standard CMOS setup, Advanced BIOS setup, Power management, advanced chipset features, PC Bios communication – upgrading BIOS, Flash BIOS -setup.</p> <p>POST: Definition – IPL hardware – POST Test sequence – beep codes.</p> <p>Diagnostic Software and Viruses: Computer Viruses – Precautions –Anti-virus Software – identifying the signature of viruses – Firewalls and latest diagnostic softwares.</p> <p>Laptop: Types of laptop –block diagram – working principles– configuring laptops and power settings -SMD components, ESD and precautions.</p>	16

	Laptop components: Adapter – types, Battery – types, Laptop Mother Board - block diagram, Laptop Keyboard and Touchpad . Installation and Troubleshooting: Formatting, Partitioning and Installation of OS – Trouble Shooting Laptop Hardware problems - Preventive maintenance techniques for laptops.	
IV	<u>COMPUTER NETWORK DEVICES AND OSI LAYERS</u> Data Communication: Components of a data communication. Data flow: simplex – half duplex – full duplex; Topologies: Star, Bus, Ring, Mesh, Hybrid – Advantages and Disadvantages of each topology. Networks: Definition -Types of Networks: LAN – MAN – WAN – CAN – HAN – Internet –Intranet –Extranet, Client-Server, Peer To Peer Networks. Network devices: Features and concepts of Switches – Routers(Wired and Wireless) – Gateways. Network Models: Protocol definition - standards - OSI Model – layered architecture – functions of all layers.	16
V	<u>802.X AND TCP/IP PROTOCOLS</u> Overview of TCP / IP: TCP/IP – Transport Layers Protocol – connection oriented and connectionless Services – Sockets - TCP & UDP. 802.X Protocols : Concepts and PDU format of CSMA/CD (802.3) – Token bus (802.4) – Token ring (802.5) – Ethernet – type of Ethernet (Fast Ethernet, gigabit Ethernet) – Comparison between 802.3, 802.4 and 802.5 Network Layers Protocol: IP –Interior Gateway Protocols (IGMP, ICMP, ARP, RARP Concept only). IP Addressing : Dotted Decimal Notation – Subnetting&Supernetting. Application Layer Protocols: FTP– Telnet – SMTP– HTTP – DNS –pop	16
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TEXT BOOKS:

1. IBM PC and CLONES, B.Govindrajalu, Tata McGrawhill Publishers, IBM PC and CLONES.
2. Computer Installation and Servicing, D.Balasubramanian, Tata McGraw Hill.
3. Computer Installation and Servicing.
4. The complete PC upgrade and Maintenance, Mark Minasi, BPB Publication, The complete PC upgrade and Maintenance.
5. Troubleshooting, Maintaining and Repairing PCs, Stephen J Bigelow ,Tata MCGraw Hill Publication ,Troubleshooting Maintaining and Repairing PCs.
6. Upgrading and repairing laptops, Scott Mueller, QUE Publication, Upgrading and repairing laptops.
7. Data Communication and networking, BehrouzA.Forouzan, Tata Mc-Graw Hill, New Delhi.

8. Data and Computer Communications, William Stallings, Prentice-Hall of India, Eighth Edition.
9. Computer Networks, Andrew S.Tanenbaum, Prentice-Hall of India, New Delhi.

REFERENCE BOOKS:

1. Computer Networks,AchyutGodbole,TataMc-Graw Hill -New Delhi.
2. Principles of Wireless Networks– A unified Approach, Kaveh Pahlavan and PrashantKrishnamurty, Pearson Education, 2002.

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UNIT – I

MOTHERBOARD COMPONENTS AND MEMORY STORAGE DEVICES

1.1 Introduction

1.1.1 Hardware

Computer hardware is the collection of physical components that constitute a computer system. Examples of hardware which is used in computer,

1. Monitor
2. Keyboard
3. Computer Data Storage
4. Hard Disk Drive (HDD)
5. Graphic Card
6. Sound Card
7. Memory (RAM)
8. Motherboard

Below is a list of **external hardware** and **internal hardware** and the categories of hardware that may be found with a computer

External hardware examples

- Flat-panel, Monitor, and LCD
- Keyboard
- Microphone
- Mouse
- Printer
- Projector
- Scanner
- Speakers
- USB thumb drive

Internal hardware examples

- Processor (CPU)
- Drive (e.g. Blu-ray, CD-ROM, DVD, floppy drive, hard drive, and SSD)
- Fan (heat sink)
- Modem
- Motherboard
- Network card
- RAM
- Sound card
- Video card

1.1.2 SOFTWARE

Software is a collection of instructions that enable the user to interact with a computer, its hardware, or perform tasks.

Software is often divided into two categories.

1. Systems software : It includes the operating system and all the utilities that enable the computer to function.

For Example: Windows xp/7/8/8.1/10, Ms-DOS, Ubuntu, Apple

2. Applications software : It includes programs that do real work for users.

For example:word processors, spreadsheets.

Difference between Hardware and Software:

Sl. No.	Hardware	Software
1	Physical parts of the computer are called hardware	A set of instructions given to the computer is called software
2	We can see, touch and feel hardware	We cannot touch and feel software
3	Hardware is constructed using physical materials or components	Software is developed by writing instructions in programming language
4	Hardware cannot be transferred from one place to another electronically through network	Software can be transferred from one place to another electronically through network
5	User cannot make new duplicate copies of the hardware	User can make many new duplicate copies of the software

1.1.3 Firmware

Firmware is a software program or set of instructions programmed on a hardware device. It provides the necessary instructions for how the device communicates with the other computer hardware. Firmware is typically stored in the flash ROM of a hardware device. While ROM is "read-only memory," flash ROM can be erased and rewritten because it is actually a type of flash memory.

Example:

Embedded Systems, computers, computer peripherals, mobile phones, and digital cameras.

1.1.4 Motherboard

A motherboard is one of the most essential parts of a computer system. It is also called as **printed circuit board, system board, baseboard, planar board** or **logic board**. The large PCB of a motherboard may include 6 -14 layers of fiberglass, copper connecting traces and copper planes for power and signal isolation. Additional components can be added to a motherboard through its expansion slots.

Here are some of the typical parts:

- A CPU socket - the actual CPU is directly soldered onto the socket. Since high speed CPUs generate a lot of heat, there are heat sinks and mounting points for fans right next to the CPU socket.
- A power connector to distribute power to the CPU and other components.
- Slots for the system's main memory, typically in the form of DRAM chips.
- A chip forms an interface between the CPU, the main memory and other components. On many types of motherboards, this is referred to as the Northbridge. This chip also contains a large heat sink.
- A second chip controls the input and output (I/O) functions. It is not connected directly to the CPU but to the Northbridge. This I/O controller is referred to as the Southbridge. The Northbridge and Southbridge combined are referred to as the *chipset*.
- Several connectors, which provide the physical interface between input and output devices and the motherboard. The Southbridge handles these connections.

- Slots for one or more hard drives to store files. The most common types of connections are Integrated Drive Electronics (IDE) and Serial Advanced Technology Attachment (SATA).
- A Read-Only Memory (ROM) chip, which contains the firmware, or startup instructions for the computer system. This is also called the BIOS.
- A slot for a video or graphics card. There are a number of different types of slots, including the Accelerated Graphics Port (AGP) and Peripheral Component Interconnect Express (PCIe).
- Additional slots to connect hardware in the form of Peripheral Component Interconnect (PCI) slots
- Additional slots to connect hardware in the form of Peripheral Component Interconnect (PCI) slots

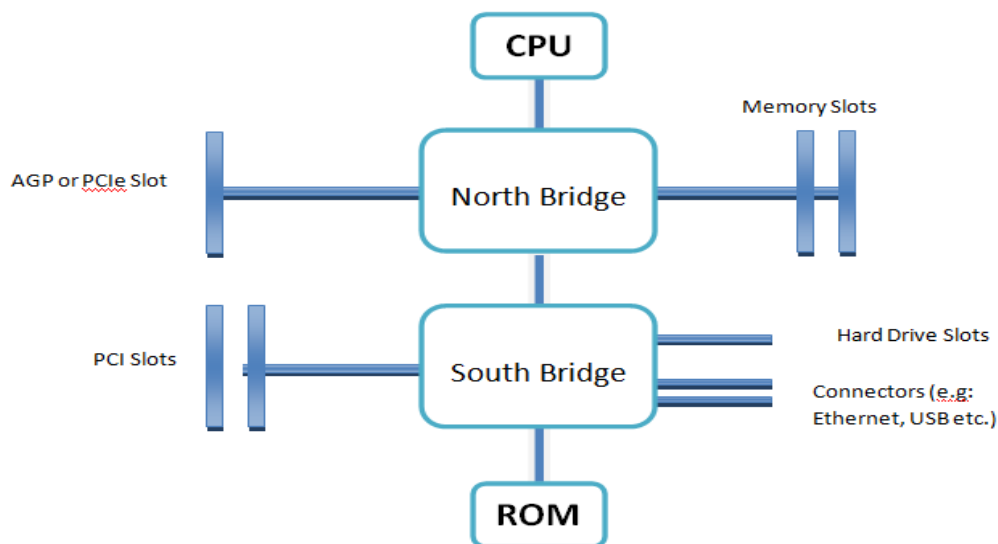


Fig1.1: Schematic Diagram of typical Mother Board

1.1.5 Input Output:

The ports on the outside of a computer are commonly referred to as "I/O ports" because they are the ones that connect input and output devices to the computer. It also refers to as I/O address, I/O ports, and I/O port address, and the input/output port is allows the software drivers to communicate with hardware devices on your computer.

1.1.6 Expansion slots:

Expansion slots provided on the motherboard are used to connect daughter boards. By connecting the necessary daughter boards we can expand the system. The following are the important expansion slots present on the motherboard.

- ISA slot
- VESA slot
- PCI slot

The I/O devices like FDD, HDD, Printers, mouse etc., are connected to the system Using their interface cards connected in the expansion slots. Expansion slots contain 8 bit or 16 bit or 64 bit bidirectional data bus, address lines etc.

Memory:

There are three types of motherboards memory as follows,

- ROM – Read Only Memory
- RAM or Main Memory – Random access memory.
- Cache RAM

1.1.6.1 ROM – Read Only Memory

Once data has been written onto a ROM chip, it cannot be removed and can only be read. Unlike main memory (RAM), ROM retains its contents even when the computer is turned off. ROM is referred to as being nonvolatile, whereas RAM is volatile. Data stored in ROM can only be modified slowly, with difficulty, or not at all, so it is mainly used to store firmware (software that is closely tied to specific hardware, and unlikely to need frequent updates) or application software in plug-in cartridges.

1.1.6.2 RAM – Random Access memory

High Speed memory and it can save the program and data temporarily. Memory chips are generally packaged into a small plastic or ceramic dual inline packages (DIP). Then these are assembled into a memory module. The different memory modules are SIMM, DIMM and RIMM.

1.1.6.3 Cache RAM

This is a small fast memory lying between the CPU and RAM. During execution, the needed data blocks are loaded from RAM to cache. From cache it is transferred to CPU.

1.1.7 SMPS (Switched-Mode Power Supply)

SMPS stands for switch-mode power supply. **SMPS** is a power supply that uses a switching regulator to control and stabilize the output voltage by switching the load current on and off. These power supplies offer a greater power conversion and reduce the overall power loss.

Advantages of switched-mode power supplies

- Higher efficiency of 68% to 90%
- Regulated and reliable outputs regardless of variations in input supply voltage
- Small size and lighter
- Flexible technology
- High power density

Disadvantages

- Generates EMI
- Complex circuit design
- Expensive compared to linear supplies

1.1.8 Drives

A drive is a mechanical device that rotates very fast and has one or more heads to read and write data on to recording medium permanently. There are different types of drives for different types of recording medium. They are

- Floppy drives to access floppy disk.
- Optical drives to access optical disks such as CD, DVD etc.,

- Hard disk drives to access hard disks.

Drives can be either within the computer system or external to the computer system.

1.1.9 Front Panel and rear Panel connectors

The following are the front panel connectors,

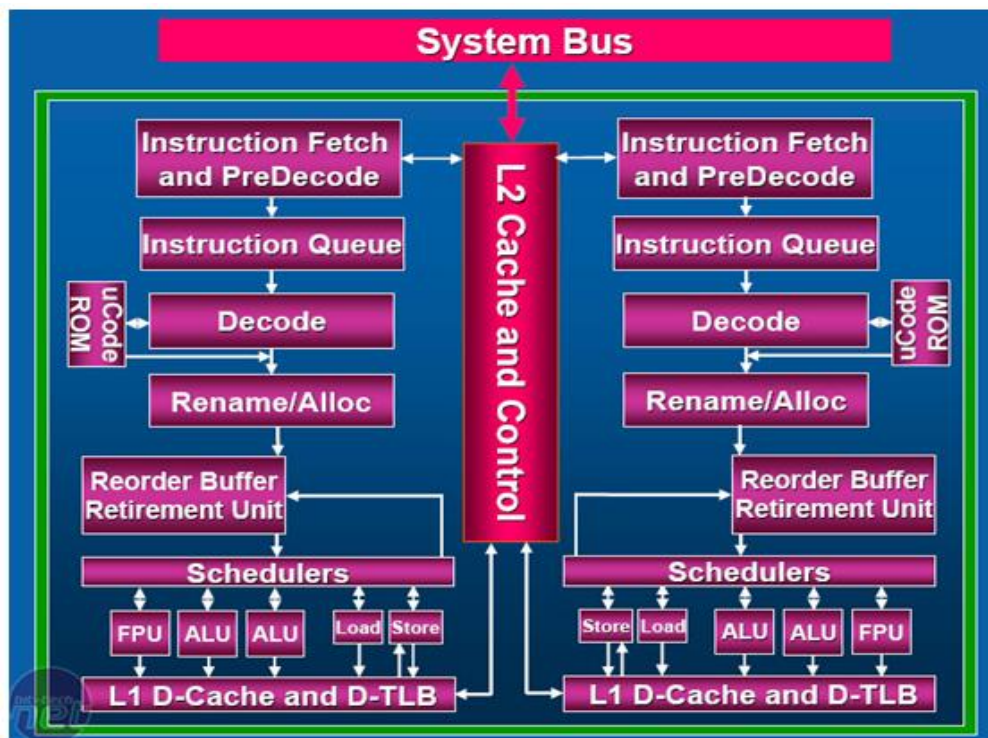
- Audio connector - To connect speaker.
- Mic Connector - To connect microphone
- USB connector - To connect USB devices.

The following are the rear panel connectors

- Keyboard connector - To connect keyboard.
- Serial port connector - To connect serial devices like mouse, modem.
- Parallel port connector- To connect parallel devices like printers, plotters and external Storage devices.
- VGA connector - To connect monitor
- RJ-45 connector - To connect LAN cable.

D1.2 Processors:

1.2.1 Architecture and Block diagram of Multicore Processor



A processor has more than one core to execute all the necessary functions of a computer, its processor is known to be a multi core architecture. In other words, a chip with more than one CPU's (Central Processing Unit)

Multiprocessor memory types.

Examples: 1. Editing a photo while recording a TV show through a digital video recorder
 2. Downloading software while running an anti-virus program

• Shared memory:

In this model, there is one (large) common shared memory for all processors.

• Distributed memory:

- In this model, each processor has its own (small) local memory, and its content is not replicated anywhere else.
- Multicore processor executes a collection of machine instructions.
- ALU (Arithmetic Logic Unit) to perform mathematical operations like addition, subtraction, division, multiplication, shifting etc.
- It moves data from one memory location to another.
- It makes decision and jump to a new set of instructions based on that decision.
- It supports 32 or 64 bit processing.
- Each core has interfaced through System bus and Memory controller.
- It has more than one core with three levels.

1.2.2 FEATURES OF NEW PROCESSORS

Features of new processors are,

- a) Hyper threading
- b) Turbo boost technology
- c) Multicore Technology

a) HYPER THREADING

It is a technique which enables the processor to execute series of instruction allow at the same time. It is used to improve parallelization of computations performed on PC microprocessor. This technique is enables single CPU to act like multiple CPU's. it also enables different parts of the CPU to work on different tasks concurrently.

b) TURBO BOOST TECHNOLOGY

Intel Turbo Boost is a technology implemented by Intel in certain versions of its processors that enables the processor to run above its base operating frequency via dynamic control of the processor's clock rate. The increased clock rate is limited by the processor's power, current and thermal limits, as well as the number of cores currently in use and the maximum frequency of the active cores. Processor generations supporting this feature are based on the Nehalem (Turbo Boost 1.0), Sandy Bridge (Turbo Boost 2.0)

C) MULTICORE TECHNOLOGY

A multi-core processor is a single computing component with two or more independent actual processing units (called "cores"), which are units that read and execute program instructions. The instructions are ordinary CPU instructions such as add, move data, and branch, but the multiple cores can run multiple instructions at the same time, increasing overall speed for programs amenable to parallel computing.

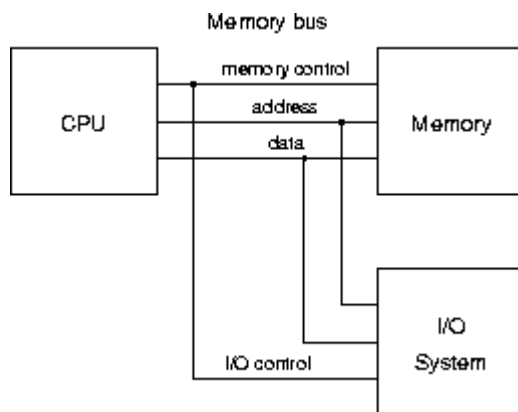
1.2.3 CHIPSET

Chipset is a group of Integrated Circuits that are designed to work together to serve a single function and are usually marketed as a single product. It refers to a set of specialized chips on the motherboard or an expansion card. It refers to a pair of chips on the motherboard – Northbridge and Southbridge. A chipset controls communication between processor and external devices, thus plays an important role in determining system performance.

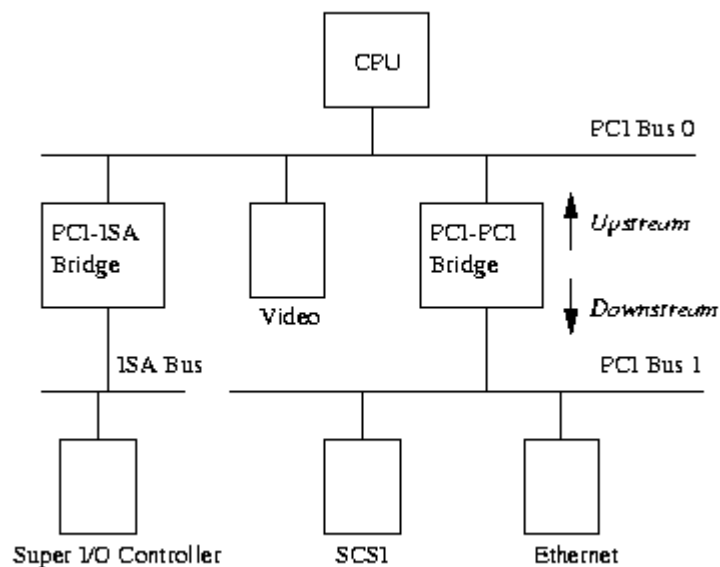
1.3 BUS STANDARDS

A collection of wires through which data is transmitted from one part of a computer to another. All buses consist of two parts : an address bus and a data bus. The data bus transfers actual data whereas the address bus transfers information about where the data should go. The fastest bus is within CPU chip. This connects the processor and its primary cache. The next level is system bus or local bus. This connects processor with main memory and Level 2 cache. The system bus is 64 bits wide and its speed is 100MHz. The next level is I/O bus. This connects the different I/O devices to the CPU.

Bus Structure



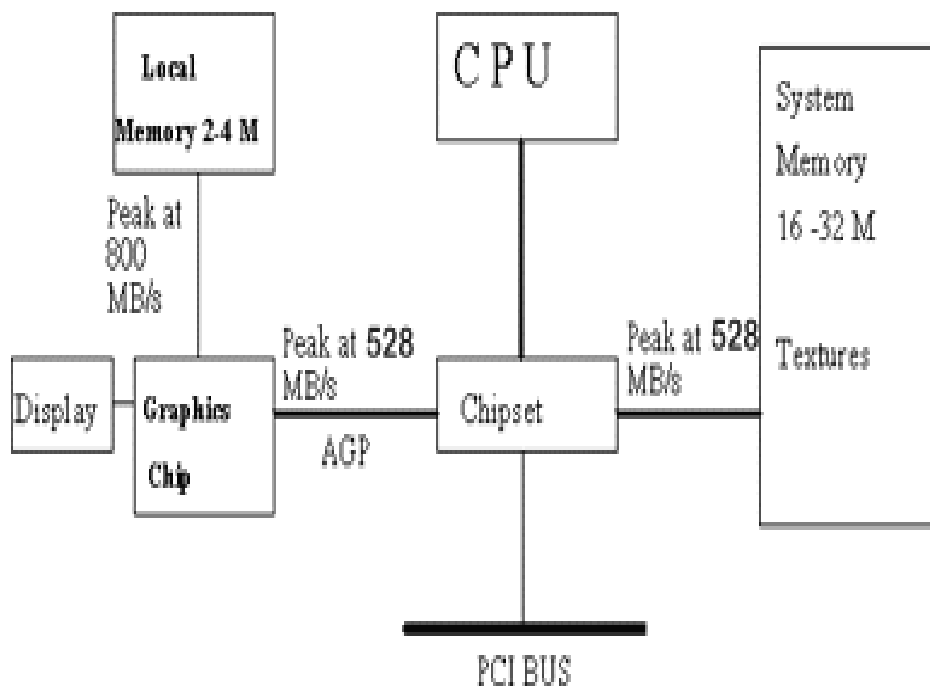
1.3.1 Overview and features of PCI



PCI refers to peripheral component interconnect. This is a special local bus developed by intel. This is used to connect peripheral devices directly with memory. The important features are,

- Support multiple market segments
- It is faster than VL bus
- Backwards compatible
- Scalable performance
- Data transfer rate is 132MBps.
- Advanced features including QoS, power management, and data integrity.
- Its supports different types of add on cards both 32 bit and 64 bit.

1.3.2 Overview and Features of AGP



Block diagram of AGP

Accelerated Graphics Port, an interface specification developed by Intel Corporation. AGP is based on PCI, but is designed especially for the throughput demands of 3-D graphics. Rather than using the PCI bus for graphics data. The features are,

- AGP introduces a dedicated point-to-point channel so that the graphics controller can directly access main memory.
- The AGP channel is 32 bits wide and runs at 66 MHz. This translates into a total bandwidth of 266 MBps, as opposed to the PCI bandwidth of 133 MBps.
- Sideband Addressing: Speeds up data transfers by sending command instructions in a separate, parallel channel.

- AGP supports two optional faster modes, with throughputs of 533 MBps and 1.07 GBps. In addition, AGP allows 3-D textures to be stored in main memory rather than video memory.
- Throughput: Various levels of throughput are offered: 1X is 266 MBps, 2X is 533 MBps and 4X provides 1.07 GBps.
- Pipelining: Enables the graphics card to send several instructions together instead of sending one at a time.

Difference between AGP and PCI

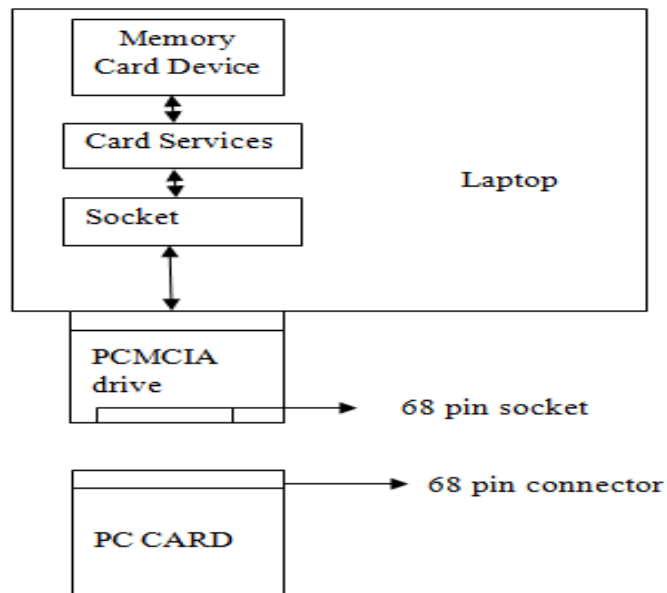
AGP	PCI
AGP is a port connecting nodes	PCI is a bus
AGP is pipelined , requests are executed in parallel	PCI is non pipelined making execution slower
AGP's address /data is demultiplexed	PCI bus's address/ data is multiplexed
AGP does not share BW with other devices	PCI bus shares BW
Peak throughput at 533 MB/s in 32 bits	Peak throughput of 133 MB/s in 32 bits
Single target, single master	Multi target, Multi master
Memory R/W only, no other I/O operation	Link to entire system
High/ low priority queues	No priority queues
Clock speed upto 66 MHZ	PCI uses fixed 33 MHZ bus

1.3.3 Overview and features of PCMCIA bus

The PCMCIA refers Personal Computer Memory Card International Association. It is an industry group organized in 1989 to promote standards for a credit card-size memory or I/O device that would fit into a personal computer, usually a notebook or laptop computer. There are three types of PC cards,

- Type I PC Cards are typically used for memory devices such as RAM, Flash, OTP, and SRAM cards
- Type II PC Cards are typically used for I/O devices such as data/fax modems, LANs, and mass storage devices.
- Type III PC Cards are used for devices whose components are thicker, such as rotating mass storage devices. These Extended cards allow the addition of components that must remain outside the system for proper operation, such as antennas for wireless applications.

Block diagram of PCMICA



The features are,

Card Information Structure:

The CIS describes the characteristics and capabilities of the card so the host system can automatically configure it. CIS is defined in the Metaformat Specification.

Card Bus:

Card Bus allows PC Cards and hosts to use 32-bit bus mastering and to operate at speeds up to 33MHz.

DMA:

The Standard allows cards to utilize Direct Memory Access technology directly in the hardware when matched with a corresponding host system.

eXecute In Place (XIP):

Allows operating system and application software to run directly from the PC Card, eliminating the need for large amounts of system RAM.

Low Voltage Operation:

The Standard enables 3.3 and 5-volt operation. A physical keying mechanism for 3.3-volt cards protects them from being damaged in a 5-volt slot.

Multiple Function PC Cards:

The Standard enables truly standardized multiple function PC-Cards.

Plug and Play:

PC Cards can be inserted or removed while the system is on because power and ground contact pins are the longest contacts, ensuring that disconnect signals disengage first, preserving data integrity.

Power Management:

The Standard provides a means to interface to APM (Advanced Power Management) through the Card Services Specification.

Zoomed Video (ZV):

Zoomed Video is a connection between a PC Card and host system that allows the card to write video data directly to the VGA controller. The data is transferred with no buffering requirements because it is transferred over the ZV bus and not the system bus.

1.4 Primary Memory

1.4.1 Introduction

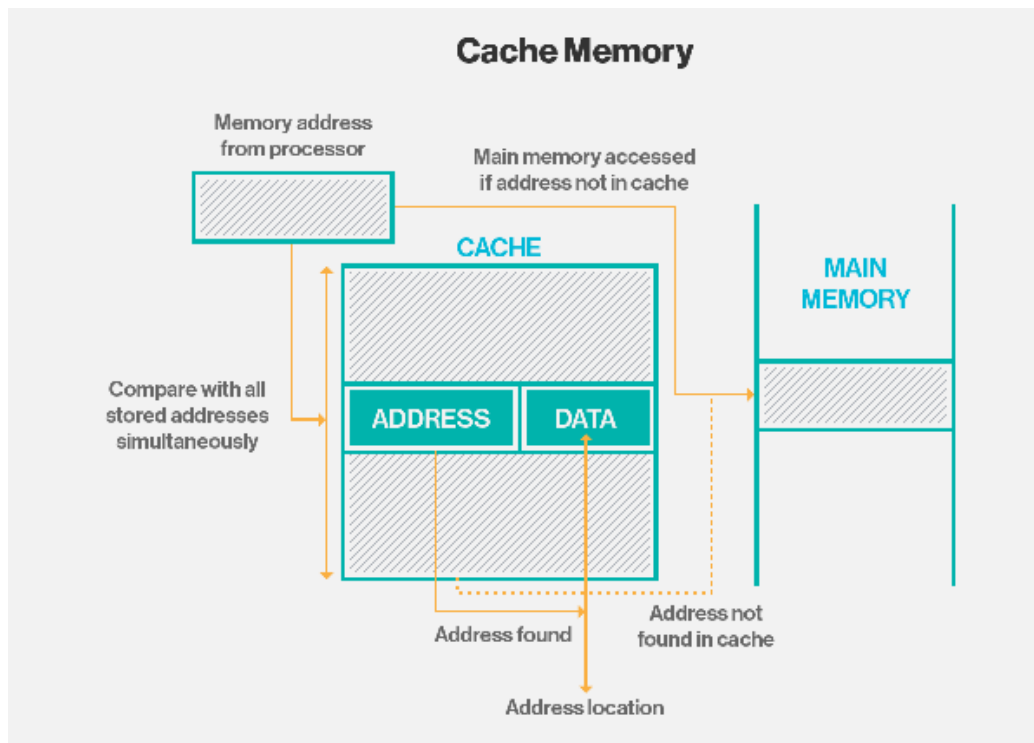
Primary memory is also known as primary storage or main memory. It is computer memory that is accessed directly by the CPU. This is used to store currently running programs and data temporarily. These are stored as blocks. The two important operations in a memory are storing and retrieving. Retrieving data from a large block takes long time than from a small block. So time of execution will increase.

To avoid this problem cache memory is used to speed up the memory retrieval process. The CPU comes with relatively small amount cache compared with main memory. It is also called as Static RAM(SRAM).

1.4.2 Cache Memory

cache memory or **memory cache** is a fast and relatively small memory, not visible to the software, that is completely handled by the hardware, that stores the most recently used (MRU) main memory (MM) (or working memory) data. The function of the cache memory is to speed up the MM data access (performance increasing) and most important, in multiprocessor systems with shared memory, to reduce the system bus and MM traffic that is one of the major bottleneck of these systems.

Cache memory makes use of the fast technology SRAM (static random-access memory cells), against a slower MM DRAM (dynamic random-access memory), connected directly to the processor(s).



Cache memory is fast and expensive. Traditionally, it is categorized as "levels" that describe its closeness and accessibility to the microprocessor:

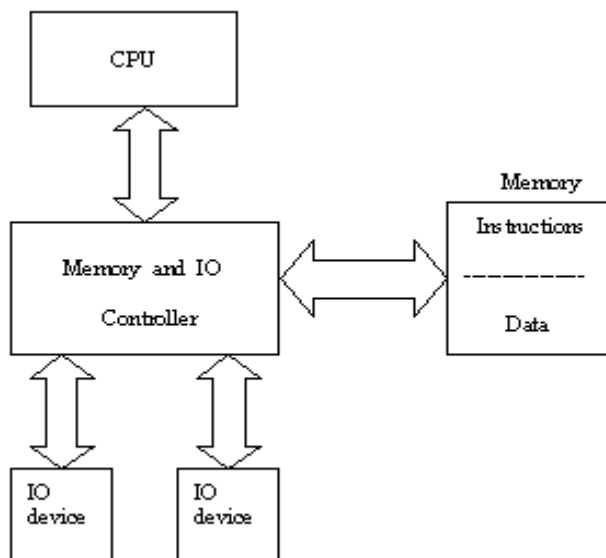
- **Level 1 (L1) cache** is extremely fast but relatively small, and is usually embedded in the processor chip (CPU).

- **Level 2 (L2) cache** is often more capacious than L1; it may be located on the CPU or on a separate chip or coprocessor with a high-speed alternative system bus interconnecting the cache to the CPU, so as not to be slowed by traffic on the main system bus.
- **Level 3 (L3) cache** is typically specialized memory that works to improve the performance of L1 and L2. It can be significantly slower than L1 or L2, but is usually double the speed of RAM. In the case of multicore processors, each core may have its own dedicated L1 and L2 cache, but share a common L3 cache. When an instruction is referenced in the L3 cache, it is typically elevated to a higher tier cache.

1.4.3 Main memory

The main memory of the computer is also known as **RAM**, standing for Random Access Memory. It is constructed from integrated circuits and needs to have electrical power in order to maintain its information. When power is lost, the information is lost too. It can be directly accessed by the CPU.

The access time to read or write any particular byte are independent of whereabouts in the memory that byte is, and currently is approximately 50 **nanoseconds** (a thousand millionth of a second). This is broadly comparable with the speed at which the CPU will need to access data. Main memory is expensive compared to external memory so it has limited capacity. Data transfer between CPU and memory takes place in a clock cycle called bus cycle. The diagram gives the structure of memory.



The different types of memories are,

- DDR2
- DDR3

1.4.4 DDR2

DDR (Double Data Rate) memory is the next generation SDRAM. DDR is synchronous with the system clock. The big difference between DDR and SDRAM memory is that DDR reads data on both the rising and falling edges of the clock signal. SDRAM only carries information on the rising edge of a signal. Basically this allows the DDR module to transfer data twice as fast as SDRAM. The important features are,

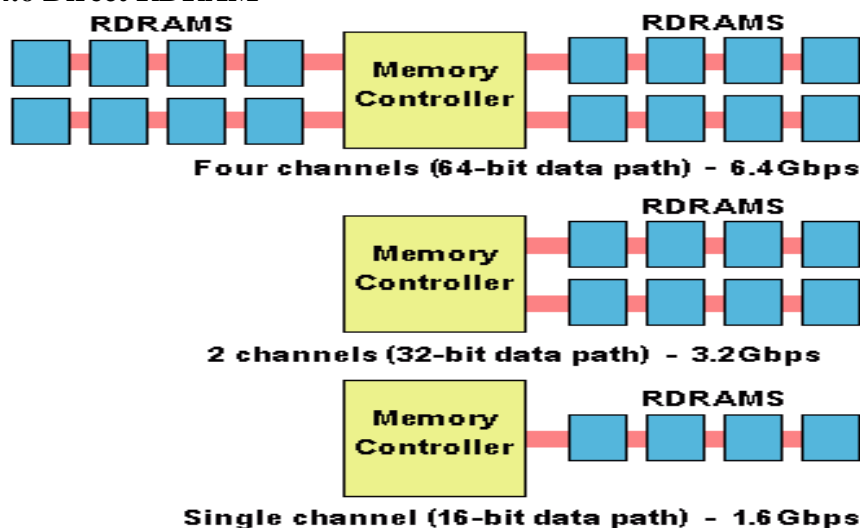
- It transfers data in raising and falling edge of a processor clock pulse. So speed of memory access increase.
- It operates 1.8 v. It leads to lower operating temperature.
- Operation speed from 400MHZ to 1066 MHZ.
- Peak data transfer rate is 3200 / 4266 / 5333 / 6400 / 8533 Mbps.
- It consumes 217 MW power.
- Size of DDR2 varies from 256 MB to 4 GB.

1.4.5 DDR3:

Short for **double data rate three**, **DDR3** is a type of dynamic random-access memory (DRAM) released in June of 2007 as the successor to DDR2. DDR3 chips have bus clock speed of 400 MHz up to 1066 MHz, range in size from 1 to 24 GB, and consume nearly 30% less power than their predecessors. DDR3 RAM sticks for a desktop computer have 240 pins. For a laptop computer, DDR3 RAM sticks have 204 pins. The important key features are,

- It transfers data in raising and falling edge of a processor clock pulse. So speed of memory access increase.
- Operating voltage is 1.5V. Higher performance at low power.
- Higher bandwidth performance, effectively up to 1600 MHz
- Size varies from 512MB to 8GB.
- Improved latencies as measured in nanoseconds.
- Enhanced low power features.

1.4.6 Direct RDRAM



RDRAM (Rambus DRAM) is a type of computer device active memory developed and licensed by Rambus Inc. RDRAM competed with synchronous dynamic RAM (SDRAM) during the late 1990s and early 2000s.

A Direct Rambus channel includes a controller and one or more Direct RDRAMs connected together via a common bus which can also connect to devices such as micro-processors, digital signal processors (DSPs), graphics processors and ASICs. The controller is located at one end, and the RDRAMs are distributed along the bus, which is parallel terminated at the far end. The two-byte wide channel uses a small number of very high speed signals to carry all address, data and control information at up to 800MHz.

Important key features are,

- Bus speed of 133MHz and above
- It uses pipeline memory architecture.
- Data transfer rate is 1.6 Gbps, 3.2 Gbps and 6.4Gbps.
- Operating speed is 100MHz to 1000MHz.
- Cost is very high.
- One or more DRDRAM's can be connected through a common bus with a memory controller.

1.5 Secondary storage:

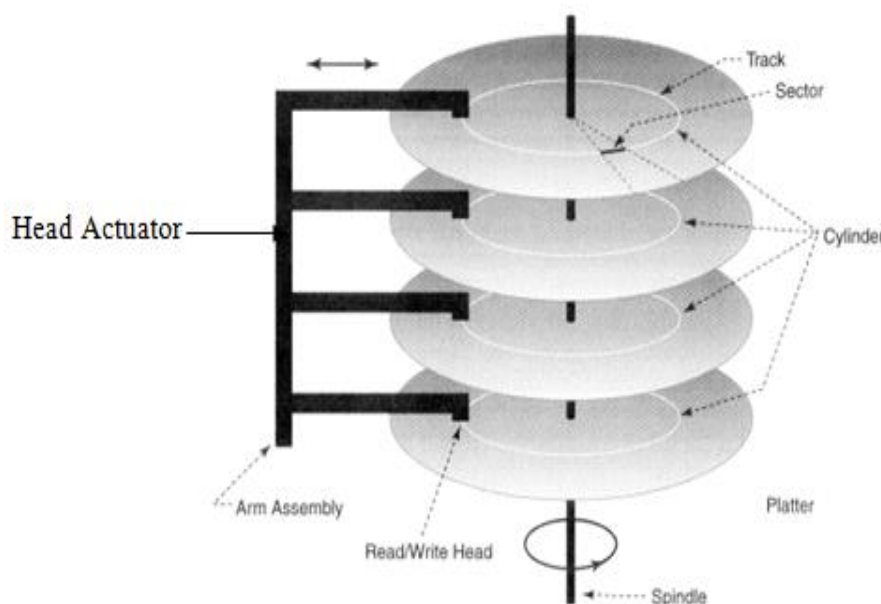
1.5.1 HARD DISK

Introduction

The hard drive of a computer is a device that stores all the software installed on a computer, as well as all the data files created and used by this software. The hard disk drive was invented by an IBM in 1954 with 5MB capacity. Nowadays, HDD with 3.5inch or 5.25 inch platters in different capacities such as 10GB, 20GB, 40GB, 80GB etc.

1.5.2 Construction:

Hard disks are rigid platters, composed of a substrate and a magnetic medium. The substrate platter's base material must be non-magnetic and capable of being machined to a smooth finish. It is made either of aluminum alloy or a mixture of glass and ceramic. It allows data storage, both sides of each platter are coated with a magnetic medium – formerly magnetic oxide, but now, almost exclusively, a layer of metal called a thin-film medium. This stores data in magnetic patterns, with each platter capable of storing a billion or so bits per square inch (bps) of platter surface.



Head Actuator:

The actuator is the device used to position the head arms to different tracks on the surface of the platter (actually, to different cylinders, since all head arms are moved as a synchronous unit, so each arm moves to the same track number of its respective surface).

The actuator is a very important part of the hard disk, because changing from track to track is the only operation on the hard disk that requires active movement: changing heads is an electronic function, and changing sectors involves waiting for the right sector number to spin around and come under the head (passive movement). Changing tracks means the heads must be shifted so making sure this movement can be done quickly and accurately is of paramount importance.

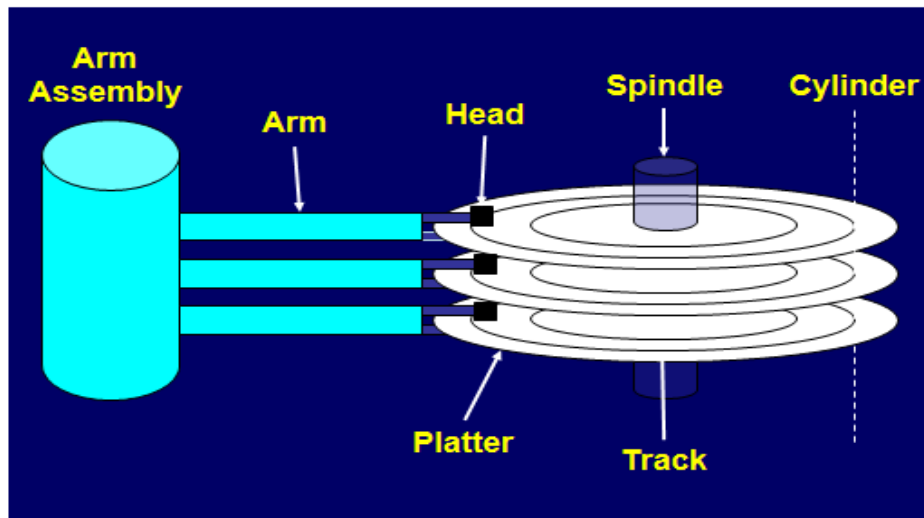
Spindle motor

The spindle motor is used to rotate the shaft or spindle where the platters or discs are placed. This motor rotates at a speed of 3600 rpm. All the platters move in the same direction. The speed of the motor is controlled by an electronics monitor.

Logic Boards

These are electronic boards which are used to control the drives spindle and head actuator systems.

Organization of hard disk

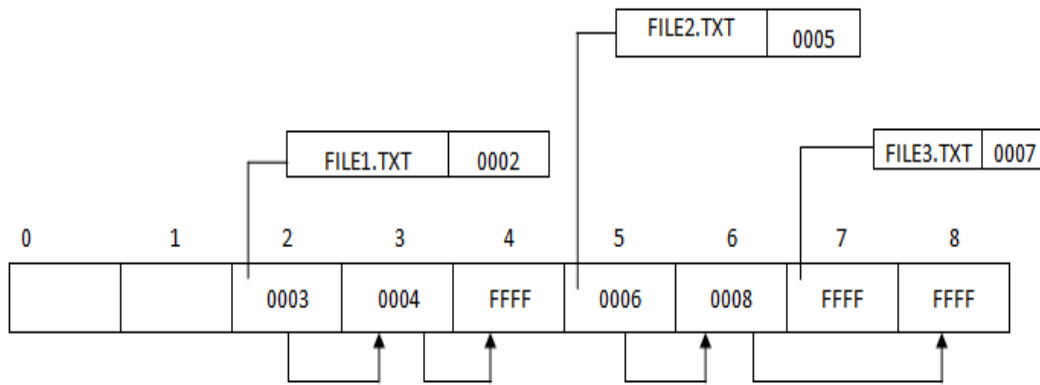


Each disk has two recording surface. The top portion of the disk and bottom portion disk are not used. It acts as a protection plate. Each recording surface is divided into tracks. A set of corresponding tracks in all sides of disks is called a cylinder. A given file or record is stored on one cylinder. Each track is further divided into sectors. A sector is the smallest addressable part of the disk and each sector class has 512 byte of data. The presence of magnetized spot represents 1 bit and its absence represent 0 bit. The storage capacity of a disk is calculated by the formula of

$$\text{Storage capacity} = \text{Number of cylinders} \times \text{Tracks per cylinders} \times \text{Sectors per track} \times \text{Bytes per Sector}.$$

1.5.3 Working principle

The working of hard disk depends on the file allocation table entry (FTA) is a table present in the beginning of the partition containing details about the data stored and free area location in hard disk. The figure given below showed the structure of a FTA.



The following are the two operations on the hard disk

- i. Reading
- ii. Writing

(i) Reading

The computer follows the following steps to read a data from the hard disk.

- When a request is given by the CUP to read data, the O/S reads the FTA from hard disk and compares the requested file with FTA.
- If it is present O/S reads the track and sector details of the file.
- Then O/S sends request to the hard disk control for reading the specified file from the hard disk.
- Disk controller drives the spending and head actuator and locate the corresponding sectors under the read/write heads.
- The heads read the magnetic information from the sectors and convert it into digital and send it to CUP.

(ii) Writing

The computer follows the following steps to write a data onto the hard disk

- When a write request is given from the cup , the O/S reads the FTA from hard disk and search for free area.
- If it is present, it informs the disk controller.
- The disk controller drives the spindle and head actuator and locate the selected free sectors (area) under the read/write heads
- Then the O/S sends write signals to the disk controller.
- The disk controller receives the digital data from CUP and convert it into analog signals.
- According to the analog signals, the head magnetizes the sectors.

To improve the operation a cache buffer is added to the hard disk drive. The size of the cache buffer is between 256KB and 8MB.

1.5.4 Hard disk specification

The important specifications are

- IDE
- Ultra ATA
- Serial ATA

(i) IDE

IDE stands for integrate drive electronics. It was developed in the year 1986 by western digital and comaq. The name IDE is because disk drive itself contains the disk controller function. The important features are

- i. IDE drives can be connected directly to the system bus
- ii. IDE drives are cost effective
- iii. IDE drives can be connected to all the types of systems.
- iv. IDE design supports two internal hard disk

(ii) Ultra ATA

This was introduced in the year 1997. it uses AT attachment program parallel interface standard. So it can provide common interface for CDROM drive, tape backup drivers and removable drives. The following are important ultra ATA's These interface can control a maximum of 2 devices.

- a. Ultra ATA-4
- b. Ultra ATA-5
- c. Ultra ATA-6

1.5.5 IDE

Short for Integrated Drive Electronics or IBM Disc Electronics. It meaning the drive can connect directly to the motherboard or controller. The older standard that SATA replaced. It was developed in the year 1986 by western digital and company. The important features are,

- IDE drives are high cost.
- IDE design supports to internal hard disk
- IDE drives can be connected to all the types of systems.
- IDE drives cab be connected directly to the system bus.

1.5.6 Ultra ATA

In the second half of 1997 EIDE's 16.6 MB/s limit was doubled to 33 MB/s by the new Ultra ATA. As well as increasing the data transfer rate, Ultra ATA also improved data integrity by using a data transfer error detection code called Cyclical Redundancy Check (CRC). Important ultra ATA's are,

- Ultra ATA-4
- Ultra ATA – 5
- Ultra ATA – 6

1.5.7 Ultra ATA 4

The standard ATA-4 interface began to support Ultra DMA data transfer mode, ATA-4 was also called Ultra DMA 33 or ATA33. It was introduced in 1997. Features are

- Double Data Rate was first introduced on ATA interface, enforcing interface to perform twice data transfer, one during ascending period and another during descending period, within one clock period, which abruptly increased the data transfer rate from 16MB/s to 33MB/8.

- Ultra DMA 33 also introduced another new technology, CRC, which sends cyclic redundancy code and checks the code when the opposite party is receiving. Only when all checks are correct will the data be received and processed, casting strong guarantee to the safety of high-speed data transfer.

1.5.8 Ultra ATA – 5

It was introduced in 1999. Features are

- ATA-5, also called as "Ultra DMA 66" or "ATA66", is built on the base of Ultra DMA 33 hard disk interface and adopts UDMA technology.
- Ultra DMA 66 has the receiving/sending rate reached 66.6 MB/s, which is two times as fast as that of U-DMA/33. As working frequency increases, EMI still arises on ATA interface.
- Interface begins to use 80-cable with 40-pin. 40-pin.
- It reduce cost and all cables newly increased on 80-cable are earth cables corresponding with original data lines which reduces electromagnetic interference between neighboring signal wires.
- Signal Voltage is 5v.

1.5.9 Ultra ATA-6

It was introduced in 2000. Features are

- ATA100 interface and data line are the same with ATA66 using 40-pin 80-core data transfer cable and with complete downward compatibility.
- It supports cyclic Redundancy check (CRC).
- All devices supporting ATA33 and ATA66 can be used on ATA100 interface. ATA100 specification can easily deal with all current thorny problems of ATA33 and ATA66.
- It allows hard disk external rate to reach 100MB/s, improving hard disk data integrity and data transfer rate and considerably improving disk subsystem performance of desktop system.
- The signal voltage is 3.3v

1.5.10 Serial ATA

It was introduced in 1999 by serial data working group. Serial ATA (SATA, abbreviated from Serial AT Attachment) is a computer bus interface that connects host bus adapters to mass storage devices such as hard disk drives, optical drives and solid-state drives. Important features are,

- It requires low voltage of 500 mv peak to peak.
- It can have flexible connector cable up to one meter. So it is easy to route inside the PC's chassis.
- The number of pins in the connector is reduced below 40.
- It has a lot of options for checking and correction.

- It's data transfer rate is 150MB/s to 600MB/s.
- Data transmission is sure.

1.5.11 HDD Partition

Disk partitioning or disk slicing is the technique for creating one or more regions on a hard disk or other secondary storage, so that an operating system can manage information in each region separately. Each partition then appears in the operating system as a distinct "logical" disk that uses part of the actual disk.

Advantages

- Hard drive to manage data in category wise.
- Portioning a hard drive is advantageous to the virus prevention and data security.
- Use the hard disk efficiently.
- Improving the efficiency of the system.
- Assign different permissions for different users.
- Helpful to install multiple operating systems.

1.5.12 Formatting

Disk formatting is the configuring process of a data storage media such as a hard disk drive, floppy disk or flash drive for initial usage. Any existing files on the drive would be erased with disk formatting. Disk formatting is usually done before initial installation or before installation of a new operating system. Disk formatting is also done if there is a requirement for additional storage in the computer. There are two types of disk formatting,

- Low-Level formatting
- High – Level formatting

Low-Level formatting

Low-level formatting is the process of marking out cylinders and tracks for a blank hard disk, and then dividing tracks into multiple sectors. This process is often called the “*real*” formatting since it creates physical format which defines where the data is saved. If users perform low-level formatting when data have been installed, all existing files will be erased, and it is almost impossible to recover them.

High - Level formatting

After a low-level formatting has been completed, users need to make high-level formatting which makes it possible to save data and should be done on a partition. It is the process of writing a file system, cluster size, partition label, and so on for a newly created partition or volume. This process does no harm to hard disk in general situations, so we suggest taking such a format to fix a logically damaged partition or device, for example, Windows asks to format a SD card.

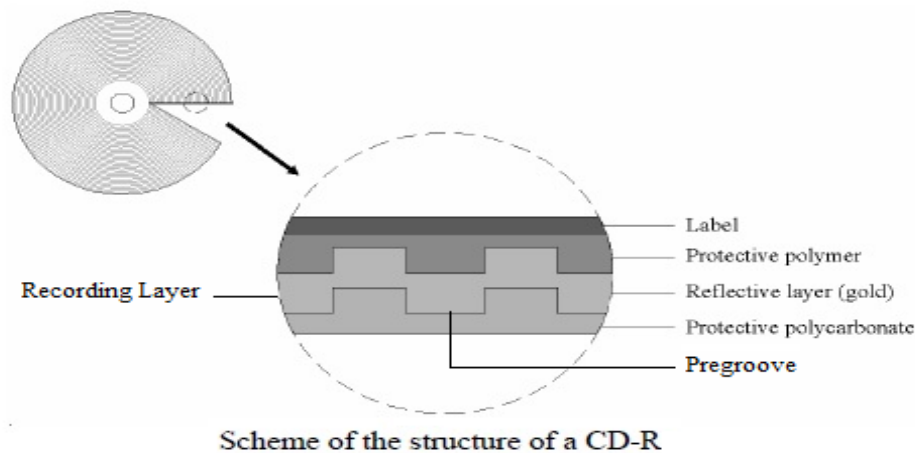
1.6 Removable Storage

Removable media is any type of storage device that can be removed from a computer while the system is running. Examples of removable media include CDs, DVDs and Blu-Ray disks, as well as diskettes and USB drives. Removable media makes it easy for a user to move data from one computer to another.

1.6.1 CD-R

The first recordable specification (CD-WO) was published in 1989 by Philips and Sony in the Orange Book. CD-R Stands for "Compact Disc Recordable." CD-R discs are blank CDs that can record data written by a CD burner. The data burned onto a CD-R disc is permanent, meaning it cannot be altered or erased like the data on a hard drive.

Typically, once a CD has been burned, it will not be able to record any more data. Some CD burning programs can record data as "sessions," allowing a disc to be written to multiple times until it is full. Each session creates a new partition on the disc, meaning a computer will read a disc with multiple sessions as multiple discs. CD-RWs, on the other hand, can be erased and completely re-recorded. Like CDs, the data on CD-RWs cannot be altered, meaning the disc has to be completely erased each time you want to add new data. The CD has spiral track of width 0.6 micron and pitch 1.6 microns over a polycarbonate disc called pregroove.



Scheme of the structure of a CD-R

The different layers of CR-R,

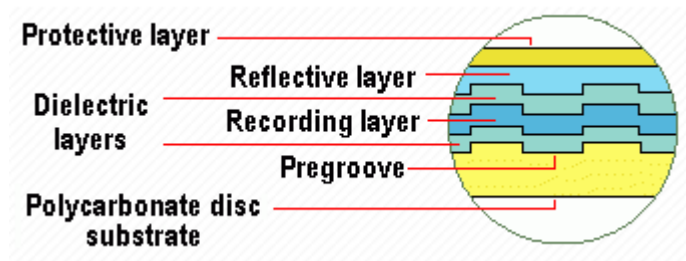
- | | |
|-------------------------|---|
| Protective layer | - This is a lacquer coating layer. It is used to protect the disk from scratch and dust. |
| Reflective layer | - This is thin layer of silvery alloy or 24 carat gold. This is used to give Effective reflection during reading. |
| Recording Layer | - This layer is coated with recording dye such as Cyanine, Phthalocyanine dye and Azo dye. |
| Pregroove | - It is made during construction of CD. The width of the spiral track is 0.6 micron and its pitch size is 1.6 micron. |

1.6.2 CD-RW

CD-RW Stands for "Compact Disc Re-Writable." A CD-RW is a blank CD that can be written to by a CD burner. Unlike a CD-R (CD-Recordable), a CD-RW can be written to multiple times. The data burned on a CD-RW cannot be changed, but it can be erased. Therefore, you have to completely erase a CD-RW every time you want to change the files or add new data. While it may be somewhat inconvenient, this capability makes CD-RWs a good choice for making frequent backups. However, because CD-RWs can be erased, they don't store data reliably for as long as CD-Rs do. Therefore, you should use regular CD-Rs for long-term backups.

The technology behind CD-RW is optical phase-change, which in its own right is nothing radical. However, the technology used in CD-Rewritable does not incorporate any magnetic field like the phase-change technology. A CD-RW disc's phase-change medium consists of a polycarbonate substrate, molded with a spiral groove for servo guidance. The

recording layer is sandwiched between dielectric layers that draw excess heat from the phase-change layer during the writing process. In place of the CD-R disc's dye-based recording layer, CD-RW commonly uses a crystalline compound made up of a mix of silver, indium, antimony and tellurium. This rather exotic mix has a very special property: when it's heated to one temperature and cooled it becomes crystalline, but if it's heated to a higher temperature, when it cools down again it becomes amorphous. The crystalline areas allow the metalised layer to reflect the laser better while the non-crystalline portion absorbs the laser beam, so it is not reflected.



The different layers are,

- | | |
|-------------------------|--|
| Protective layer | - This is a lacquer coating layer. This is used to protect the disk from scratch and dust. |
| Reflective layer | - This is thin layer of silvery alloy or 24 carat gold. This is used to give effective reflection during reading. |
| Recording Layer | - It is a layer of crystalline compound. This contains a mix of silver, indium, antimony and tellurium. The property of this layer is, <ul style="list-style-type: none"> • When it is heated to high temperature and cooled, it becomes amorphous. • When it is heated to a medium temperature and cooled, it becomes crystalline. The crystalline layer reflects more than non crystalline layer. This layer is placed between two dielectric materials. |
| Dielectric Layer | - It is a layer which is used to absorb the excess heat generated during writing process. |
| Pregroove | - It is made during construction of CD. The width of the spiral track is 0.6 micron and its pitch size is 1.6 micron. |

Writing

During writing, a focused Write Power laser beam selectively heats areas of the phase-change material above the melting temperature (500-700°C), so all the atoms in this area can move rapidly in the liquid state. Then, if cooled sufficiently quickly, the random liquid state is frozen-in and the so-called amorphous state is obtained. The amorphous version of the material shrinks, leaving a pit where the laser dot was written, resulting in a recognizable CD surface. When an Erase Power laser beam heats the phase-change layer to below the melting temperature but above the crystallization temperature (200°C) for a sufficient time (at least longer than the minimum crystallization time), the atoms revert back to an ordered state (i.e. the crystalline state). Writing takes place in a single pass of the focused laser beam. This is sometimes referred to as direct overwriting and the process can be repeated several thousand times per disc.

Reading

To read the data in the CD, a low power laser is made to fall on the surface of the CD. The amorphous area (pits) reflects less light and crystalline area reflects more light with the help of the difference in reflectivity we can read the data.

Erasing

Erasing of a CD-RW disc is performed by returning the material in the recording layer which has been changed to the amorphous state back to the crystalline state. This is done by an annealing process, consisting of heating the layer to a temperature of about 200°C (i.e. less than the melting point) and maintaining that temperature for an extended period (in practice, this takes some 37 minutes for a complete disc). The disc is then returned to its original, completely unrecorded state.

1.6.3 DVD – ROM

Digital versatile disc-read only memory (DVD-ROM) is a read-only digital versatile disc (DVD) commonly used for storing large software applications. It is similar to a compact disc-read only memory (CD-ROM) but has a larger capacity. A typical DVD-ROM can hold up to 17 GB/s of data if both sides of the disc are writable. The technology used in DVDs are,

- i. DVD-ROM has the same 5 inch diameter and 1.2 millimeter (mm) thickness. It has three layers
 1. Polycarbonate layer,
 2. Thin sheet of aluminum over the polycarbonate layer.
 3. A lacquer coating over the aluminum. This is to protect the disk from internal scratches and dust.
- ii. A DVD-ROM uses a shorter wavelength laser with tighter compacted pits, the disc capacity is increased. In fact, the smallest DVD-ROM can store approximately 7 times more data than a CD-ROM.
- iii. The DVD-ROM is comprised of two 0.6 millimeters (mm) acrylic layers bonded together. The double-sided disc consists of two recordable grooved sides. With two layers, a DVD's laser beam only has to go through 0.06 mm to reach the recording layer. Having a thin layer allows the lens to focus the beam to a smaller spot size, which in turn writes smaller pits for more data.
- iv. The data is encoded in the form of spiral pits that are merely nanometers apart. The spiral path begins at the center of the disc and coils numerous times until it reaches the outer edge. With a double-layered disc the path continues to the second layer. A double-sided disc needs to be manually turned over and the path resumes in the center.
- v. DVD has effective error correction codes. So DVDs are a best medium to store data.

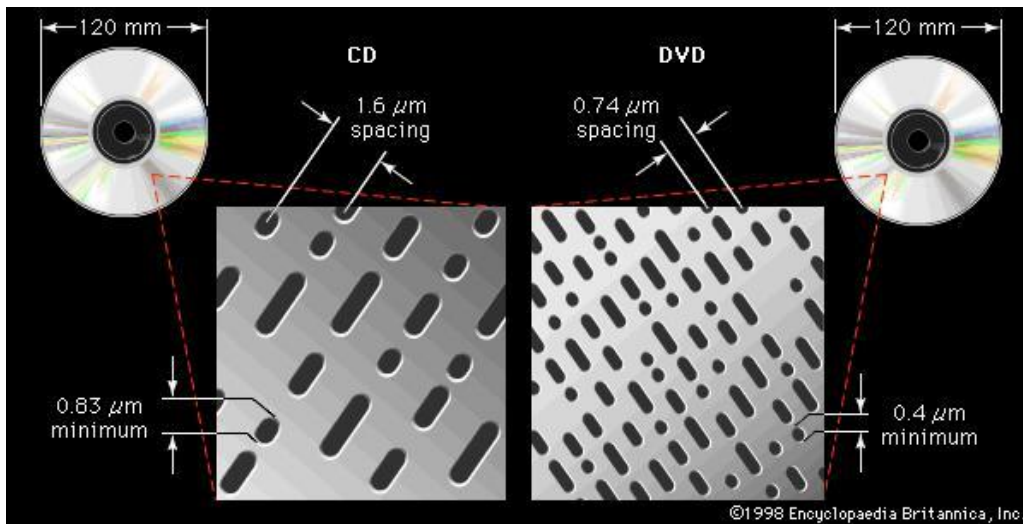
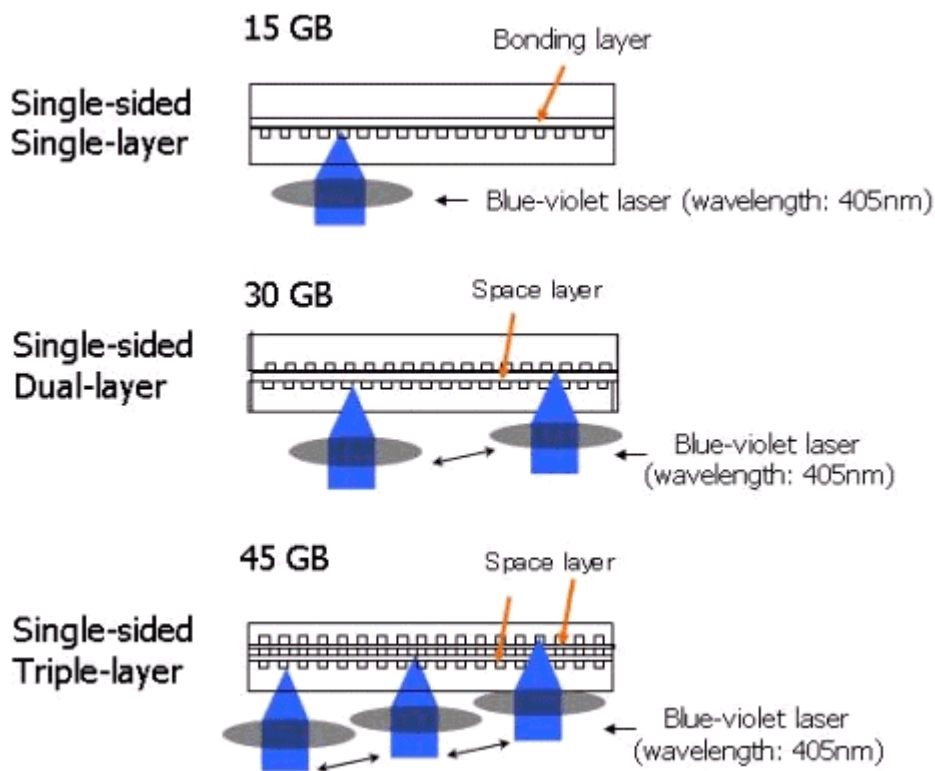
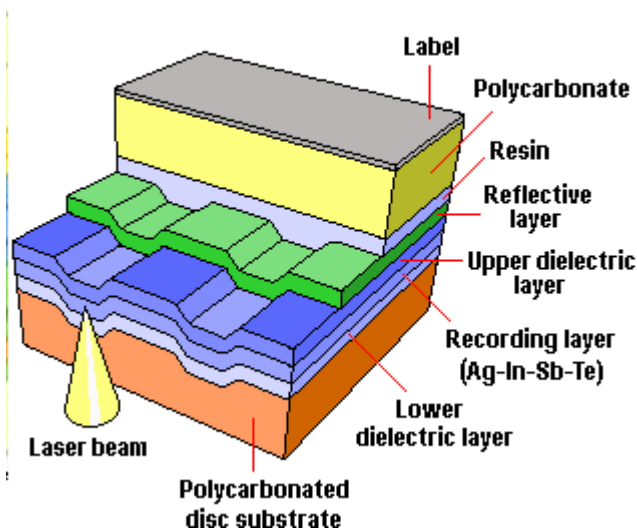


Fig: Single side dual layer



1.6.4 DVD – RW

DVD-RW Stands for "Digital Versatile Disk Rewritable." A DVD-RW is like a DVD-R but can be erased and written to again. Like CD-RWs, DVD-RWs must be erased in order for new data to be added. DVD-RWs can hold 4.7GB of data and do not come in double-layered or double-sided versions like DVD-Rs do. Because of their large capacity and ability to be used multiple times, DVD-RW discs are a great solution for frequent backups. To record data onto a DVD-RW disc, you'll need a DVD burner that supports the DVD-RW format.



Writing

During writing, laser beam of wave length $650\text{ }\mu\text{m}$ is used to heat selected spots 500°C to 700°C . So the spots change to liquid state. Then the spots are allowed to cool. After cooling the spots become amorphous state.

Reading

To read the data in the DVD, a low power laser is made to fall on the surface of the DVD. The amorphous area reflects less light and crystalline area reflects more light with the help of the difference in reflectivity we can read the data.

Erasing

To erase the data in the DVD, a medium power laser of temperature 200°C is made to fall on the recording layer. This melts the amorphous area and reverts back to crystalline state.

1.6.5 Construction and Working of DVD Reader / Writer

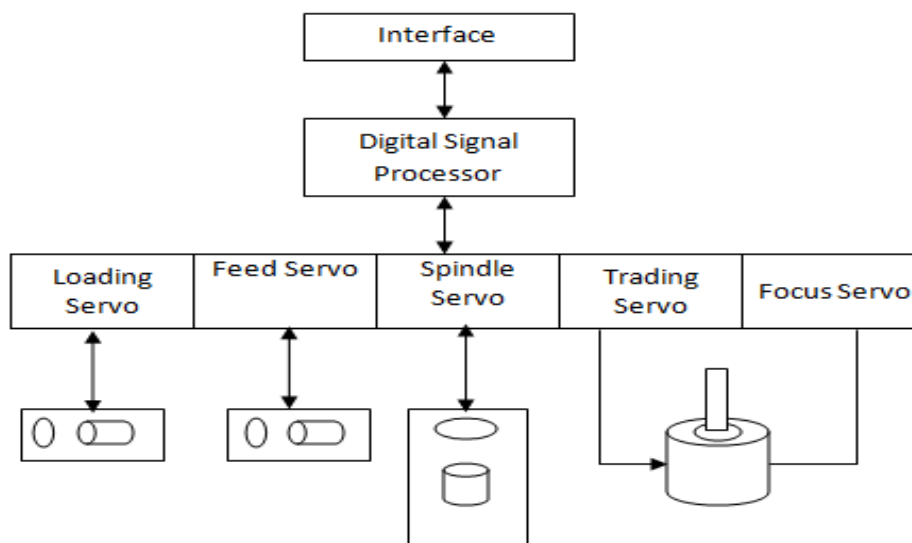


Figure shows that the block diagram of DVD RW drive

Focus servo:

Focus servo is used to focus the laser beam in the middle of the pit to read the recorded data on the track and to focus the laser on the track to write the data. This is done by moving the object lens.

Spindle servo:

Spindle servo is used to send the error signal generated. This is used to correct the speed of rotation.

Tracking servo:

This is used to trace the spots on the track. This is done by moving the object lens in the traverse direction.

Feed servo:

It is used to move the entire pickup mechanism in the radial direction of the disk from inner to outer track, by holding the relative position of the object lens and disk.

Loading servo:

Loading servo is used to load the disk into the drive.

1.6.6 Blue-ray**Introduction**

Blu ray disc (BD) is the name of the next-generation optical disc. The blu ray format allows recording and playback of high definition video (HD) and also the capability to store huge amounts of data on a single disc. The plastic disc is 120 mm in diameter and 1.2 mm thick, the same size as DVDs and CDs. Conventional (pre-BD-XL) Blu-ray Disc discs contain 25 GB per layer, with dual layer discs (50GB) being the industry standard for feature-length video discs.

Main Parameters of Blu-ray Disc

Parameters are measurable factors which defines the disc. The important parameters are,

- Physical parameter
- Optical parameter

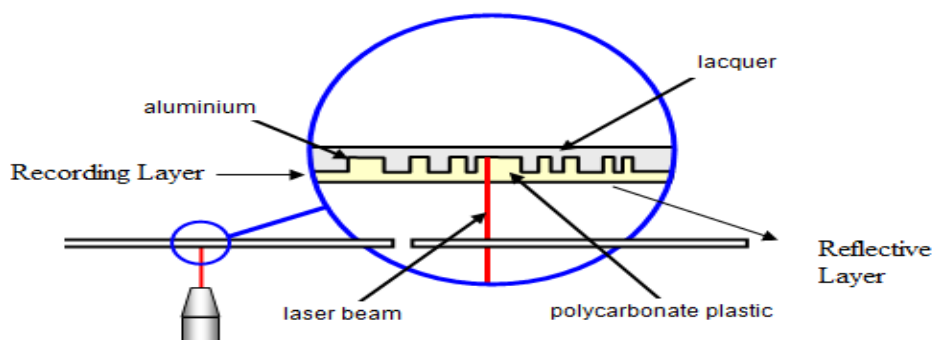
Physical parameter

It has divided into two parts are,

1. Structural details
2. Groove details

1. Structure details

Blu-ray disc is a polycarbonate disc of 12cm diameter and 1.2mm thickness. The figure shows the structure of a single layer disc.



The different layers are,

Cover Layer

It is a layer which is having 0.1mm thickness and it contains the recording layer. The silicon dioxide coating over this layer protects the disc from scratches.

Reflective layer

This is thin layer of silvery alloy or 24 carat gold. This is used to give effective reflection during reading.

Recording Layer

It is a layer of crystalline compound. This contains a mix of silver, indium, antimony and tellurium. The property of this layer is,

- When it is heated to high temperature and cooled, it becomes amorphous.
- When it is heated to a medium temperature and cooled, it becomes crystalline. The crystalline layer reflects more than non crystalline layer. This layer is placed between two dielectric materials.

Dielectric Layer

It is a layer which is used to absorb the excess heat generated during writing process.

1.Groove details (Track details)

Blu-ray disk contains spiral tracks. The tracks start from the center and move outwards. The following are the details of the track.

Track width - 0.3 micron

Pitch - 0.32 micron. The distance between track is pitch.

Pit length - 0.15 micron. The length of the pit made over the track during recording.

Optical Parameter

The following are the optical parameters.

Wavelength of blue laser - 105 nm.

Numerical aperture - 0.85. This is a measure of the lens systems ability to focus the laser and detect the details at a fixed distance. Smaller the distance the higher the numerical aperture.

The important blu-ray discs parameters as follows,

Sl.No.	Parameter	Value
1	Storage capacity	25GB or 50GB
2	Diameter	12cm
3	Thickness	1.2mm
4	Track pitch	0.32 micron
5	Cover Layer	0.1mm
6	Wave length	405nm
7	Data transfer rate	26mbps
8	Pit length	0.15 micron
9	Numerical aperture	0.85

REVIEW QUESTION

PART – A

1. What is firmware?
2. Define mother board.
3. What is the use of port?
4. Define SMPS.
5. Define Chipset.
6. What are the front panel indicators?
7. Define Cache memory.
8. Define Bus.
9. Define Direct RDRAM
10. What is the expansion of PCMC/A & AGP?

PART – B

1. What is the difference between Hardware, Software and Firmware?
2. What are the Hard disk specification explain any one in detail?
3. Define formatting and its types.
4. Draw the PCI block diagram.

PART – C

1. Explain the architecture and block diagram of multicore Processor
2. Explain any two bus standards in details?
3. Explain the working principles of Ultra ATA, Serial ATA
4. Explain the working principles of CD-R.

UNIT – II

I/O DEVICES AND INTERFACE

2.1. Keyboard

Introduction

Keyboard is an input device. It is used to give text, numbers and controls as input to computer. The keyboard resembles the structure of ordinary typewriter keyboard with some additional keys.

2.1.1. Keyboard signals



The keyboard is connected to the system board through a flexible standard DIN connector. There are two types of DIN connectors. They are

- (i) 5 PIN DIN connector
- (ii) 6 PIN DIN connector

The signals are

Pin 1 - keyboard clock	Pin 1 – keyboard data
Pin 2 - keyboard data	Pin 2 – Not used
Pin 3 - Not used	Pin 4 – Ground
Pin 4 - Ground	Pin 4 – Vcc(+5V)
Pin 5 - Vcc(+5V)	Pin 5 – keyboard clock
	Pin 6 – not used

Keyboard clock - This provides the clock pulse to the keyboard from the system.

Keyboard data - This is used to send the scan codes from the keyboard to the computer serially.

Ground - This is the common ground for all the keyboard circuits.

Vcc(+5V) - This will provide the required supply for the operation of keyboard

The keyboard clock line and keyboard data line are bidirectional.

Types of keyboard

There are two types of keyboard depending on the type of the key switches. They are

- (i) Simple or membrane keyboard
- (ii) Mechanical keyboard

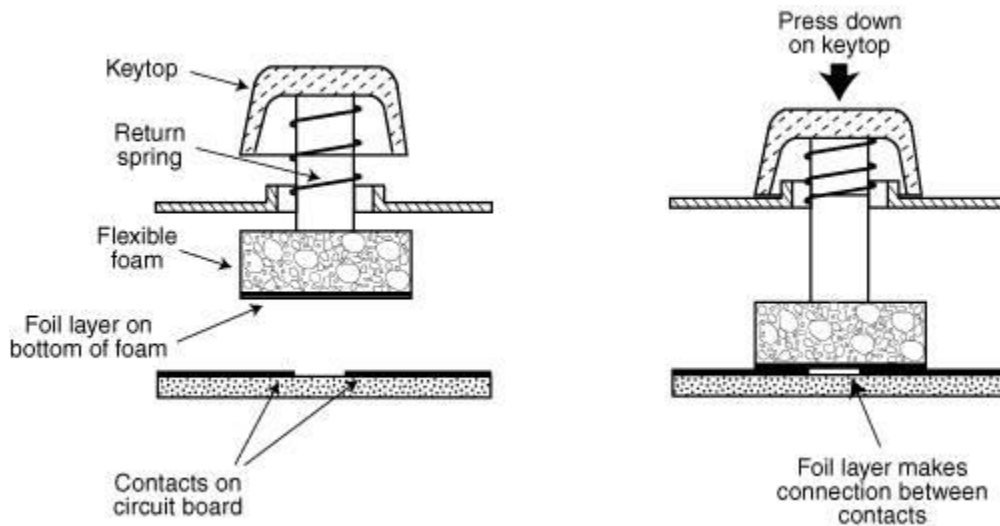
2.1.2 Simple or membrane keyboard

The simple keyboard consists of a plastic actuator. Top side of the actuator consists of a push button and the bottom side rests on a rubber boot coated with conductive silver – carbon compound.

When the user presses the keyboard push button, the plastic actuator compresses the rubber boot and makes a contact between the row and column circuit in the keyboard matrix. When the push button key is released, the compressed rubber boot releases and breaks the contact.

2.1.3. Mechanical keyboard

The figure given below shows the structure of a mechanical keyboard switch.



As shown in the above figure, a plastic actuator separates two tempered bronze contacts. Top side of the actuator consists of a push and the bottom side rests on a spring.

When the user presses the keyboard push button, the actuator slides down and compress the spring. This action makes the gold contacts to close the row and column circuit in the keyboard matrix. When the push button key is released the spring releases the actuator and breaks the contact.

2.1.4. Trouble shooting the keyboard

Typical problem and trouble shooting

Problem - During initialization an error message indicating that the keyboard lock is on.

Solution

- ❖ Make sure that the keyboard lock is unlocked. If not unlock it.
- ❖ If the switch is in unlocked position and if the system deflates unlocked check the working of the switch.
- ❖ If the switch is working, the problem may be with the motherboard.

Problem – The keyboard is completely dead – no keys appear to function.

Solution

- ❖ Try with a alternate keyboard. If it works, the problem is probably on the keyboard interface chip. It is better to replace the keyboard rather than the chip.
- ❖ If the alternate keyboard fails, using multimeter check for +5V supply at the keyboard connector. If this is missing, the female keyboard connector may be broken.
- ❖ Check the keyboard connector pico – fuse.
- ❖ If the problem still exists replace the mother board.

Problem- KBC error or a similar message displayed during system bootup.

Solution

- ❖ This is due to either data signals are missing or keyboard clock missing. It is better to replace the motherboard.

2.1.5. Wireless keyboard

Wireless keyboard is a keyboard connected to the computer without wires. But it is connected to the computer through infrared(IR) or Bluetooth or radio frequency connections. The signals sent from the keyboard is received by the receipt. The receiver is either in or plugged into the USB port. Since the keyboard has no connection with the computer it must be powered has no connection with the computer it must be powered by either battery or AC power.

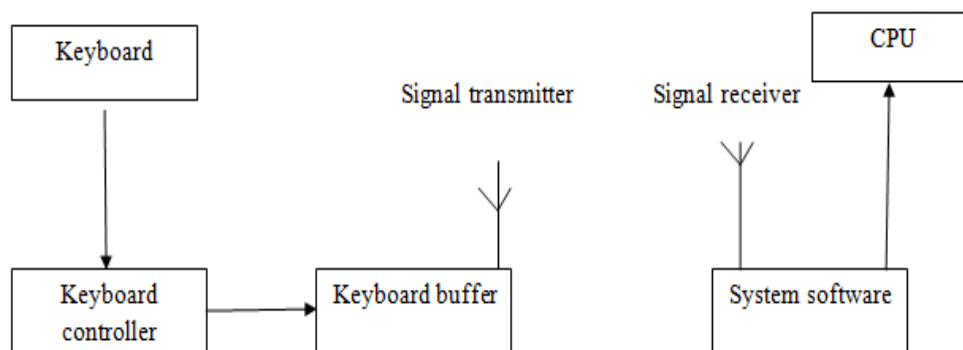
Signals

The signals in the wireless keyboard are

- (i) Ratio frequency of infrared or Bluetooth signal sent from the keyboard to the receiver.
- (ii) The receiver in the USB port receives the signal and sends it to the CPU. The CPU converts the scan code into ASCII form.

Operation

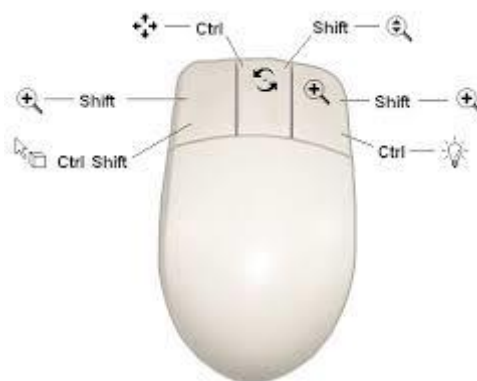
The PC keyboard has a micro controller chip called keyboard controller. This has a built in ROM program that senses the pressed key. The key switches are connected in a matrix of rows and columns to the micro controller chip. The figure given below shows the block diagram of keyboard operation.



When a key is pressed on the keyboard, it sends a control signal to the keyboard controller. The keyboard controller generates a code called scan code corresponding to the signal received. This code is placed in the keyboard buffer and it sends interrupt signal to the CPU through a system software using wireless transmitter.

The CPU stops its current execution and reads the scan code from the keyboard buffer. Then it converts the scan code into its ASCII form.

2.2. Mouse



Mouse is an input device. This is used to control the pointer movement on the screen by moving it over a flat surface. It contains two or three buttons on the top.

When the user presses one of the buttons, the mouse either marks a location on the screen or makes selections from data on the screen. This can also be used in combination with a keyboard. The operations on a mouse can be classified into three types. They are

- (i) Click
- (ii) Double click
- (iii) Drag

1.2.1. TYPES

The following are the different types of mouse.

- (i) Serial mouse
- (ii) PS/2 mouse
- (iii) Optical mouse
- (iv) Wireless mouse

2.2.2. CONNECTORS

A mouse connector is a dedicated socket or interface in the computer for connecting a mouse. A mouse can be connected to the system using any one interface.

- (i) Through a D- type DIN connector in the serial port interface.
- (ii) Through a 6 pin PS/2 DIN socket interface.
- (iii) Through USB port.
- (iv) Through wireless methods.

Depending on the structure of the connector present in the mouse cable end, it is connected to any one of the above interfaces.

2.2.3. OPTICAL MOUSE OPERATION

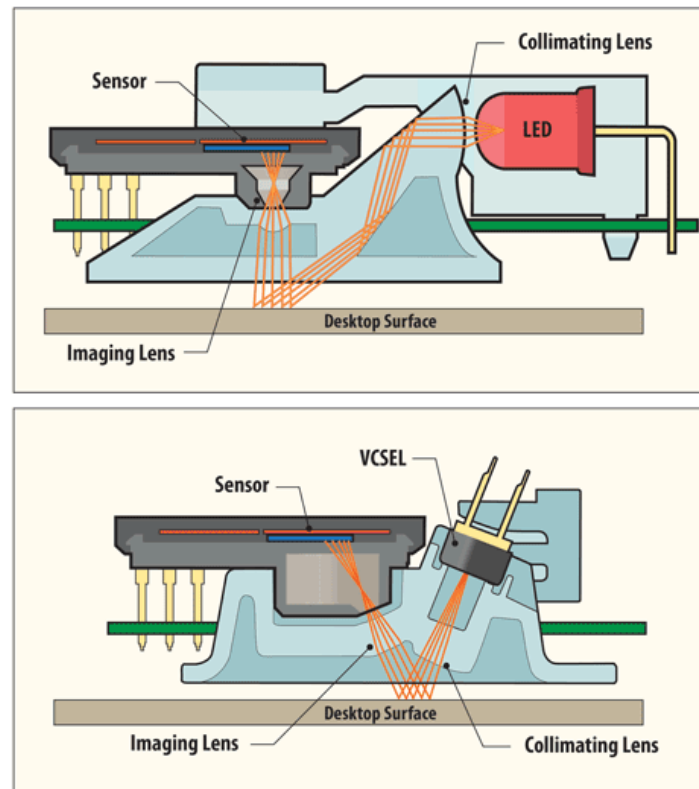
Optical mouse is made up of plastic with one or more switches the top and a light emitting diode (LED) on its lower surface. The figure given below shows the block diagram.

When the mouse is moved, the light from the LED is reflected by the surface. The reflected light is made to fall on a metal- oxide semiconductor sensor called **tracking sensor**.

The sensor sends each reflected image to a digital signal processor (DSP) for analysis. The DSP detects the patterns in the images and finds how the patterns moved since the previous image.

Based on the change in patterns over a sequence of images, the DSP determines how far the mouse has moved. Then it sends the corresponding co – ordinates to the computer. The computer moves the cursor on the screen based on the coordinates received from the mouse.

OPTICAL MOUSE



2.2.4. Trouble shooting optical mouse

The following are some important problems occurring in optical mouse and the solution for trouble shooting.

Problem – Mouse cursor is not moving properly.

Solution

- ❖ Check the cable and see it is properly inserted in the port.
- ❖ Clean the optical sensor and the bottom surface with a moist towel.
- ❖ Check whether the mouse settings in the control panel are properly selected.
- ❖ Still the problem exists, replace the mouse with a new one.

Problem – Mouse button do not work.

Solution

- ❖ Check whether any obstructions blocking the buttons.
- ❖ Blow air using vaccum cleaner through the gap between the buttons.
- ❖ Check whether the settings in the control panel are properly selected.
- ❖ Still the problem exists, the button may be worn out because of continuous usage.

So replace the mouse.

2.3. Printers

2.3.1. Introduction

Printer is an output device. This is used to take hard copies of any computer based application.

2.3.2. Types

The following are the important types of printers used with personal computers.

- (i) Dot matrix printer
- (ii) Ink jet printer

- (iii) Laser printer
- (iv) Line printer
- (v) Multi function printer(MFP)

2.3.3. Dot matrix printer

In this printer the characters are formed with the help of dots. So this is called dot matrix printer. There are three types of dot matrix printers. They are

- (a) 7- pin pointers
- (b) 9- pin pointers
- (c) 24- pin pointers

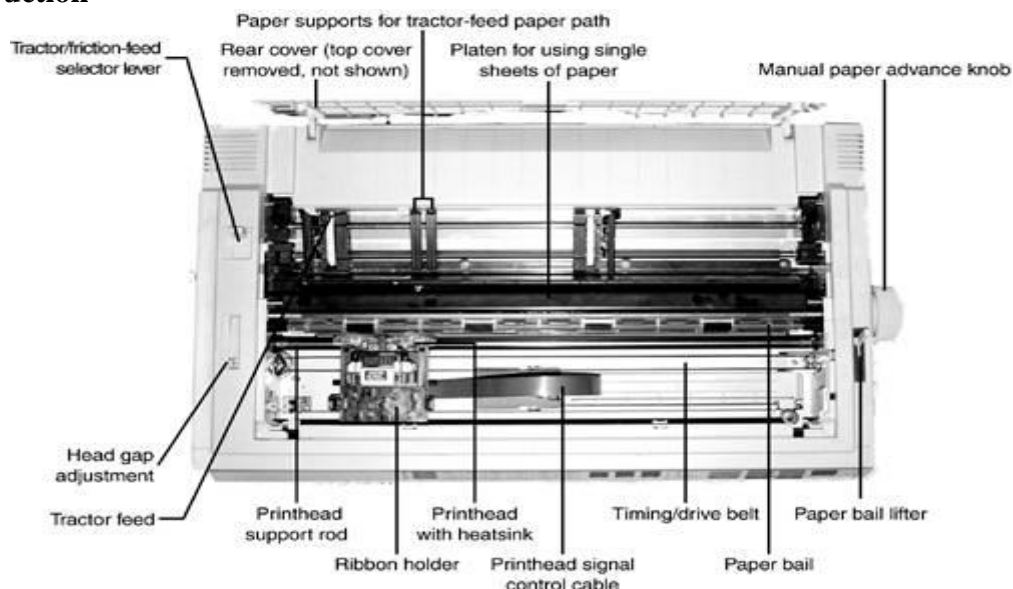
Operation of 7- pin pointer

The print head of the dot matrix printer consists of a column of 7 small needles. Each needle can move freely.

Each needle can be made to print a dot by means of a hammer action that forces the needle to come out and press the ribbon against the paper. Standard characters are produced in a 5x7 dot matrix. (7dots high and 5 dots wide). The figure given below shows the operation of a dot matrix printer.

The characters are printed column by column and not all at once, for example to print the character T, initially pin number 1 is made to contact the ribbon. Thus first column of the characters is got. Then the print head is moved towards right and once again the pin 1 is made to contact the ribbon. Thus second column of the character is got. Then the print head is moved to get the third column and so on.

Construction



Front panel

This consists of a minimum three status light (LED) and three soft touch switches. The lights are used to give information about the status of the printer to the user. Switches are used to give control commands. For example font selection.

DIP switches

These switches are present in the interface card and are used to change the printer settings. The settings that can be changed are

- (i) Printing of graphics and accented characters
- (ii) Page length

- (iii) Slashed zeros
- (iv) Line spacing
- (v) Print quality
- (vi) Auto line feed
- (vii) Character set for different countries.

Sensors

These are used to keep the printer safe from abnormal conditions. The different sensors are

- (i) Home sensor - this is used to detect whether the head carriage is in the extreme left margin.
- (ii) Paper sensor - this is used to signal when there is sensor no paper in the printer.
- (iii) Temperature - this is used to detect the normal sensor timings used to fire the pins.

Print mechanism

This contains two subsystems. They are

- (i) Carriage movement - this moves the carriage control Mechanism bidirectionally by means of a stepper motor
- (ii) Ribbon feed - this feeds the ribbon when mechanism the print head is printing.

Features

- (i) Both text and graphics can be printed.
- (ii) Printing cost is very low
- (iii) Multiple copies can be taken with the help of carbon papers.
- (iv) By increasing the number of pins from 7 to 9 or 24 the quality of printing can be increased.
- (v) It's operating speed is slow.

Troubleshooting dot matrix printer

Problem – printer does not function.

Solution

- ❖ Check the AC supply, if not proper fix it properly. Check the fuses, if necessary replace it.
- ❖ If the power light is ON. Check the ON – LINE connection, cable connections and try again.
- ❖ If the printer is still not working, try a self test printing. If it prints, the problem is with the cable or computer else the problem is with the printer.

Problem – The printer does not print during self test.

Solution

- ❖ Check the manual for the proper selection of combination of switches for self test. Power on the printer and try self test. If the printer is not printing, the problem is with the cable connecting the print head and the motor board control or with the command electronics in the printer's main board. Get the help of service engineer.

2.3.4. Ink jet printer

Operation

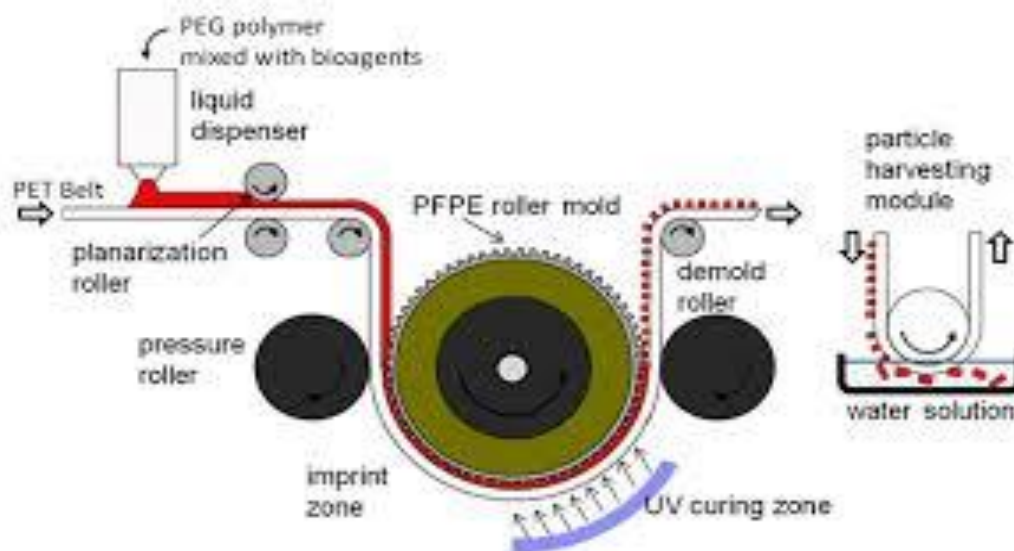
Inkjet printers are non – impact printers. The characters are formed by spraying ink droplets on the paper. This is done by pumping ink through a nozzle from an ink tank.

The figure given below shows the structure of an inkjet printer.

The ink jet from the tank is filtered and pumped out through a nozzle. A crystal oscillating a high frequency makes the ink to split into small drops. The ink drops are charged by using two electrodes as shown in the figure. This charged ink drops are deflected on the paper in such a way that it prints characters by using vertical deflection plates.

Construction

The figure given above shows the block diagram of an inkjet printer.



Interface Connector

Printers are connected to the computer through a 36 pin centuries interface cable. The data are received from the computer and stored in the printers buffer RAM. The buffer RAM can store one line to one page depending on the size of the RAM.

Control electronics

This unit contains an intelligent processor for controlling the functions of the printer.

Driver Circuit

This unit is used to control the print cartridge movement, paper feed mechanism, firing mechanism and control panel. Also it sends feedback signals to control electronics for monitoring the speed displacements of the mechanisms.

Paper feed mechanism

This unit is used to feed paper to the printer for printing .there is a paper sensor to sense the availability of paper. If there is no paper, it informs it to the user.

Ink cartridge carriage movement

The ink cartridge is placed on this carriage and is moved left and right by a stepper motor.

Firing mechanism

The ink from the cartridge is drawn into the firing chamber. In this, the ink drop is headed up to 900⁰C by means of a film resistor. This produces an ink bubble and is ejected out of the firing mechanism. The ejected heat ink bubble is deposition on the paper to form a dot.

Control panel

This unit contains the following buttons and lights

- (i) ON/OFF switch - to switch on the power
- (ii) Load/eject switch - to load or eject paper
- (iii) Nozzle cleaning button - to clean the cartridge nozzle or to replace Inkcartridge
- (iv) LED light - this light blinks when the ink cartridge becomes empty

Features

- (i) Both color and B & W printing is possible.
- (ii) Speed of printing is higher than dot matrix printer.
- (iii) Noise is less than dot matrix printer.
- (iv) Print quality is high
- (v) Variety of fonts is available
- (vi) Ink cartridges are portable and low cost.
- (vii) Replacing of cartridge is easy.
- (viii) Different paper sizes can be used.

Troubleshooting inkjet printer

Problem- printer sounds like it is printing, but not prints

Solution

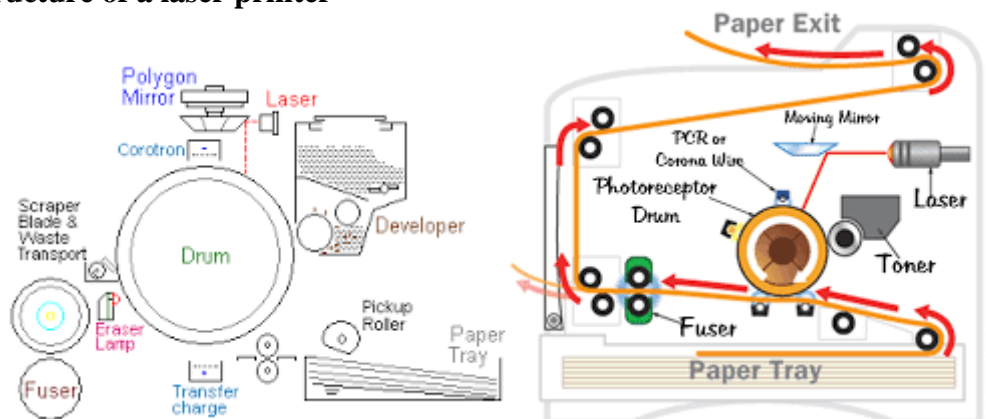
- ❖ print head nozzles may be clogged. Clean the print head nozzles by using the nozzle clean facility in the printer software.
- ❖ The ink cartridges may be older than six months. Clean the print head by using print head cleaning facility in the printer software.
- ❖ If the problem still exists replace the ink cartridge.

2.3.5. Laser printer

The laser printer was introduced by Hewlett- Packard in 1981. These printers are high speed non- impact printers.

Operation

structure of a laser printer



The heart of the laser printer is a small rotating drum made up of aluminium. This contains a coating that holds an electrostatic charge when exposed to light. Initially the drum

is given a high negative charge of about 600V. Then a laser beam is made to scan the drum with the help of rotating polygonal mirror. The light- beam discharges the area on the drum from – 600V to – 100V according to the characters to be printed.

Now a toner is applied over the drum surface. The low negative area(characters) on the drum attracts the toner. Then a positive charged paper is made to move over the drum. Now the characters on the drum are transferred to the paper. By applying heat and pressure to the paper the image is made permanent.

Construction

The figure given below shows the block diagram of a laser printer.

The important units are

(i) Drum cleaning blade

This unit is used to clean the photosensitive drum before printing new images. If it is not cleaned properly ghost images will appear on the output.

(ii) Eraser lamp

The light from this lamp is made to fall on the drum to neutralize the residual charges.

(iii) Primary corona

This unit is used to charge the photosensitive drum to -600V .this is the first step in printing and is called conditioning.

(iv) Laser beam unit

Using this unit a laser beam is focused on the drum using a rotating polygonal mirror. This light discharges there on the drum according to the characters to be printed This is the second step in printing and is called transferring the image to the drum

(v) Toner unit

This unit contains a developing cylinder maintained -600V. The toner from the toner tray is spread over this. When the cylinder comes in contact with the aluminium photosensitive drum, the toner particles are attracted on the image. This is the third stage in printing and is called deposition of toner.

(vi) Transfer corona

This unit is used to charge the paper to +600V. when the rotating aluminium drum comes in contact with the charged paper, the toner image will transfer on to the paper. This is the fourth stage in printing and is called image transfer.

(vii) Fusing rollers

These rollers are maintained at 180°C. The toner image paper is made to pass between the hot rollers. Because of heat and pressure, the toner particles melt and stick on to the paper. This is the last stage in printing and is called fusing.

Features

- (i) Quality of printing is high
- (ii) Low printing cost
- (iii) Colour printing is possible
- (iv) It is very easy to print on envelopes, cards and other non-regular media.
- (v) Speed of operation is high.

Troubleshooting the laser printer

Problem - Stains of small round black dots appear on the front or back side of the page
solution

- Check the type of the paper used by referring the media guide lines required for
- the printer using printer manual and use the prescribed paper.

- Clean the toner cartridge.
- If still the problem exists it is better to replace the toner Cartridge.

Line Printer

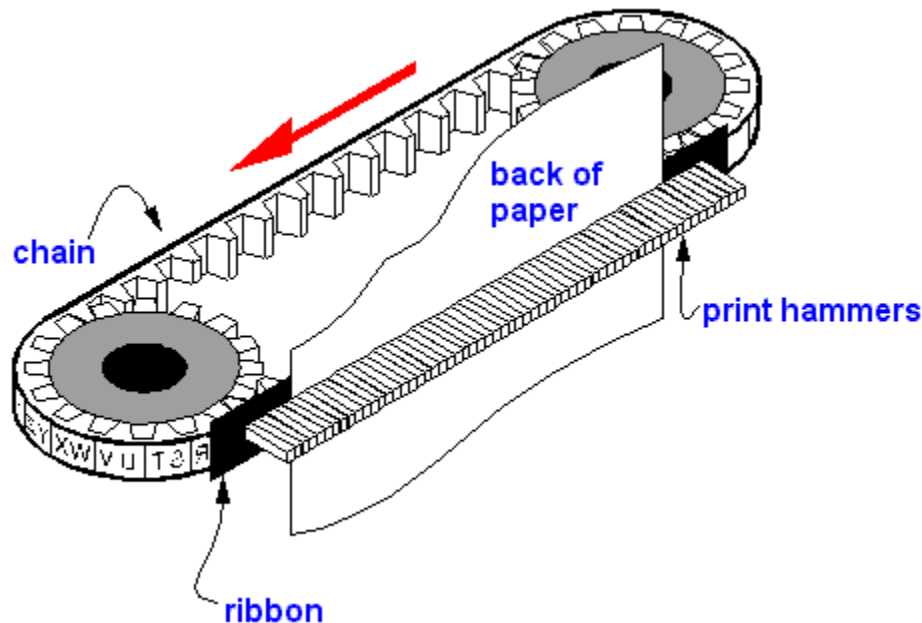
Line printer is an output device that can print one line at a time. so they are very fast. The speed of the line printers vary from 300 to 3000 lines per minute. There are two they are

- Chain printer
- Drum printer

(i) Chain Printer

The most common type of the line printer is the chain printer. In this the print characters are mounted on a chain which moves horizontally .independent print hammers are placed just opposite to each character but behind the paper. That is the paper and ribbon placed between hammer and the character as shown in the figure given below.

As the character to be printed passes of each print position of the paper, corresponding magnetically controlled hammer strikes on the character font, thus the paper kept in between gets printed. Here all the characters in a line are printed one after other. But because of the speed of operation it looks as if the entire line is printed in a single strike. The speed of line printers vary from 300 to 2000 lines per minutes.



Features

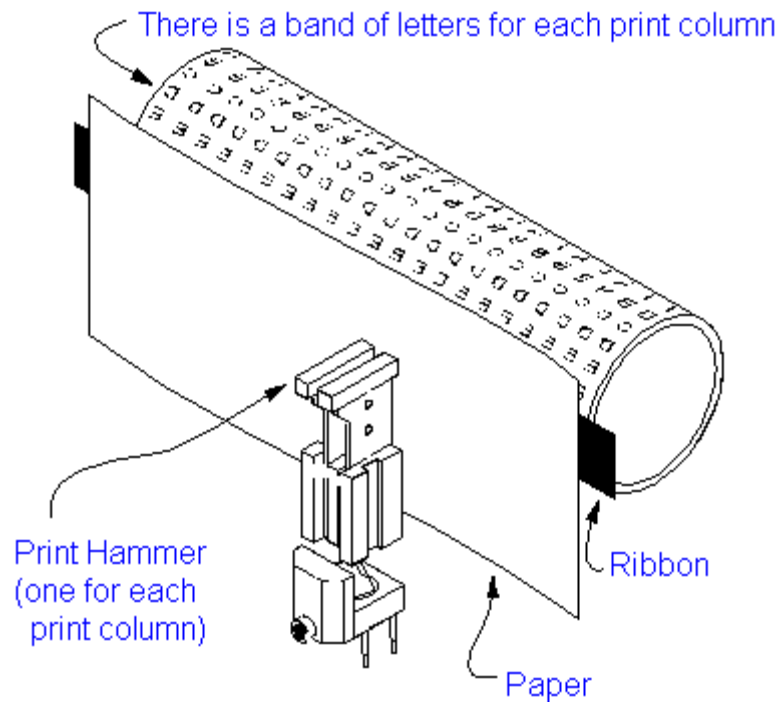
- we can different chains having different types of fonts
- High speed
- Operating cost low
- Continuous operation

Drum Printer

This printer has metal drum with rows of characters engraved on it. Small print hammers are arranged in front of the drum. in between the hammer and the drum the paper and the ribbon are placed as shown in the figure given below.

The drum at constant speed and are struck by magnetically controlled hammer as the required character passes the print position. Characters do not get printed one at a line from left to right. instead they are printed in the order in which they pass under the hammer. for example consider the printing of the line.

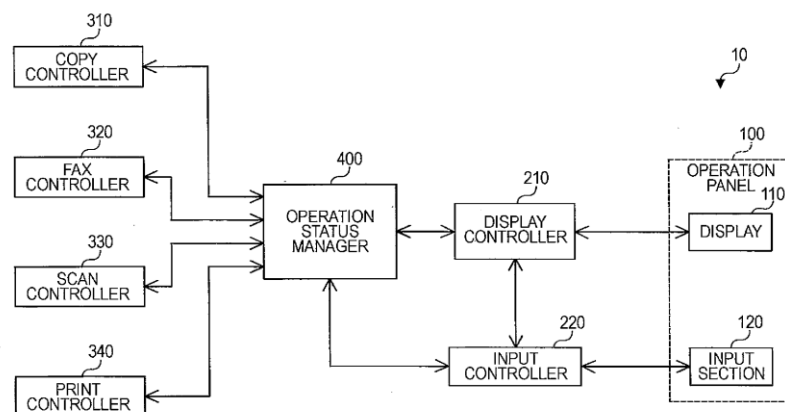
Drum Printer



2.3.6. Multi function printer(MFP)

Multifunction printer is a laser or inject printer that contains the functionality of multiple devices. The different function can be called out using an MFP are

- (i) E-mail
- (ii) Fax
- (iii) Photocopier
- (iv) Printer
- (v) Scanner



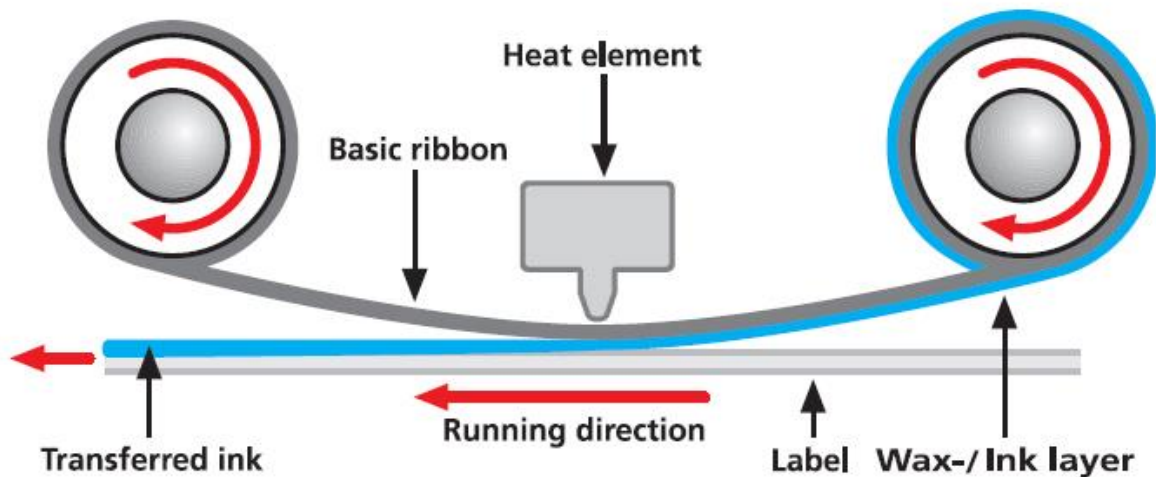
Features

- (i) Multifunction printer improves the efficiency and productivity of the organization.
- (ii) It saves time and energy.
- (iii) The cost of MFP is cheap compared to the cost of individual devices such as printer, fax, scanner, copier

2.3.7. Thermal Printer

Thermal printer is a non impact printer. This uses heat to be print the image on the paper. The print head contains many small resistive heating pins to heat the paper or the ribbon. Depending on the technology used, Thermal printers are divided into two types. They are

- (i) Direct thermal printer
- (ii) Thermal transfer printer



In **direct thermal printer** the images are formed by heating a special paper coated with a chemical called thermal paper. The thermal paper changes colour when thermal print head moves over. This type of printers do not use ribbons.

In thermal transfer printer the images are formed by heating a ribbon containing wax based ink. when ribbon is heated by thermal print the ribbon melts and transfers the image on to the ordinary paper.

The print head contains an array of electrical resistor heating elements. According to the character to print the microprocessor determines the heating resistors. The ribbon consists of three layers. They are

- (i) Base material
- (ii) Heat melting ink
- (iii) Coating on the print side of the base material

As the printhead moves over the ribbon, the heated resistors melts the ink behind the ribbon forming the character over the paper. Ribbons with different colours are available to print characters in colour

Features

- (i) Thermal Printers are small in size so they do not consume lot of scope.
- (ii) It is available in different sized and styles.
- (iii) Thermal printers are easy to operate and faster than ordinary printer.
- (iv) It is less noisy. This is because, this has less moving parts.
- (v) It is used in variety of applicants such as printing output of ultra sound scanning.

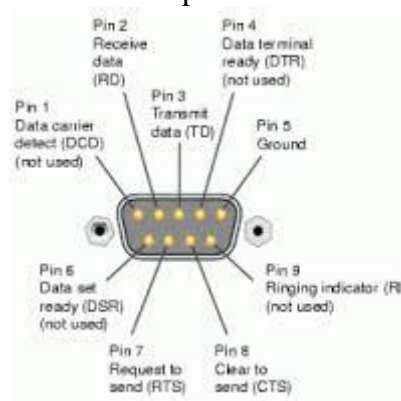
2.4. IO Ports

I/O Ports are used to connect I/O devices like keyboard, mouse, printer, modem, etc. with the system. The following are the standard I/O Ports.

- (i) Serial port
- (ii) Parallel port
- (iii) USB Port
- (iv) Game port
- (v) Blue tooth port
- (vi) IR connectors

2.4.1. Serial Port

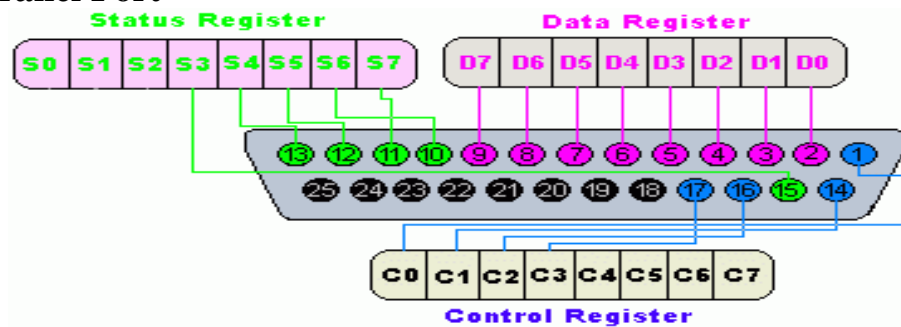
This port is used to send 1 bit 0, data, at a time between I/O device and the system. This port follows RS-232 standard. Present day computers have four serial Ports namely com1, com2, com31 and corm4 A 9 to 25 pin connector is used to connect the I/O devices to any one of the available serial ports. The figure given below shows the structure of a 9 pin connector.



The signals are

- pin 1 – Carrier detect signal. It is represented as CD
- Pin 2 - Driver/ Receiver. It is represented as RD
- pin 3 - Send data. It is represented as CD
- pin 4 - Data terminal ready, It is represented as CD
- pin 5 - Ground. It is represented as GND
- pin 6 - Data set ready. It is represented as DSR
- pin 7- Request to send. It is represented as RTS
- pin 8 – Clear to send. It is represented as CTS
- pin 9 – Ring Indicator. It is represented as RI

2.4.2. Parallel Port



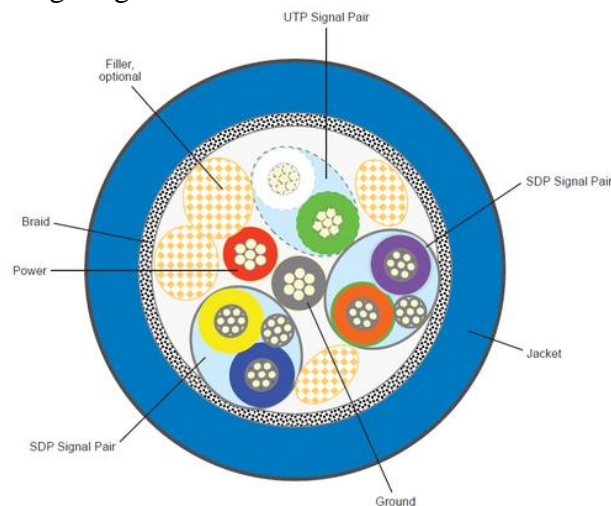
Parallel port is used to send 8 –bit of data at a time between I/O device and the system. This port is also called by the following names.

- (a) Centronics printer port
- (b) Parallel printer port

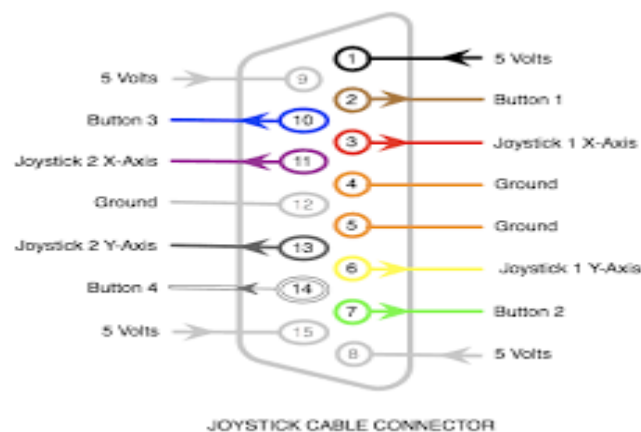
- (c) Standard printer port(SPP)
- (d) Line printer port
- (e) Enhanced parallel port (EPP)
- (f) Extended capability port (ECP)

2.4.3. USB port

USB port refers to universal serial bus port .using this port ,we can connect all types of I/O devices such as mouse, keyboard, scanners, digital camera, modem etc. This port sends data using a bi-directional pipe regulated by a host controller and hub controller.it has a 5v power supply. Using this we can connect hand held scanners and hard disks directly onto the USB ports. The figure given below shows the structure of a USB port with signals.



2.4.4. Game port



This port is used for connecting game controllers like joystick, cracker ball etc. to the system. The game port adapter is available in the multi I/O adapter board or on a separate 8 bit I/O card, with the help of special split cables we can connect two game controllers simultaneously. A 15 pin D type female connector is used to connect the game controller to the game port. The figure given below shows the structure of the game port connector and the signals.

Bluetooth interface



Bluetooth is a wireless device using this data can be exchanged within a short distance from fixed and mobile devices this uses open wireless protocol. This technology was developed in the year 1994 by Bluetooth specification was introduced by Bluetooth special interest group. The fig given below shows the Bluetooth logo.

Bluetooth uses a video technology called frequency hopping spread spectrum for communication. This technology splits the 2.402 to 2.480 GHZ radio frequency band into 79 frequencies of each 1MHZ wind called hops. Then it transmits the signal using a sequence of channels known to both sending and receiving devices using Bluetooth the user can connect 8 devices simultaneously.

The transmitter change frequencies 1600 times per second. This is to make use of the small radio frequency by more devices.

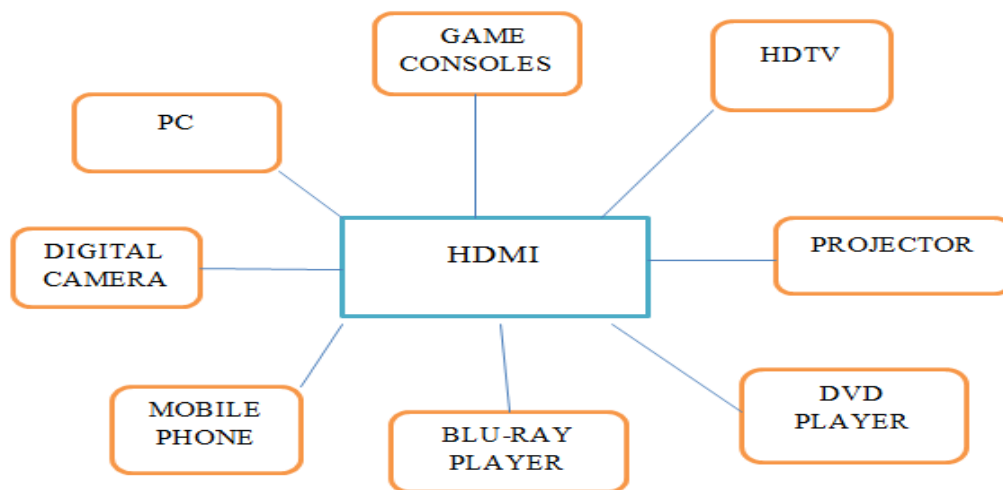
IR connector

An infrared (IR) connector is a port that can send and receive data using infrared light. Once it was common in laptops cell phones etc. Now days this is replaced by Bluetooth devices, but it is mostly used in remote controllers in various home and office equipments.



2.4.5. HDMI (High Definition Multimedia Interface)

HDMI is a connector and cable capable of transmitting high-quality and high-bandwidth streams of audio and video between devices. It is a digital replacement for analog video standards. The HDMI technology is used with devices such as an HDTV, Projector, DVD player, or Blu-ray player.



Features:

- i) HDMI technology eliminates unnecessary signal conversions.
- ii) It supports up to 8 channel digital audio on a single cable eliminating costly A/D signal conversions.
- iii) It offers Bi-directional control signal transfer.
- iv) It offers 5 Gbps bandwidth, 55% spared for future expansion.

Advantages:

HDMI technology is the global standard for connecting high-definition equipment. HDMI is the intelligent, all-digital interface that delivers both dazzling quality and unmatched ease of use. More than 1,600 of the world's largest consumer electronics, PC and mobile device manufactures incorporate HDMI connectivity into their products.

2.5. Displays

PANEL DISPLAYS

Panel displays are created with the help of technology other than CRT technology. The different types of panel displays are

- (i) LCD panel.
- (ii) Plasma panel.
- (iii) TFT panel display
- (iv) LED display

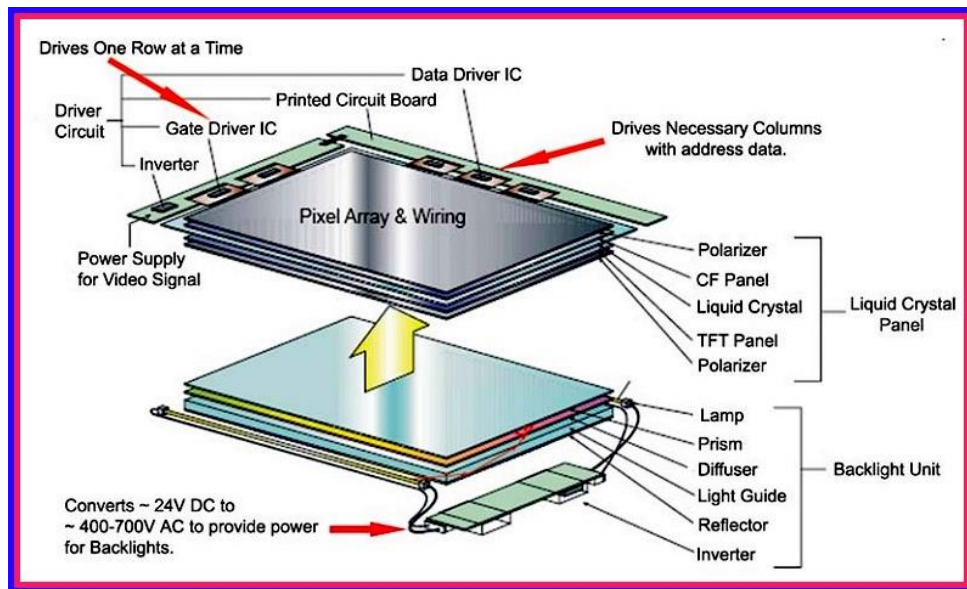
2.5.1. LIQUID CRYSTAL DISPLAY (LCD)

Introduction

This was discovered in 19th century by an Austrian botanist friedrichreinitzer. In this display is made up of liquid crystals. Liquid crystals are transparent substances having a property of both solid and liquid.

LCD principles

Most liquid crystals contain long rod-like molecules. In their natural state the molecules are arranged (aligned) almost parallel to their long axis. By placing the liquid crystal in a finely grooved surface, the molecules arrangement can be controlled that is, if the grooves are parallel, the alignment of molecules also becomes exactly parallel.



Polarizing filter-light is made to fall on the polarizing filter. The polarizing filter changes the direction of the light parallel to the axis of the filter. That is, it allows only the light rays parallel to its axis. Refer Grooved plate1 and plate2-liquid crystals are placed in the finely grooved plates are kept perpendicular. So the plate 2 molecules are arranged in north to south direction and the plate 1 molecules are arranged in east west direction. Because of this, molecules are forced to a twisted state of 90° . Therefore, the light passing through this is twisted to 90° . Polarizing filter on the bottom-this polarizer is kept perpendicular to the top filter. Since the light rays from the polarizer is twisted to 90°

Electric voltage is given across the liquid crystal, the molecules between the grooved plates realign vertically. Because of this, the polarized light is passed through without any twist. So the bottom polarizer does not allow the light to pass producing a dark pixel.

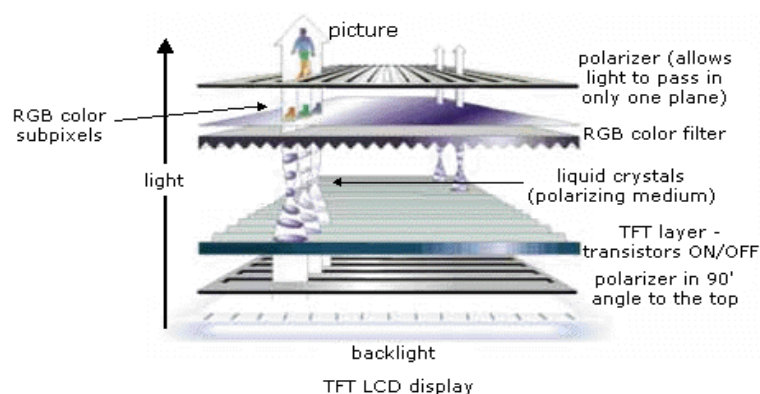
Colour LCD displays use additional red, green, blue coloured filters over three separate LCD elements to create a single multicolour pixel.

By changing the across the voltage across the liquid crystal, we can make the images to appear on the screen.

2.5.2. TFT displays

The full form of TFT is thin film transistor. This transistor is a special kind of field effect transistor. This is made by depositing a thin film of a semiconductor layer over a dielectric such as glass. This technology is used to improve the image quality of LCD's by eliminating ghosting and slow response speed of images.

Construction



TFT LCD displays are made by placing liquid crystals in-between two glass plates namely color filter and TFT glass.

TFT glass has number of thin transistor (TFT) to match the number of pixels to be displayed. Color filter glass has color filter to generate color. Voltage is given between the colour filter glass and TFT glass.

Working

When an electric voltage is applied, liquid crystals move according to the difference in voltage between the color filter glass and the TFT glass. The direction of polarization changes depending upon the amount of voltage. As the polarization direction changes, more or less light passes through the polarization layer on the face of the display.

The image in TFT panel is formed by a method called active matrix driving. The figure given below shows the structure of the active matrix LCD.

TFT are formed by means of a thin film of silicon deposited on a glass plate. The transistor acts as a pixel and the remaining area are etched away to allow light to pass. Depending on the amount of light passed, the transistors act like a storage capacitor and refresh to display the image.

2.5.3. LED displays

The full form of LED is light emitting diode. This is a special kind of diode. When electric current is applied it emits light. In LED TV, an array of LED bules are used to provide the back light to illuminate the display. The figure given below shows the structure of LED displays.

The working principle of LED TV is same as LCD, but instead of fluorescent back light LED light is used. LED array consumes less space and weight than fluorescent one. Therefore, the thickness and weight of the LED T via less than the LCD TV. LED TV gives much more color quality than the LCD. There are two types of LED more color quality than the LCD. There are two types of LED TV.

- (i) Edge LED lighting
- (ii) Full LED lighting

Edge LED TV consists of light emitting diodes around the edge of the back light panel. The light enters from the outer edge to the middle of the screen.

Full LED TV consists of LED's across the entre back.

2.7Graphics cards

2.7.1. Video Graphics Card (VGA)

Introduction

A video card is used to process images so they can be displayed on your monitor. A good video card can make a big difference in the quality of your graphics, so this is particularly important if you play games or work with photography and video.

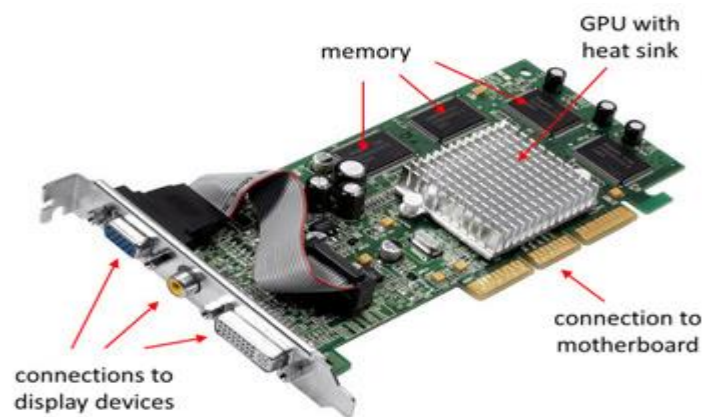
Definition

A **video card** connects to the motherboard of a computer system and generates output images to display. Video cards are also referred to as **graphics cards**. Video cards include a processing unit, memory, a cooling mechanism and connections to a display device.

Functions

For relatively low-end computer systems, the ability to create output images can be integrated into the motherboard or central processing unit (also called CPU). However, if you want to watch movies or play games on your computer (and who doesn't, at least once in a while?), a dedicated video card greatly improves the quality of the graphics. For serious gamers, a high-quality video card may just be the most important part of the computer system - it's a must for rendering 3D graphics in particular.

A video card is a printed circuit board (like a motherboard) and contains its own processing unit and memory. It is like a kind of computer in itself. This essentially takes the load off the motherboard's CPU and memory to process images. The processing unit on a video card is referred to as a **graphics processing unit (GPU)**. This is very similar to a CPU, but its design is optimized to work with images. The memory on a video card is very similar to the regular random-access memory (or RAM) on a motherboard. A video card connects to the motherboard of a computer system using a slot, typically an Accelerated Graphics Port (AGP) or a Peripheral Component Interconnect Express (PCIe) connection.



Video card with the major components labeled

2.7.2. SVGA

The full form of SVGA is Super Video Graphics Array. This display adapter was introduced by Video Electronics Association in 1989. It is a high-resolution standard used to channel video data to a compatible visual output device-usually a computer monitor. This is actually a board umbrella term for other computer display standards. Originally, it was just an extension to the VGA standard, which was a purely IBM-defined standard also known as ultra video graphics array (UVGA).

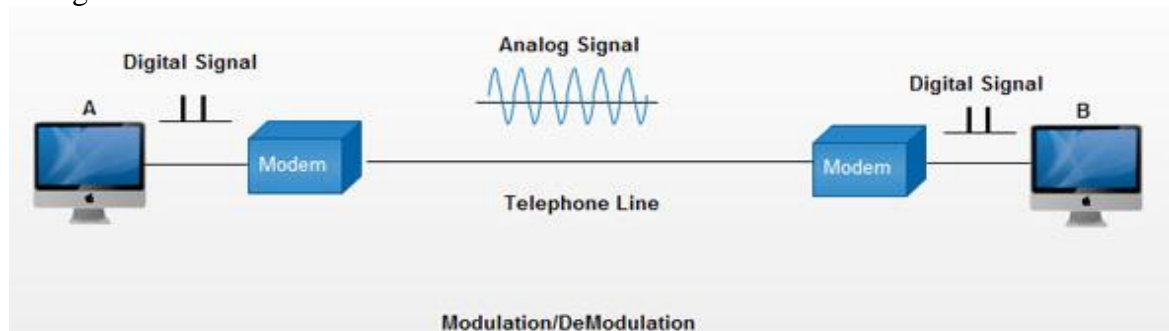
The important features are,

- (i) It offers very high resolution of 800 x 600 and 1024 x 768 pixels in 16 colours.
- (ii) It supports both graphics and text mode.
- (iii) It has 0.5 MB or 1MB Video buffer RAM.
- (iv) It offers 32 bit interface.
- (v) It offers wide range of colors (256 colors)

The figure given below shows the pin connection

2.8. MODEM

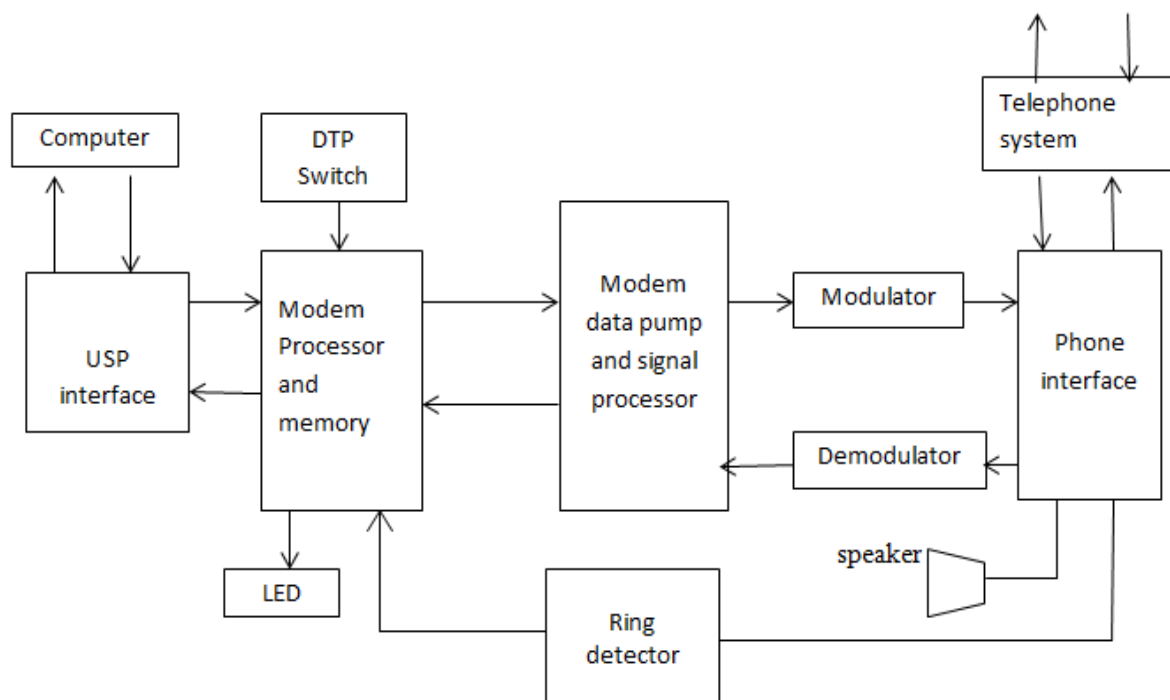
Modem is a device which is used to connect computers with telephone system. Its full form is modulation and demodulation. It helps communication between computers through the existing telephone cables. The figure given below shows the structure of data communication through modem.



2.8.1. Operation

The digital data from the computer is converted into analog data by the modem and is transmitted over the telephone line. The analog data received from the telephone line is converted to digital by the modem and is given to computer.

Block diagram of modem



USP interface

This interface is used to connect computer and modem through USP port. The user communicates to the modem with the help this interface.

Modem Processor and Memory

This unit is used to control the operations of the modem with respect to the Hayes commands. DTP switches are used to set auto answering.

Modem data pump and signal processor

This unit receives serial signal data and gives it to the modulator. Also it receives demodulated data from the demodulator and gives it to the mode processor.

Modulator

This unit is used to convert the digital data from computer into analog data (signal). This process is called modulation. This is done by adding a carrier signal to the digital signal.

Demodulator

This unit is used to convert the analog data (signal) from telephone system into digital data. This is done by eliminating the carrier signal from analog signal.

Phone interface

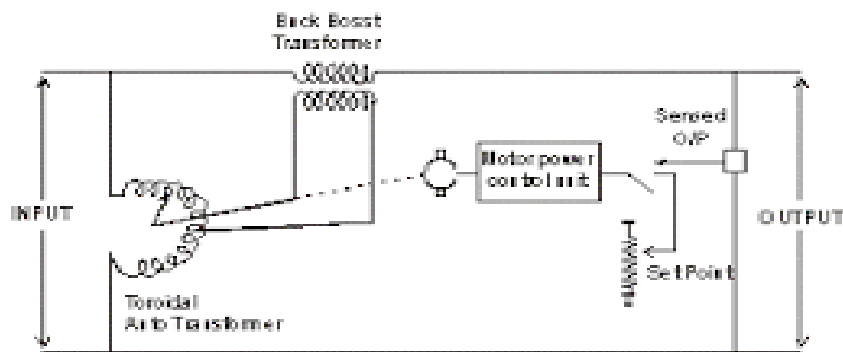
This interface is used to

- (i) Connect modem with the phone socket.
- (ii) Dial the number for making communication.
- (iii) Detect the incoming ring signals.
- (iv) Connect speaker for giving voice information, ring tone, data tone, engaged tone, etc.

2.9. Power supply

2.9.1. Servo stabilizer

Stabilizers are used to boost or buck the incoming voltage to give a constant output voltage. The figure given below shows the structures of a servo stabilizer.



Servo stabilizer Circuit Diagram

Construction

Servo stabilizer is made up of an auto transformer. This has two windings wound in different direction as shown in the above figure. There is a moving contact which moves over the windings. The moving contact is rotated by a servo motor. The error amplifier is used to give an error voltage to the driver which the servo motor.

Working

In ordinary stabilizer, the transformer has a number of tappings or windings. With the help of relays, the appropriate tapping can be switched to give output voltage that is nearly equal to the line voltage required.

But in servo stabilizer there is an error amplifier to give an error there is an error amplifier to give an error voltage. This voltage is got by subtracting the dc reference voltage V_{ref} and dc

voltage rectified from the output line. This voltage drives the servo motor in a direction to boost or buck the output voltage from the secondary of the transformer. Since the error amplifier continuously monitors the output voltage, we get constant voltage output. By adjusting the value of V_{ref} , we can set the desired output voltage.

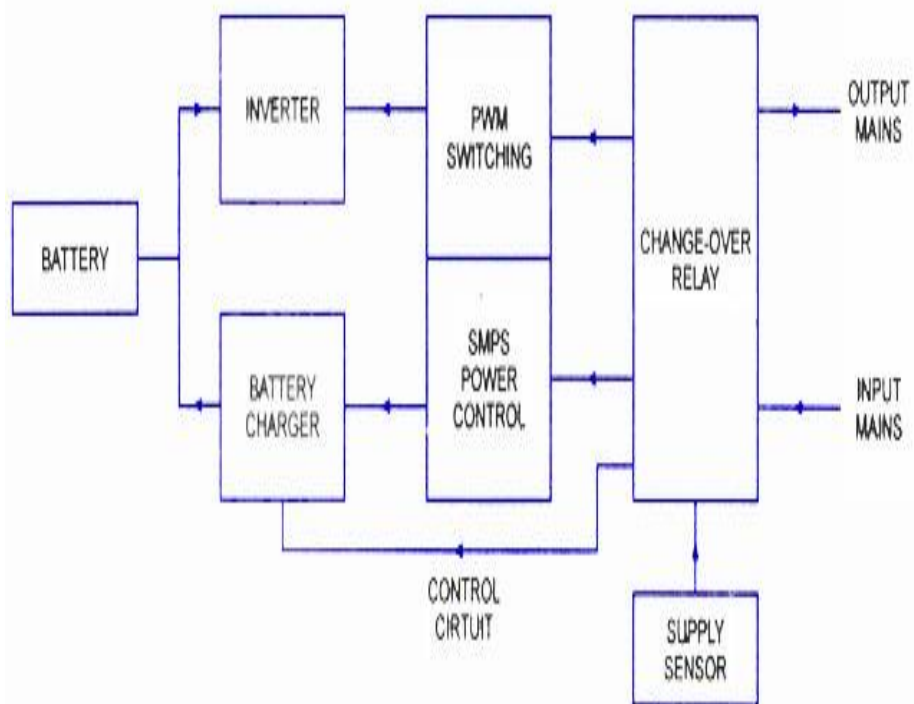
2.9.2. Uninterrupted power supply(UPS)

Uninterrupted power supplies are used to provide continuous power to the computer system during availability of a/c and during power cut. There are two types of ups

- (i) Off – line ups
- (ii) On – line ups

(i) Off – line ups

block diagram of off – line ups.

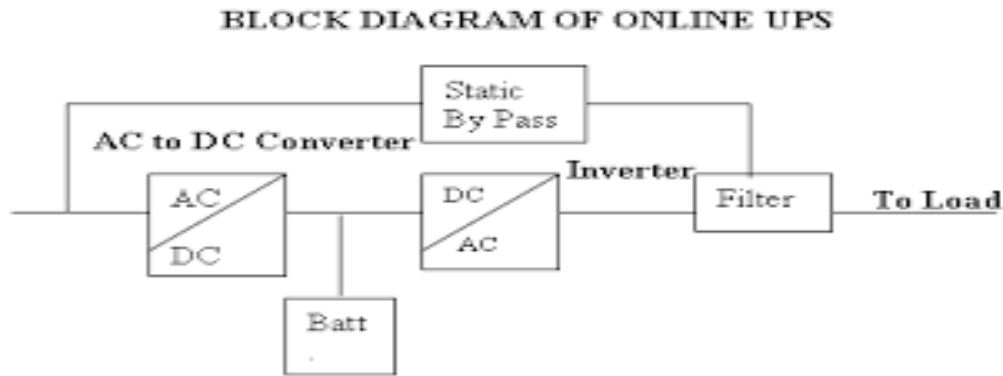


An off- line ups is otherwise called standby power system. It uses a circuit to sense the AC input. If the sensing circuit detects any failure, it quickly switches to the standby Power system (SPS). The SPS changes the load to the inverter and it draws from the attached batteries and supplies continuous power.

Disadvantages

- (i) Electronic sensor takes a finite time to sense power failure. So system will shut down.
- (ii) Switching time is high, so system will shut down.
- (iii) Power regulation is poor
- (iv) No protection against surges or spikes.

(ii) ON- line ups



As Shown in the above figure, batteries are always connected to the output through inverter. So always it is supplying power from the battery to the computer. Therefore on – line ups's get never interrupted because it does not need to switch its output from main power to batteries.

When AC power is available, the batteries are charged through the rectifier circuit. When the power fails, the charging of the battery stops and the system gets a continuous supply from the battery.

Advantages

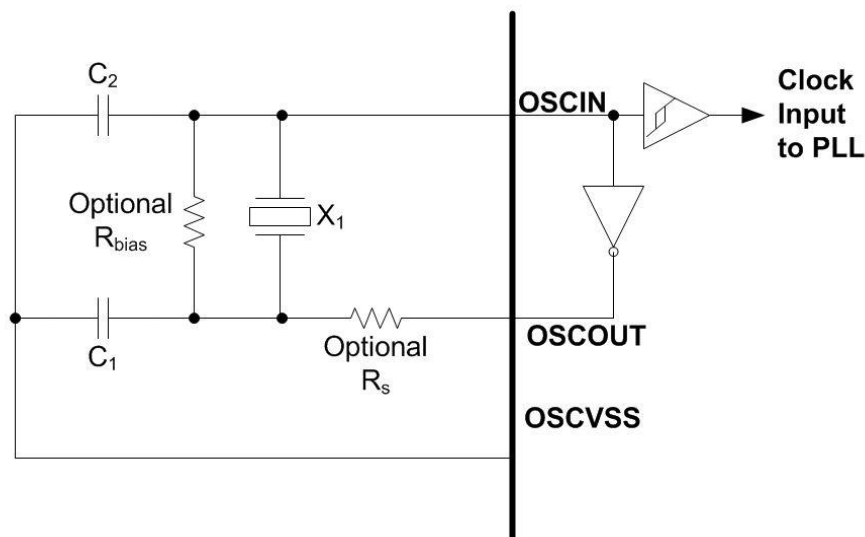
- (i) It protects against surges and dips.
- (ii) If there is a problem with ups, we can connect the incoming ac directly to the with the help of the bypass switch.
- (iii) It supplies smooth constant power supply.
- (iv) It guards the computers from lighting effects.

Surge Suppressor and spike isolators

Surge is defined as an over voltage that lost for longer duration say three or four nano seconds. This damages the electronic equipments. **Surge suppressor** is a device inserted in the AC line to prevent damage to electronic equipment from over voltage.

Spike is defined as a over voltage that lasts for shorter duration say one or two nano seconds. This damages the electronic equipments. **Spike isolator** is a device inserted in the AC line to prevent damage to electronic equipment from over voltage.

Operation



Normally the standard voltages in India is 240v. If the voltage rises above 240volts there is a problem in the input voltage. Surge or spike suppressor helps to prevent the over voltage from damaging the equipments. The figure given below shows the structure of a surge or spike suppressor.

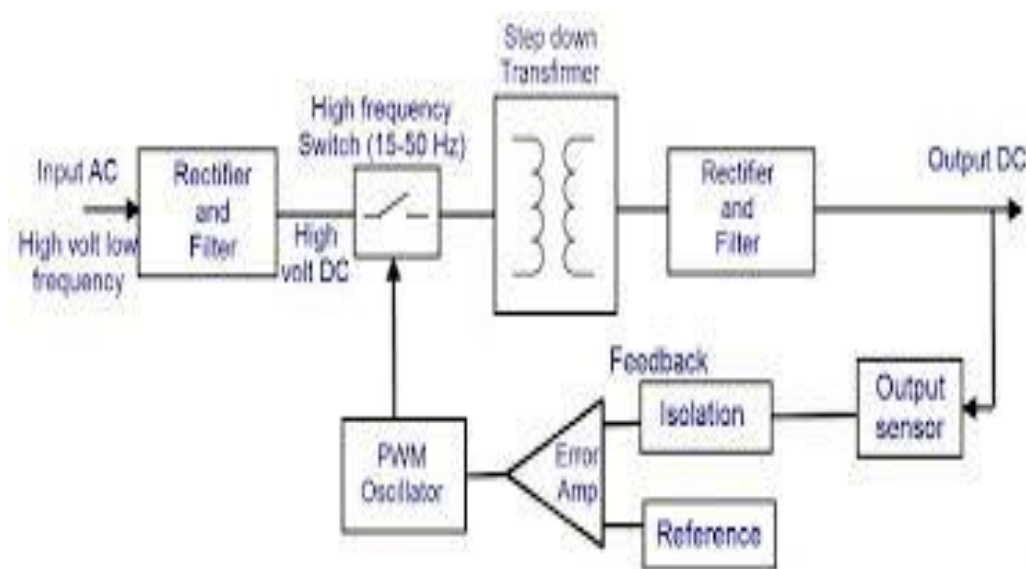
The main part of the surge suppressor is metal oxide varistor called MOV. This contains a piece of metal oxide material in the middle joined to the power and grounding line by two semi conductors. The varistor is a variable resistance and this depends on voltage.

Let the threshold voltage be ± 230 . When the input voltage is below this, the electrons in the semi conductor flow in such a way to create a very high resistance. Therefore no current flows to ground. But if the input voltage exceeds the threshold, the electrons in the semiconductor flow in such a way to create a low resistance and allow the extra current to flow to ground. When the input voltage is correct MOV does nothing. By increasing the resistance, the input current is controlled.

2.9.3. SMPS

SMPS stands for switch mode power supply. This receives 230V a.c and translates it into different dc levels such as + 5V, - 5V, +12 V and -12 V.

Block diagram and basic principle of operation of SMPS



Basic principle

Basic principle of SMPS is, the input C voltage is first rectified and filtered. This unregulated Dc voltage is fed to a high frequency DC- to – DC converter to produce regulated Dc voltage levels.

Operation

The power supplies used in computers are switched mode power supplies. The primary power received from a.c mains is rectified and filtered as high – voltage Dc. Then it is switched on to a high frequency approximately 10 to 100 KHz by a bipolar transistor and fed to the primary side (P) of a step- down transformer. The secondary side (S) of the transformer is rectified and filtered. Then it is sent to the output of the power supply. A sample of this output is sent back as feedback for regulation as shown in the above figure.

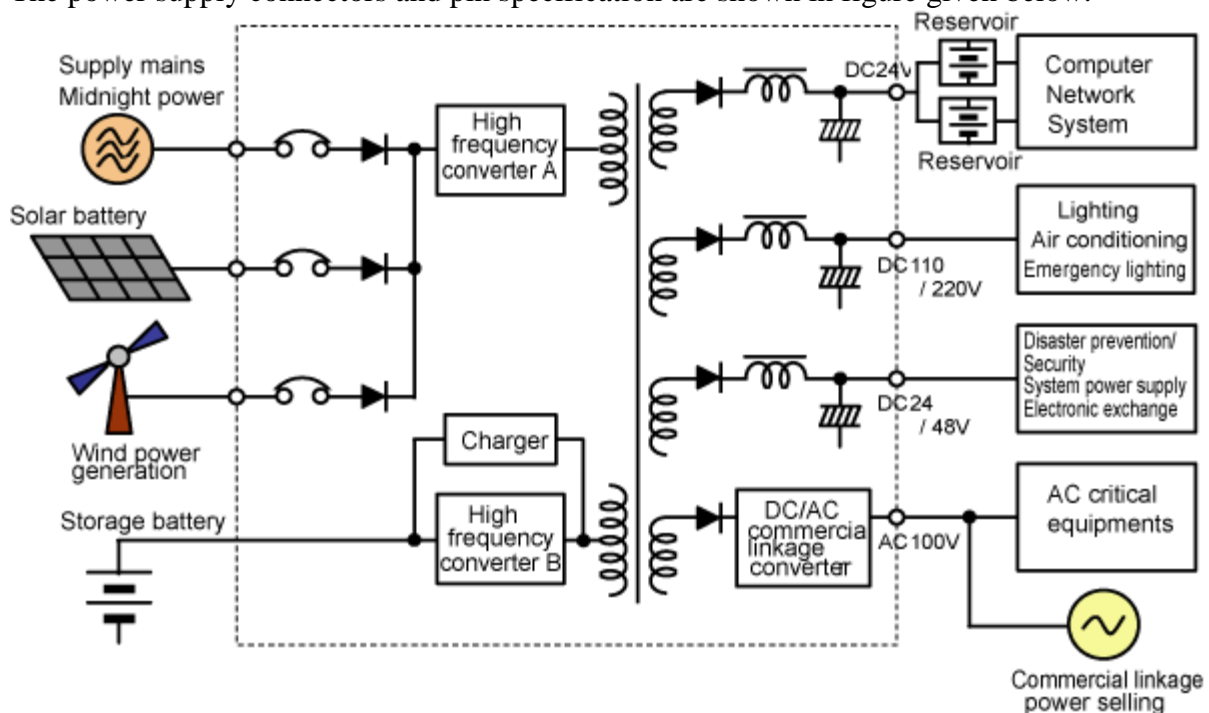
Regulation

The output voltage is regulated by means of pulse width modulation. In this the following happens

- (i) When the output load increases, the output voltage falls. The pulse width modulator control senses the change in the output voltage and increases the ON time of the transistor. This amount of voltage will be passed through the transformer. So the output will be maintained normally.
- (ii) When the output voltage increases, the pulse width modulator control senses the change and decreases the ON time of the transistor. This reduces the amount of the voltage passed through the transformer. So the output will be maintained normally.

2.9.4. ATX Power supply connector specification

The power supply connectors and pin specification are shown in figure given below.



- | | |
|--------|--|
| +3.3 V | - The +3.3v DC supply is used to support the low- voltage logic. |
| +5V | - It is used to give power supply to the components like hard disk, floppy disk, compact disk, etc |
| GND | - GND signal gives ground connection to all the devices attached with the CPU. |
| +12 V | - It gives power supply to the motors in the drives. |
| - 5 V | - This voltage level is used for dynamic memory bias voltage. |
| -12V | - This voltage level is used by the RS232C serial port. |

- Power Good - This signal is tied to the CPU's reset pin. This is used to release the reset and the CPU can begin processing.
- Power ON - Power ON is an active – low signal that turns on all the main power outputs (+3.3) Vdc, +5Vdc, -5Vdc, +12 Vdc and -12 Vdc)
- FanM signal - The FanM signal is an open collector 2- pulse per revolution tachometer signal from the power – supply fan. This signal allows the system to monitor the power supply for fan speed or failures. If the signal is not implemented on the motherboard, it should not impact the power – supply function.
- FanC signal - The FanC signal is an optional fan – speed and shutdown – control signal. The fan speed and shutdown are controlled by a variable voltage on this pin. This signal allows the system to request control of the power supply fan from full speed to off. The control circuit on the motherboard should supply voltage to this pin from +12 Vdc to 0Vdc for the fan – control request.
- 3.3 – V sense line – A remote 3.3 – V sense line can be added to the optional connector to allow for accurate control of the 3.3 – Vdc line directly at motherboard loads.
- 1394V pin - This pin on the optional connector allows for implementation of a segregated voltage supply rail for use with unpowered IEEE–1394 (“fire wire”) Solutions. The power derived from this pin should be used to power only 1394 connectors (unregulated anywhere from 3 to 10 V).
- 1394 R pin – The 1394 R pin provides an isolated ground path for unpowered IEEE – 1394 (“fire wire”) implementations. This ground should be used only for 1394 connections and should be fully isolated from other ground planes in the system.

REVIEW QUESTIONS

PART - A

1. Expand the term LED.
2. What are membrane and mechanical keyboard?
3. Define: Blue tooth interface.
4. List out the types of printers.
5. What is parallel port?
6. Define: Spike Isolator.
7. Expand the term UPS.
8. What is Multi-Function Printer?
9. Write the signal specification problems with interfaces.

PART - B

1. Explain the operation of optical mouse.
2. Write the working principle of Ink jet printer.
3. What are the features of MFP?
4. Explain the working principle of modem.
5. Explain in detail about SVGA.
6. Write the working principle of LCD.
7. Explain Bluetooth interface.

PART - C

1. Explain the working of wireless keyboard with block diagram.
2. Explain the construction and operation of laser printer.
3. Explain the working principle of LED and LCD displays.
4. Briefly explain the working principle of offline UPS.
5. Briefly explain the working of servo stabilizer.

UNIT – III

MAINTENANCE AND TROUBLE SHOOTING OF DESKTOP AND LAPTOPS

3.1. BIOS – Setup

Basis of BIOS

BIOS stands for basic input output system. All the motherboards comes with a BIOS chip called CMOS RAM. This contains read only programs that are used to setup the computer system. These programs acts as an interface between the raw PC hardware and the operating system. Therefore every system uses a slightly different BIOS. It is necessary to setup the BIOS during system installation.

Once BIOS setup is done and saved , it is stored in the CMOS Ram. Since Ram lost its contains when power is removed, a battery is added to the PC that gives continuous power of the CMOS RAM. We can change the setup settings by executing the setup program. When computer is switched on, a message will he displayed on the screen to enter setup. This message varies with different BIOS setup. Normally the message **press DEL to enter setup** will be displayed on the screen. If this option is selected starts the setup utility and displays the main menu of the utility.

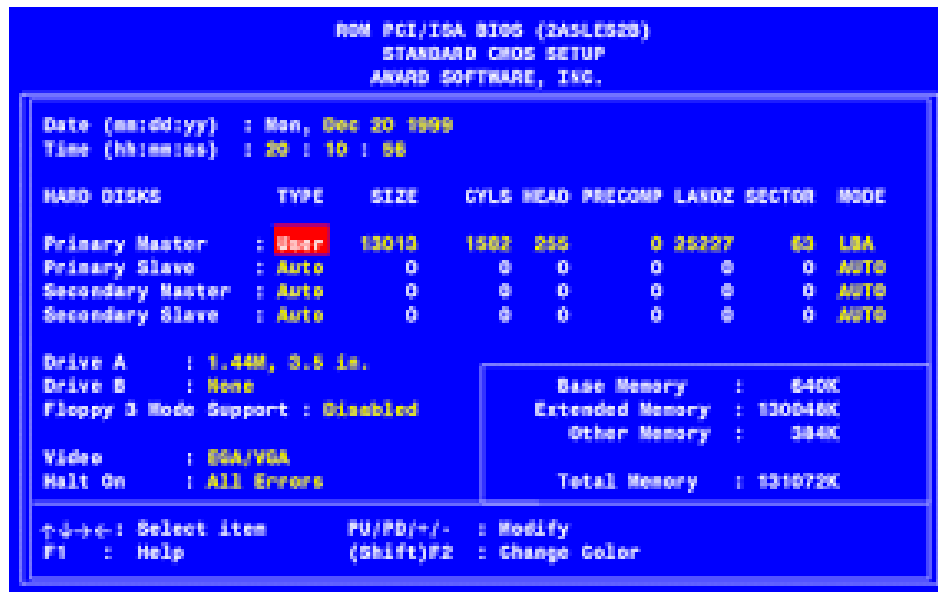
Various setup options

If we enter into BIOS CMOS setup utility, a main menu appears on the screen . Arrow keys are used to select items and enter is used to run the selected item. Some options lead to tables of items. These items have a value on the right side and the first value is highlighted. By using pgUp or pgDn keys the value for each item is selected . The table given below lists the various options.

Options	Usage
Standard setup	To set date/ time , floppy drive A& B , master hard disk and slave hard disk.
Advanced setup	To set keyboard , display , mouse support , system boot sequence and drive seek.
Chipset setup	To set cache memory , seek time
Power Management setup	This menu provides functions to set time – out value for monitor and HDD. This includes sleep mode time out. Suspend mode time- out , VGA power down and HDD power down.
Load fall save default	This menu is used to load the BIOS values for the minimal stable performance of the system.
Load optimized defaults	This menu is used to load the factory settings of BIOS.
Supervisor/ User password setting	This allows is used to limit the access to the system by setting password. So every time the system is booted it asks for the password.
Save and exit	To save all changed values to CMOS and to exit the setup.
Exit without saving	Drop all changed values and exit setup,.

3.1.1. Standard CMOS setup

Standard CMOS setup consists of basic data about our system such as system's date, time, and attached devices such as floppy drives and hard drives. It is very important to enter this data correctly. If it is not entered correctly, the system will not boot. The following are the common entries found in the standard CMOS setup menu.



(i) Assign IRQ for VGA

When this option is **enabled**, the system assigns an IRQ for the video card. This speeds up for the transfer of data between CPU and video card. When this option is **disabled**, the IRQ can be used for other purpose.

(ii) Date and time

This option is used to change the data and time of the system clock.

(iii) Day light savings

When this option is enabled, the RTC (Real time calendar which maintains regular date and time) automatically adopts to the daylight savings scheme. That is, it removes one hour on the last Sunday of October and adds it to the last Sunday of October and adds it to the last Sunday of April 8, this option must be enabled.

(iv) Error halt

This option is used to decide whether the system has to be stopped when an error is detected during booting. The different options are.

- (a) No errors : The system will not stop for any errors.
- (b) All errors : The system will be stopped when the BIOS detects a nonfatal error. The error will be prompted.
- (c) All, but keyboard : The system will be stopped for all errors except keyboard error.
- (d) All, but disk : The system will be stopped for all errors except disk error.
- (e) All, but disk/ keyboard : The system will be stopped for all errors except disk / keyboard error.

(v) Floppy drive A & B

This option is set by selecting the type of the floppy disk in drive A and B.

(vi) Hard disk

This shows the characteristics of the hard disk drives on the IDE channels. SCSI hard disk drives do not appear. Generally all modern hard drive parameters will be auto detected. If the hard drive cannot be auto detected the following six parameters must be given manually.

- (a) Cyl : Enter the number of cylinders on the installed hard disk.
- (b) Heads : Enter the number of heads on the installed hard disk.
- (c) WPre : Enter the write precompensation value as – 1 or maximum number of cylinders on the hard disk.
- (d) LZ : Enter the cylinder used for the landing zone for older drives Without auto parking feature . Set it to 0 or maximum cylinders.
- (e) Sect/Trk : Enter the number of sectors per track .it is normally 17 For mfm drives and 26 for RLL drives.

(vii) Memory

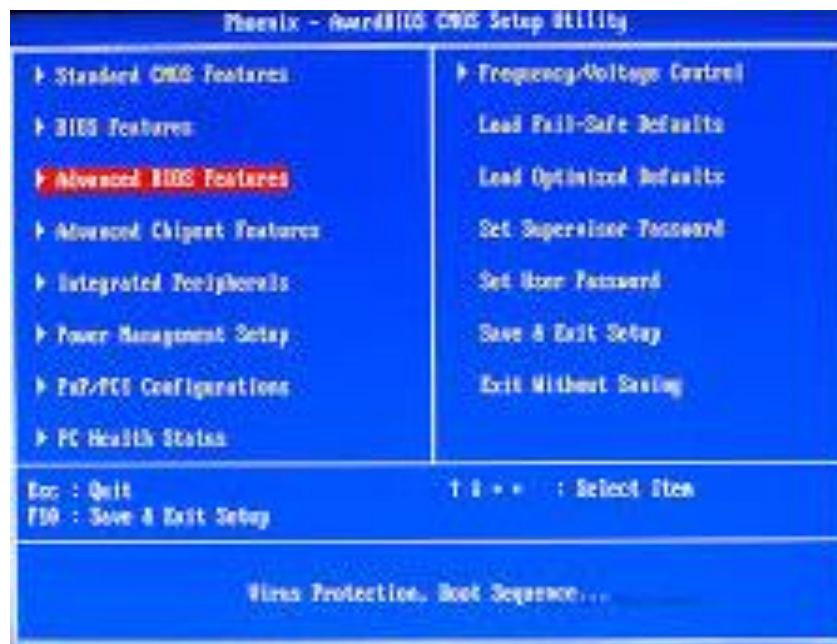
This option tells about the details of the memory elements. The contents are determined by the POST (power on self test). The different memory elements are

- (a) Base memory** : The BIOS POST determines the amount of base memory installed in the system.
- (b) Extended memory** : The BIOS POST determines the amount of extended memory installed in the system.
- (c) Other memory** : This memory can be used for other applications. The most common use of this area is shadow RAM and AGP buffer area.
- (d) Total memory** : This total memory is the sum of base, extended and other memory.

(viii) Primary display

This option is used to specify the type of the display the system is using.

3.1.2. Advanced BIOS setup



Advanced BIOS setup contains settings to boost the booting characteristics. This optimizes the performance of the memory and cache. Most options found in this are not important to the proper working of the system. But it helps the user to make the system for their taste. The following are the options available in the advanced BIOS setup menu.

(i) Above 1MB memory test

When this option is enabled, the system will check only the memory above 1 MB for errors.

(ii) Auto configuration

When this option is enabled, the user cannot change the advanced DRAM timing options.

(iii) Boot sector virus protection

This option gives a warning whenever any virus attempts to write into the bootsector. It is always better to enable this option.

(iv) External cache memory

This option allows the user to enable or disable the external cache(L2 cache)in the system. If there is L2 cache in the system enable this option else disable it. If this option is enabled without L2 cache, the system will lock.

(v) Internal cache memory

This option allows the user to enable or disable the internal cache (L1 cache) in the CPU. If there is L1 cache in the system enable this option else disable it. if this option is enabled without L1 cache, the system will lock.

(vi)Floppy drive seek at boot

This option is used to select whether floppy drive has to be checked at boot time or not. It is always better to disable this option for faster booting and damage to FDD R/W heads.

(vii)Memory parity check error

Parity checking improves the integrity of data in the memory. When this option is enabled, it gives an error message as given below when an error is detected.

PARITY ERROR AT OAB5:00BE SYSTEM HALTED

If disabled, the memory error will go undetected. This leads to system failure.

(viii)Memory test tick sound

This option is used to generate audible tones or ticks when memory test is going on.

(ix)Numeric processor test

This option is used to test the built in coprocessor. This must be enabled.

(x)Password checking option

This option enables the user to set password to access the system.

(xi)Shadow memory cacheable

Shadowing is a process of copying ROM to RAM. This process increases the performance of the system. Therefore it is always to enable this option.

(xii)System boot sequence

This option is used to set the order in which the drives are checked by the operating system while booting. It is always better to select C:/A: for faster booting. Modern BIOS supports booting from CD- ROM also.

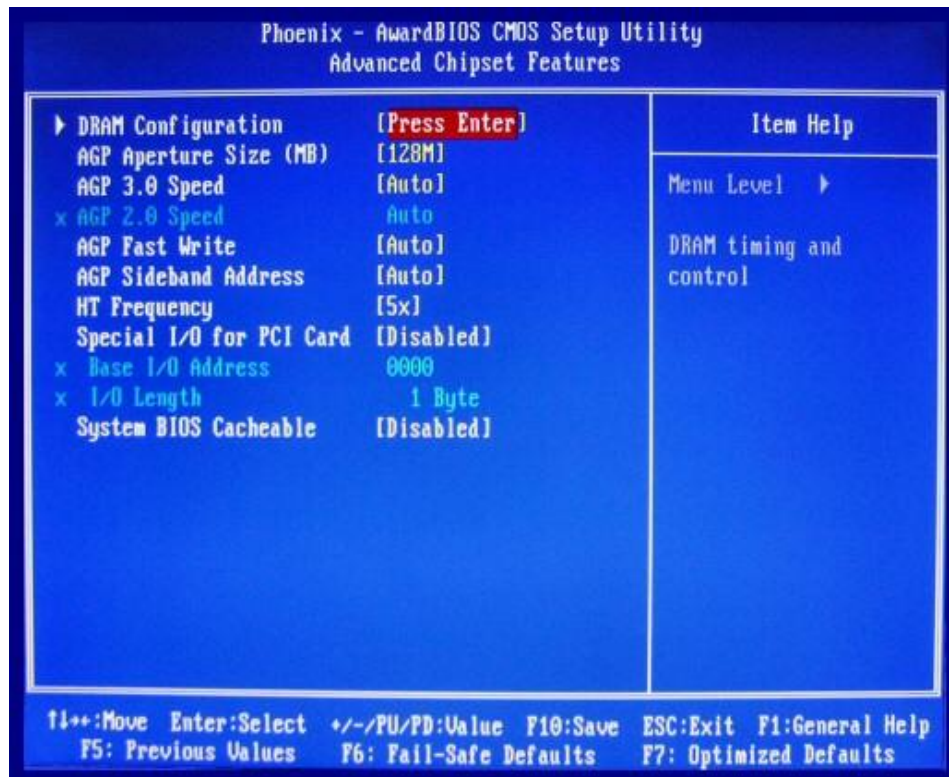
(xiii) System boot- up number lock

Using this option, the user can enable or disable the number lock key at boot up.

(xiv) Wait for F1 for any error

When this option is enabled, the system will halt and wait for F1 key to be pressed for any errors before proceeding. If disabled, the system displays an error message and continues with booting without waiting for a F1 input.

3.1.3. Advanced chipset features



In today's computer systems, the chipset core logic provides a number of advanced features. To configure the chipset, a number of variables are involved. The advanced chipset features in CMOS allow the users to tune the performance of the chipset. The following are the advanced chipset features available in CMOS.

(i) 16 – bit memory I/O wait state

This entry lists the number of wait states inserted with 16 – bit memory and input/output operation. Too many wait states reduce bus performance and too few wait states cause bus error and system locks. It is always safe to use BIOS default value.

(ii) 8 – bit memory, I/O wait state

This entry lists the number of wait states inserted with 8 – bit memory and input/output operation. Too many wait states reduce bus performance and too few wait states cause bus error and system locks. It is always safe to use BIOS default value.

(iii) Alternate bit in tag RAM

Tag bits are used to determine the state of the information stored in the L2 cache. If we want to use write back caching method, use 7+1 setting; else use 8+0 setting.

(iv) Automatic configuration

When this option is enabled, BIOS automatically set the settings in the advanced chipset setup.

(v) Burst copy back option

This option can be enabled or disabled, when enabled it makes the chipset to make a second memory read.

(vi) Burst refresh

This option performs several refresh cycles at once.

(vii) Burst RAM cycle

This option is used to specify the timing of the burst mode read and write cycles from the L2 cache. This option has two timings 4-1-1-1 and 3-1-1-1. It is best to choose the lowest setting.

(viii) Bus mode

This option is used to select the clock mode used to drive the bus. There are two modes namely synchronous and asynchronous. It is better to choose synchronous mode.

(ix) Concurrent refresh

This option enables both the processor and refresh hardware to have enables to the memory at the same time. If this option is disabled, the processor has to wait until the refresh hardware has finished. This slowdown the system performance.

(x) Decoupled refresh option

This feature ISA bus and RAM to refresh separately. Because ISA bus refreshes slowly, separating the refresh cycles cause less strain on the CPU. it is better to enable this option.

(xi) DMA clock source

This option is used to set the clock used for the DMA transfer. The maximum setting for ISA based system is 5MHz.

(xii) DMA wait states

This option is used to set the number of wait states inserted before DMA is attempted. It is better to choose lower number.

(xiii) Fast AT cycle

This option speeds up the ISA cards data transfer. It is better to disable this option for system stability.

(xiv) Fast cache read/write

This option improves cache performance through memory interleaving techniques. If there are two banks of cache (64 KB or 256 KB) it is always better to enable this feature.

(xv) Keyboard reset control

This option enables CTRL-ALT-DEL reboot.

(xvi) Memory read wait state

This option is used to set the wait state in nano seconds when the cpu wants to read from RAM. It always better to set minimum value. This value is calculated approximately using the formula.

$(\text{RAM speed in ns} + 10) * \text{clock speed in MHz} / 1000 - 2.$

(xvii) Refresh value

This option is used to set the refresh value. Lower the value better the performance.

(xviii) Video BIOS area cachable

This option is used to improve the performance of video.

3.1.4. Power Management

The CMOS setup has number of power management features to save the energy when the system is idle. Even though PC's consume less power, this feature makes the PC more power efficient. The following are the power management options in CMOS.

(i) Doze timer

This option is used to set the time delay before the system reduce its 80% activity. Ten to twenty minutes is the preferred time.

(ii) Green timer of main board

This option is used to set the time before a CPU of an idle system will shutdown.

(iii) HDD standby timer

This option is used to set the shutdown time of HDD after the system is idle.

(iv) Modem use IRQ

This option is used to enter the IRQ assigned to modems. If there is an activity on the selected IRQ the system will be in **awaken** mode. This feature is called **wake on ring**.

(v) Power management scheme

This option is used to define the amount of power management in the system by the user. The options are

- ❖ Disabled - Global power management will be disabled.
- ❖ User define - User can define their own power management settings.
- ❖ Min saving - Predefined timer values are used when all timers are in maximum value.
- ❖ Max saving - Predefined timer values are used when all timers are in minimum value.

(vi) Standby timer

This option is used to set the timer delay before the system reduces its 92% of its activity.

(vii) Suspend switch

This option is used to enable or disable hardware suspend switch on the motherboard.

(viii) Suspend timer

This option is used to set the time after which the system goes into the most inactive state. When this option is enabled, the system requires a warm up period for cpu, hardware and monitor to go on line.

(ix) Video off option

This option is used to turn off the display. The different options are

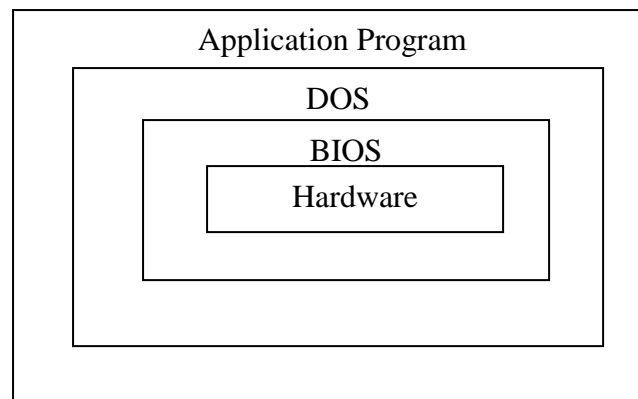
- ❖ Always on – BIOS will not turn off the display
- ❖ Suspend off – Display is off when system is in suspend mode.
- ❖ Suspend standby off – Display is off when system is in standby or suspend mode.
- ❖ All modes off - Display is off when system is in doze, standby or suspend mode.

3.1.5. PC BIOS Communication

At the end of the system bootup, the operating system is located and loaded into the memory. After loading, the operating system takes the control of the system. The operating system takes the control of the system. The operating system acts as an interface between the application programs and the hardware through the help of BIOS. There are two types of PC BIOS communication depending on the operating system used. They are

- (i) BIOS – DOS communication
- (ii) BIOS – Windows communication

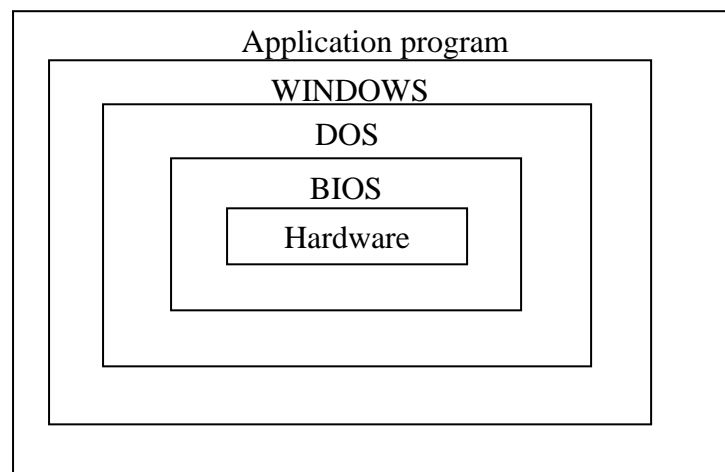
(i) BIOS – DOS communication



The hardware BIOS – DOS interaction in a PC system is shown in the above figure. BIOS is the first software layer that covers the PC hardware. It is also called a firmware since it is closely linked with hardware for I/O operations. DOS occupies the next layer. The user programs and commands are given to the hardware(CPU, memory etc)through BIOS by DOS.

(ii) BIOS – Windows communication

The hardware BIOS- DOS – WINDOWS interaction in a PC system is shown in the figure given below. DOS can run only some programs. To widen the application WINDOWS was developed. This is placed between the DOS and application program. All DOS programs can be able to run under all versions of windows. Windows simplify the user task into greater extent. The later versions from windows 95 is a full operating system that doesn't need DOS.



3.1.6. Upgrading BIOS

Upgrading the BIOS is a process of changing the existing in the system to a higher version. The BIOS contains essential codes, which allows the computer to boot and provide critical interface between the hardware and software. BIOS is encoded in a chip and is called

CMOSRAM. Earlier versions of systems had removable BIOS chip. Now a days motherboards come with fused BIOS chips.

Suppose if a user wants to add more features to the existing BIOS, the only way is to upgrade the BIOS. Upgradation of BIOS is possible in the following ways.

- (i) If the BIOS chip is removable replace the old BIOS chip by a new one.
- (ii) If the BIOS chip is fused, it can be upgraded with the help of the upgraded BIOS versions provided in the BIOS manufactures web sites. The upgraded versions can be downloaded in the system and can be programmed in the BIOS chip.

3.1.7. Flash BIOS

Flash BIOS is nothing but a BIOS utility stored in a electrically erasable programmable read only memory (EEPROM) chip. This is normally fused in the motherboard and can be erased and reprogrammed.

The main use of flash BIOS is, the user does not have to go a new BIOS chip for upgradation. Instead, the user can upgrade the flash BIOS by flashing (storing) the new version of the BIOS in the EEPROM chip.

3.2. POST

3.2.1. Definition

Post is a series of program routine in the motherboard ROM firmware and is used to check the system components. This was introduced by IBM in 1981. When we switch on the computer, POST is executed first and automatically performs a series of tests that check the various components in the system. The components tested by POST are CPU, ROM, motherboard support circuitry, memory and major peripherals.

Whenever a faulty component is found, it gives an error or warning message. There are two types of error message. They are

- (i) Audio error codes
- (ii) Display error codes

The POST programs are stored in the final 8KB area of the 1 MB BIOS ROM. At once the computer is switched on or reset, the microprocessor starts processing POST from memory address FFFF0.

3.2.2. IPL hardware(Initial program load)

IPL hardware is the minimum hardware needed to begin POST successfully. At once the computer is switched on or reset, the IPL hardware transfers control to POST. After completion of all tests, POST transfers control to the bootstrap program. Boot strap program can be either read form hard or floppy disk. The IPL hardwares are

- (i) Power supply
- (ii) Clock logic
- (iii) Bus controller
- (iv) Micro processor
- (v) Address latches
- (vi) Data bus and control bus transceivers
- (vii) BIOS
- (viii) ROM address decode logic

3.2.3. POST test sequence

Table below the tests performed by POST. It also gives the address if an error is encountered in the sequence of the test. The half address tells us how far POST has

progressed and indicates where the problem lies. This halt address can be read from the I/O slot address signals.

Sequence NO	Test	Activities	Halt address
1.	CPU test	Interrupts are masked off internal flags are tested internal registers are tested	FE0AD
2.	BIO ROM checksum test	Check sum test is performed on the ROM. The least significant byte of the resultant checksum should be zero.	FE0AD
3.	Timer 1 test	8253 timer 1 is programmed for mode 2 operation check for basic access count check for count interval	FE0EE FE101
4.	DMA	DMA channel address registers and count registers of all channels are tested. DMA channel 0 is initialized. Timer 1 is initialized.	FE121
5.	16KB DRAM	Memory refresh cycle starts. Different five test patterns (AA,55,FF,01,00) are written and read back	FE164
6.	Interrupt controller 8259 initialization	Control words are sent to 8259 to initialize the interrupts modes. Setup the interrupt vectors in memory.	
7.	Interrupt controller test	Setting and resetting the interrupt mask register. Looking for the presence of any stack or false interrupt.	FE23E FE23E
8.	Timer 0 initialization	Timer 0 is initialized to operate in mode 3. Check timer 0 for correct rate	
9.	CRT controller test	Initialized the 6845 CRT controller test the video RAM. Check for any parity error setup the video mode by reading configuration (DIP) switches verifies the timings of video and sync signals.	
10.	DRAM after 16KB test	Different five test patterns (AA,55,FF,01,00)are written and read Back. if test fails, POST displays the failing address and data on the screen.	
	Keyboard test	Check the keyboard by issuing a keyboard reset. Check for any stuck keys. Check BASIC ROM by using the	

		checksum test. Check if any diskette adapter card and disk drive A are present if present. POST will load the operating system from the disk if not present, it is loaded, it is loaded from hard disk.	
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3.2.4. Beep codes and error message

POST error codes are audio codes consisting of various beeps that identify the faulty component. If any problem is detected during start of the system, the different series of audio codes are sounded. The table given below lists the different audio codes and its related problem area.

Beep code	Error message
No beep	Power supply
Continuous beep	Power supply, memory
Repeating short beep	Power supply
1 long and 1 short beep	Motherboard
1 long and 2 short beep	Video adapter card
1 short beep and bad/no display	Video cable and / or display
1 short beep and no boot	Disk cable, adapter or disk

3.3. Diagnostic software and viruses

3.3.1. Computer viruses

Viruses are malicious computer programs. These programs attach themselves as executable code and infect the user's computer. They can replicate themselves on the computer and damage data or executable files without the users knowledge.

These programs hide copies of themselves in various locations such as boot sector, FAT, partition table, program files, hidden files and data types. Virus programs attaches itself with other programs and spreads from one machine to another. The full form of various is **vital information resources under seize.**

With the help of the following, we can feel the presence of virus in our system.

- (i) Programs take longer time to load
- (ii) Takes more disk space than normal operation
- (iii) Disk volume name changes
- (iv) Hidden files or bad sector appears
- (v) Size of executable files changed
- (vi) Unexpected changes to file date and time
- (vii) Less free memory available than usual
- (viii) Random, unexplained error occurring.

3.3.2. Precautions to be taken to avoid viruses

- (i) Regularly execute CHKDISK and check the size of the base RAM of the memory
- (ii) Important files or data should be given read only attributes.
- (iii) Note down the size of the COMMAND, COM file. It should not change.
- (iv) Check regularly for hidden files and bad sectors.
- (v) Do not allow outside floppy disks in our computer.
- (vi) Install a good anti virus software in the machine.
- (vii) Take backups of important files and data.
- (viii) Use separate directories for program and data files.
- (ix) Before installing new programs, carefully check for viruses.

3.3.3. Anti- virus software

Anti-virus software or scanners are programs which are used to search the system area as well as program files for known virus infections. These are created as a response to known viruses. No virus scanner is 100% effective. There are two basic types of virus scanners.

(i)On demand

These scanners must be initialized through some manual or automatic process. Once started, it searches the entire drive or system for known viruses and tells about infection.

(ii)Memory resident or on access

Memory resident virus detection program will be loaded in RAM during system is booting and is active as long as the system is on. Whenever a program is accessed it checks for the known viruses and tells about the infection.

The presently available anti-virus software's are

- (i) Microsoft antivirus
- (ii) Norton antivirus
- (iii) Norton doctor
- (iv) Symantec's Norton antivirus
- (v) K7 Anti-virus
- (vi) Avira

Norton

Norton is antivirus software. It is used to protect the computer resources from known viruses. With the help of this we can detect and clean the known viruses. Since new viruses are evolving every day, the Norton developers introduced number of versions of software. The important versions are

- (i) Norton antivirus 2000
- (ii) Norton antivirus 2001
- (iii) Norton antivirus 2002
- (iv) Norton antivirus 2003
- (v) Symantec's Norton antivirus 2004.

The latest version supports all type of operating systems such as windows XP, XP Pro, XP home etc. the important features are

- (i) Automatically removes viruses, worms and trojan horses.
- (ii) Scans and cleans both incoming and outgoing e- mail messages
- (iii) Detects and blocks viruses in instant message attachments.
- (iv) Downloads new virus protection updates automatically to protect against new threads.

- (v) Worm blocking facility worms such as **Nimdain** outgoing mail
- (vi) Script blocking facility defends against fast moving script based viruses such as **I LOVE YOU** and **ViratKohli** etc..
- (vii) Worm blocking and script blocking can detect new threads even before virus protection updates are created for them.

3.3.4. Identify the signature of the virus

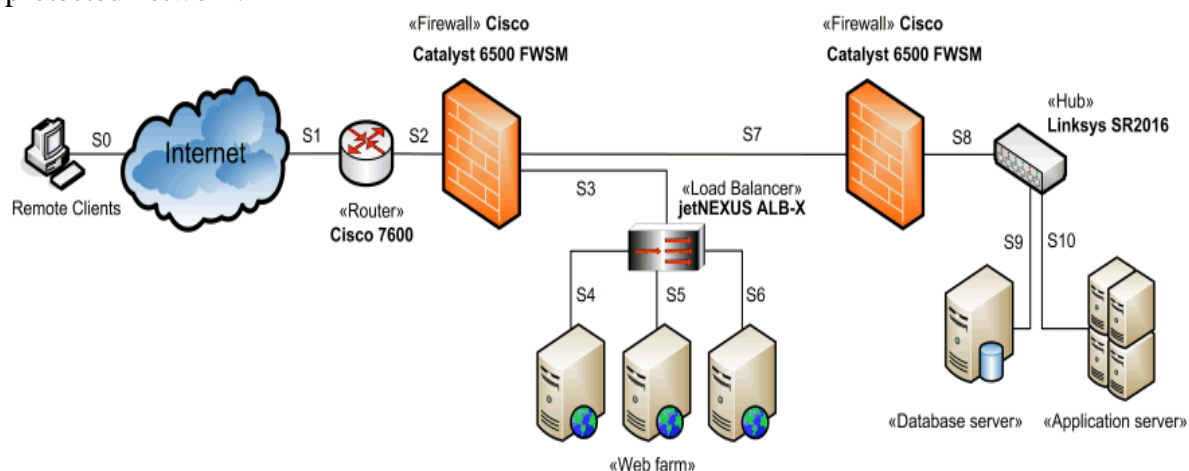
Antivirus scanners are used to protect against known viruses. These scanners use a file called **signature file** to detect the viruses. A **signature file** is simply a database that lists all known viruses, along with their specific attributes. The attributes are

- (i) Samples of each virus code
- (ii) The type of files it infects
- (iii) Any other useful information

When the scanner checks a file, it checks whether any of the code within the file matches any of the entries in the signature file. If it matches, it detects the virus and informs it, for necessary action.

3.3.5. Firewalls

Firewall is a protection barrier (software) between the network of computers or a computer and outside world(internet). The figure given below shows the structures of firewall protected network.



As shown in the above figure, firewall software is loaded in a separate computer. All traffic between the local network or computer is made through the firewall. The firewall inspects all the data coming in and out of the network using a predefined security checks. So it act as a guard to protect the network or a computer from unwanted codes or viruses reaching the computer or network from internet. The important types of firewalls are

(i) Packet filtering gateway

This is the simplest firewall. This contains filters to screen the incoming and outgoing traffic this for unwanted codes.

(ii) IP packet screening routers

In this, the firewall contains number of predefined screening rules. The rules include allowed IP addresses and allowed incoming message protocol such as (TCP, UDP, ICMP). So all the incoming or outgoing information are checked with these rules. If they match the rules they will be allowed to pass. All others will be screened.

3.3.6. Latest diagnostic softwares

1. Process Explorer

It is a small utility available for free. It can help to find out the files directory opened by a program. If you need information that what file or folder is using a process then this tool is very helpful. It is useful to track the DLL version problems or handle leaks.

2. Widows Sysinternals Suite

Sysinternals suite is collection of diagnostic and troubleshooting utilities provided by Microsoft for free. So it includes all the utilities which can help to troubleshoot a PC. Process explorer and other useful tools like Autoruns, PsTools, desktops etc are bundles with this.

3. System Explorer

It is also a free software tool to get the detailed system information. It is an award winning software which can explore the internal system and process running in the computer.

Main features:

- Get details about tasks, process services, drivers and opened files,
- File database can help to find out the suspicious files.
- System resources detailed graphs.
- WMI browser and more.

4. SIW (System Information for Widows)

SIW technician's version is a portable utility which can be run from USB to analyze and gather all the detailed information of the system. Check out some of the great features of it. It comes as home edition and technician edition. It is a paid utility.

5. HWiNFO

Popular and award winning hwiinfo is a free software utility for hardware monitoring and reporting with detailed analysis. It can generate reports and logfiles in XML, CSV and HTML Formats. It alerts about the system health by real time monitoring. Customized tables and graphs option.

6. Speccy

Speccy is a hardware information tool by Piriform. It gives detailed information about motherboard, graphics card, CPU, RAM etc. It is a free utility. There are some more advanced features are available in its Pro version.

7. hddscan

It is a disk drive diagnostic tool. HDDScan is available free to download. It can check storage devices including USB drives for bad sectors. You can change some HDD parameters like AAM and APM. It show the SMART information in detail. Temperature of the disk is also monitored by this utility. It is very helpful to get alert before your disk drive get damaged.

3.4. LAPTOP

A laptop is a personal computer. It is a small weightless computer designed for mobile use. Laptop computer **integrates most of the components** of the desk Top computer. This is powered by a rechargeable battery.

Difference between laptop and desktop

The table given below lists the important difference between laptop and desktop.

S.No	Desktop	Laptop
1.	Desktop can be used only at affixed position. It is portable.	Laptop can be used anywhere. It is portable.
2.	Heavy weight	Less weight
3.	It costs less	It cost high.
4.	It can be expanded easily	Less chance for expansion.
5.	It produce more heat	It produce less heat
6.	It operates in direct AC supply	It has a built in battery for operation

3.4.1. Types of laptop

The following are the most commonly available laptop types. They are

- (i) Light weight or ultra-portable
- (ii)Every day computing
- (iii)Desktop replacement
- (iv)Entertainment

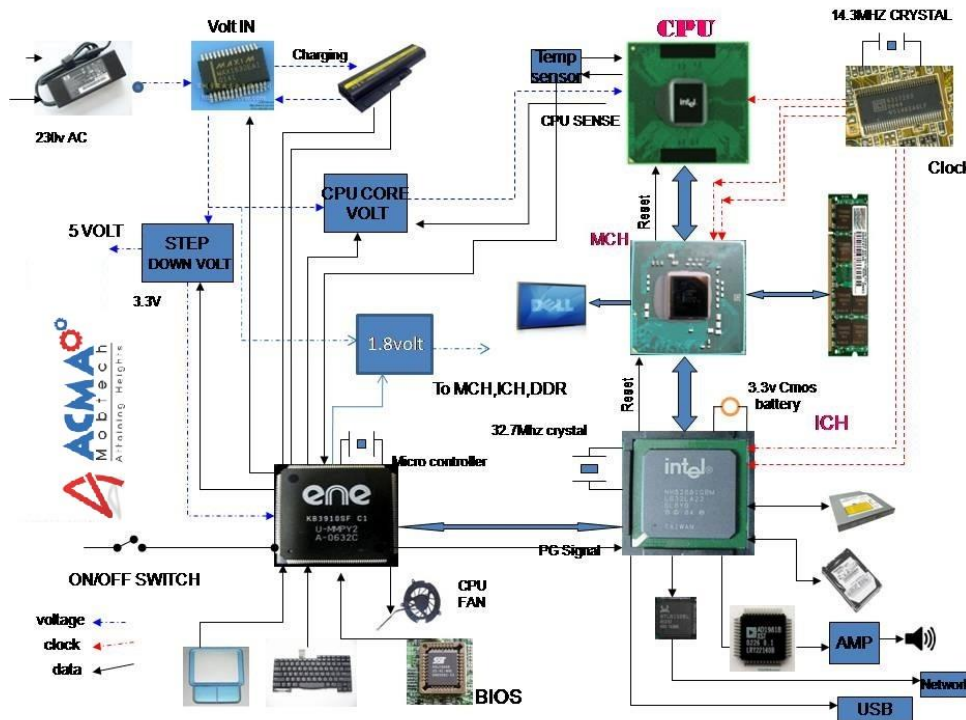
Light weight or ultra-portable laptops are designed to carry easily. The size and weight are very less. It is less than 2kg, 1.5 inch thick and 13 to 14 inch screen size.

Every day computing laptop is a mid size laptop. The size and weight is more then light weight laptop.

Desktop replacement laptop gives a full PC experience. It offers comfortable keyboards, large hard disk, big screen and large memory.

Entertainment laptop serve as an entertainment center. It has a wide screen with in good quality speakers, blu- ray players, large memory etc, the users can watch movies and play games.

3.4.2. Block diagram of laptop



3.4.3. Working principle

The working components of the laptop are represented by a rectangular box. When the laptop is switched on, the needed DC power is given by the power supply part. the data and programs for execution are given to the laptop through the input device and are stored in the hard disk. The I/O controller controls the operation of I/O units.

During execution the needed data instructions are loaded into the main memory and it is transferred to the CPU. According to the pulse of the RTC (real time clock) it is executed. The processed result is again sent to the main memory. From memory it can be displayed on the LCD monitor or can be stored permanently on the HDD. The memory controller controls the operation of main memory and the video controller controls the operation of LCD.

3.4.4. Configuring laptops

Configuring laptop is defined as a process of setting the new laptop for normal usage. The following basic configurations are necessary for type of laptop.

- (i) Uninstall all the unwanted software installed by the manufacturer.
- (ii) Protect the laptop by assigning so that nobody can access the laptop contents.
- (iii) Install security programs to protect the laptop against viruses and other software threads.
- (iv) Install recovery software. Recovery softwares are used to trace the system location so that it can be traced by police incase of theft.
- (v) Install encryption software. Using this valuable contents can be encrypted and stored.
- (vi) Install all the essential software and documents.

3.4.5. Configuring laptop power settings

Configuring laptop power setting is defined as a process of setting the power features of laptop for longer battery life. The following are the basic power settings used to improve the battery life using windows XP operating system.

- (i) Click the **start** button and select control panel. **Control panel** window opens.
- (ii) Select **power options** from the window. Power options properties dialog box opens as shown below.

(iii) **Power schemes** tab is used to set the turn off time for monitor and hard disk To turn off if not used for the selected time.

(iv) **Alarms** tab is used to set the low battery alarm and critical battery alarm. This Can be done by moving the rider as shown in the figure given below. When the battery power goes below 13%, the system gives message. When the power goes below 4% the system automatically goes to stand by mode.

(v) The power meter tab contains the available power percentage of the battery. In the system.

(vi) The advanced table is used to set the advanced power settings. The figure given below shows this Set the necessary by selecting the necessary options.

(vii) The hibernate tab is used to set the hibernate mode. This mode saves the current state of the system and automatically turned off when it is not in use. When it is turned on it resumes operation from the state before it is turned off. The figure given below shows the hibernate dialog box.

3.4.6. SMD components

The full form of SMD is surface mound device. These are electronic devices in which the electronic components are attached to the printed circuit board(PCB)by means Of soldering. The process of attaching the components directly on to the PCB is called surface mount technology. This technology replaces the old technology of fitting the components with wire leads into the holes in the PCB.

The different types for SMD components are

(i) Active components

Example – Transistors, IC's etc

(ii) Passive components

Example – Resistors, capacitors etc

3.4.7. ESD and precautions

The full form of ESD is electric static discharge. This is defined as a flow of static electrically when two objects come into contact.

Static electricity is developed when two objects that are not good electrical conductors are rubbed together.

Example

(i) Shock received when touching metal door knob.

(ii) Shock received when walking over a carpet.

Many electronic devices are sensitive to ESD. When exposed to higher ESD, the chance of failure is high. The following are some ESD sensitive devices

(i) MOSFET

(ii) CMOS IC

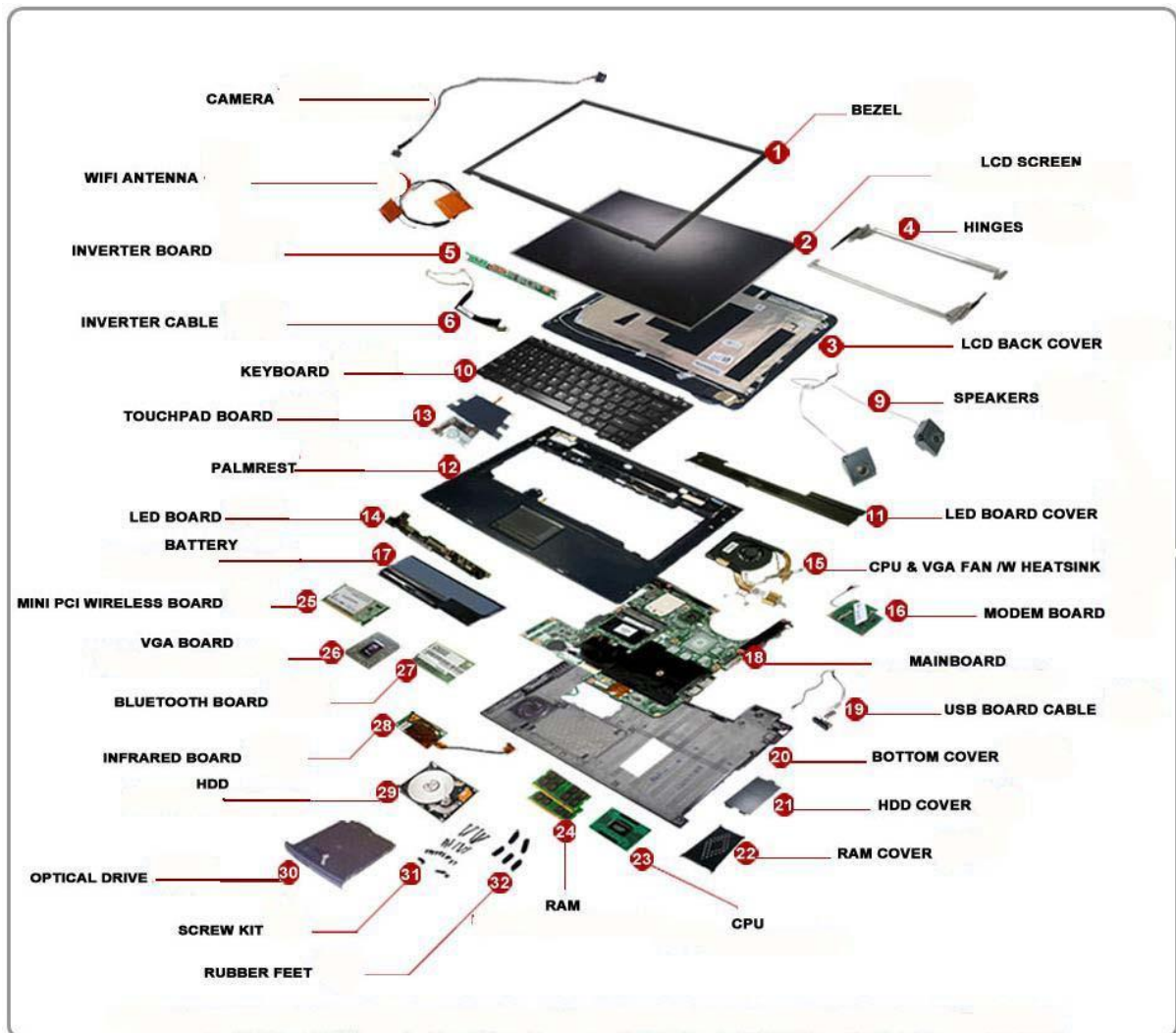
(iii) Computer Cards

(iv) High precision resistors

The following are the important precautions to avoid ESD.

- (i) All equipments including instruments, testing devices, conveyors, work benches, tools, solder irons must be earthed.
- (ii) The worker must use a wrist angle strap to earth the body.
- (iii) Use gloves to prevent direct contact with the devices. Avoid nylon gloves or cloths which develops a ESD.
- (iv) Static electrically increase with low humidity. There fore keep the humidity level of the environment between 35 and 50 percent by means of a humidifier.
- (v) When shipping or storing printed circuit boards, store them in conductive bags, or conductive plastic containers or conducting racks. Avoid placing them in plastic boxes, vinyl bags etc., when wrapping multiple circuit boards use inserts to prevent the boards into contact with each other.

3.5. Laptop components



3.5.1. Adapter

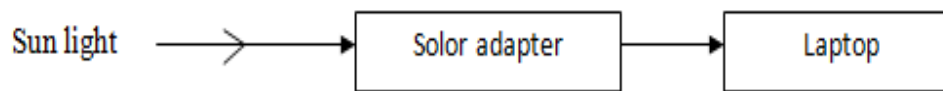
Adopter is a device used to connect laptop computers to the AC source. This converts the AC to single DC power. The DC power is used to charge the laptop battery.

Types of adapter

The following are the different types of adapters.

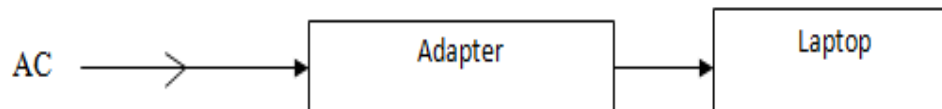
(i) AC adapters

This uses AC current as a source to charge the laptop batteries. The figure given below shows the structure.



(ii) Solor adapters

This uses sun light as a source to charge the laptop batteries.



3.5.2. Battery

Battery is a hardware component used to power the laptop. All laptop's come with a built in battery.

Battery types and basic problems

There are three types of laptop batteries. They are

(i) Nickel cadmium battery(Nicd)

This battery is the most cost effective power source and it is introduced in the year 1988. This can hold charges upto two hours. The basic problems are,

- It produces excess heat during operation. So it takes long time to charge.
- It produces voltage depression between 0.1 to 0.15 v when over charged.
- It will not operate bbw 0°C
- Discharge rate is too high
- It will not lost for long. One or more cells may wear out with in short span of time.

(ii) Nickel metal hydride battery (NiMH)

This was introduced in the year 1990 and it holds charge for long time than nickel cadmium battery. The basic problems are,

- High rate of self discharge .if kept unused it loses its charge quickly.
- Performance degrades if stored in high temperature.
- Requires regular full discharge to prevent crystalline formation
- It is expensive than nickel cadmium battery

(iii) Lithium ion battery(Li-ion)

This was introduced in the year 1991. This is a light weight battery and performs better than other type of batteries. Latest laptops use these type of batteries. The basic problems are,

- Requires protection circuit to maintain voltage and current within safe limits.
- High rate of self discharge. If kept unused it loses its charge quickly.
- It is 40 % costlier than nickel cadmium battery.
- Over charging and temperature reduces. Its charging capacity.

RAM – types

The full form of RAM is random access memory. This memory is directly accessed by the CPU. Laptop computers uses SODIMM memory (small outline DIMM). This is the

smaller version of DIMM module. The following are the different types of memory used in laptops

- (i) DDR 266 PC 2100
- (ii) DDR 333 PC 2700
- (iii)DDR 400 PC 3200
- (iv)DDR2 -400 PC 3200
- (v) DDR2 – 533 PC 4200

CPU – types

The full form of cpu is control processing unit. This is the heart of the laptop and is used to process the data according to the instructions given by the uses. The main cpu manufactures are intel and AMD. The following are the different types of laptop cpu's

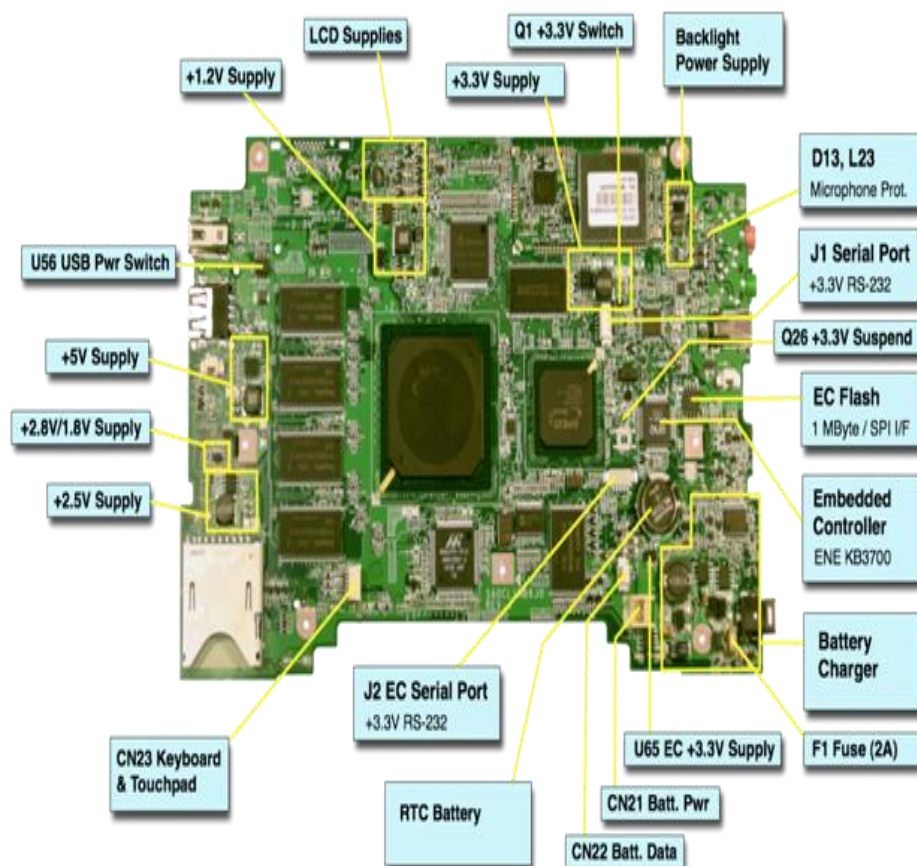
- (i) Intel atom, cleron, pentium M , core is series
- (ii) AMD neo.
- (iii)Via nano, turion, sempron

3.5.3. Laptop motherboard

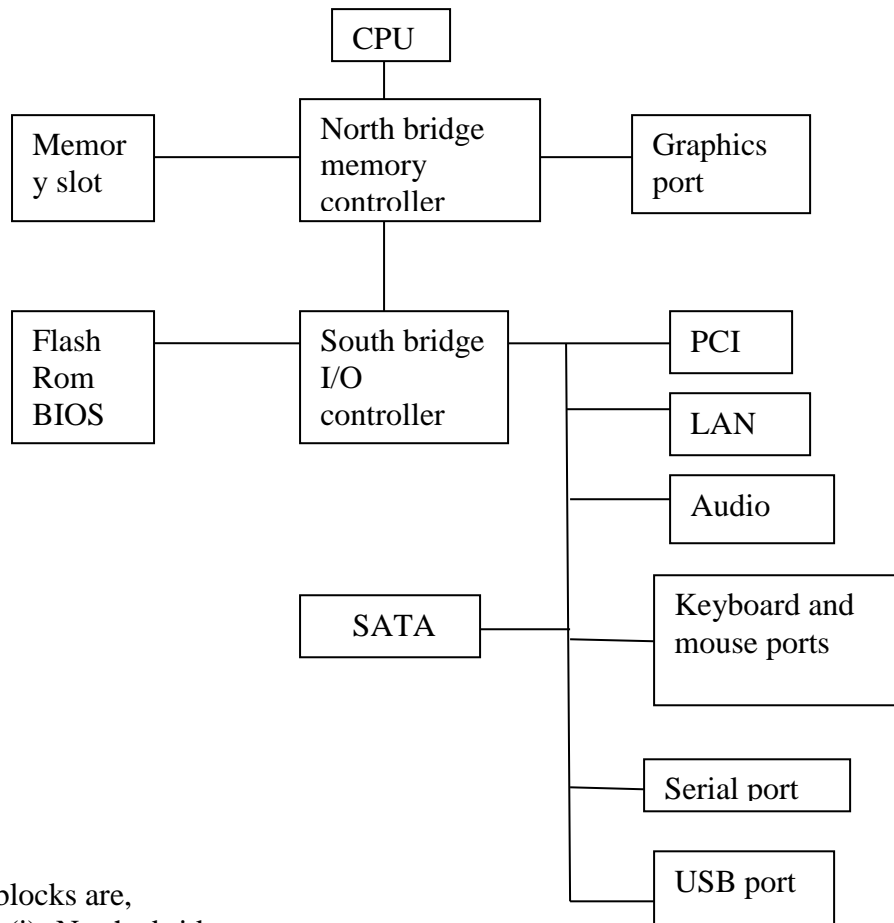
The motherboard is the main circuit board inside the laptop computer. The functions of the motherboard are,

- ❖ Mount the components such as CPU , memory etc., together
- ❖ Connects each component by means of buses.
- ❖ Manages the power supply to the components
- ❖ Provides clock to synchronize the operations.

Laptop motherboard



3.5.4. Block diagram of motherboard



The main blocks are,

- (i) North bridge
- (ii) South bridge

North bridge controls the high speed components like CPU, RAM and graphics card (video card). This is responsible for the continuous flow of data between these components.

South bridge controls the slower components such as sound card, hard disk, USB port, BIOSIC etc.

3.5.5. Laptop keyboard

Laptop keyboard is an input device. Each key corresponds to a single written character or number. When a key is pressed, the corresponding character is generated. The following are the important features of the keyboard.

Laptop keyboard



- (i) The keyboard buttons are small in size compared to normal keyboard.
- (ii) The travel distance for the keystroke is shorter than normal keyboard.
- (iii) There is no number keys on the right hand side.

3.5.6. Mouse and touchpad

All laptops consists of a built in mouse called touch pad. This is a pointing device used to control the pointer movement over the screen. Touch pad works by using the users finger movement. Touchpad contains the following layers of material



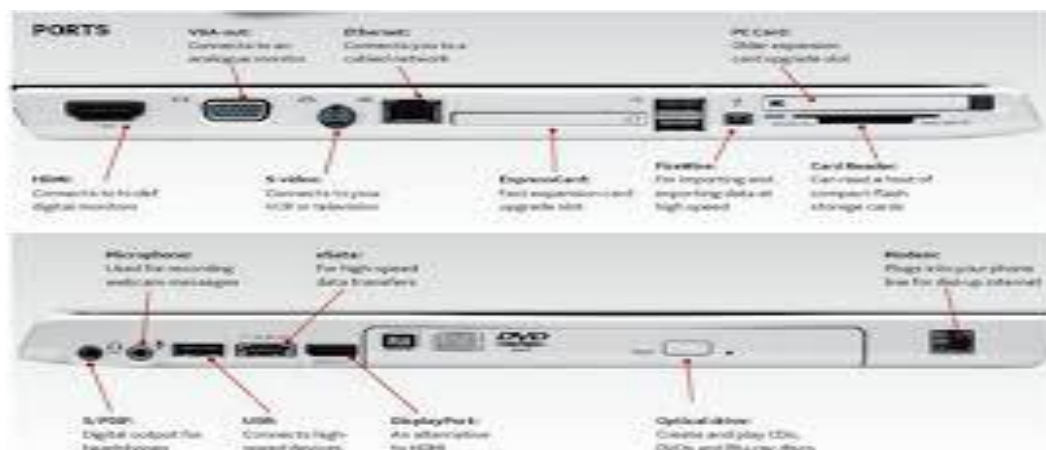
- (i) Top layer contains the pad to touch
- (ii) Under the top layer, a grid of horizontal and vertical electrodes.
- (iii) Under this middle layer a circuit board to which the middle layer electrodes are connected.
- (iv)

The electrodes are given alternating current. When the user touches the pad, the grid of electrode touches. This interrupts the current flow and the initial co – ordinates are calculated. Using the sequence touches the pointer moves over the screen from the initial point.

Ports

Ports are used to connect I/O devices like mouse, printer, modem with the laptop. The following are the standard ports present in the latest laptops.

Ports



- (i) USB ports
- (ii) Audio input/output port
- (iii) Ethernet port to connect network
- (iv) HDMI port to connect high definition external monitor

3.6. Installing and troubleshooting

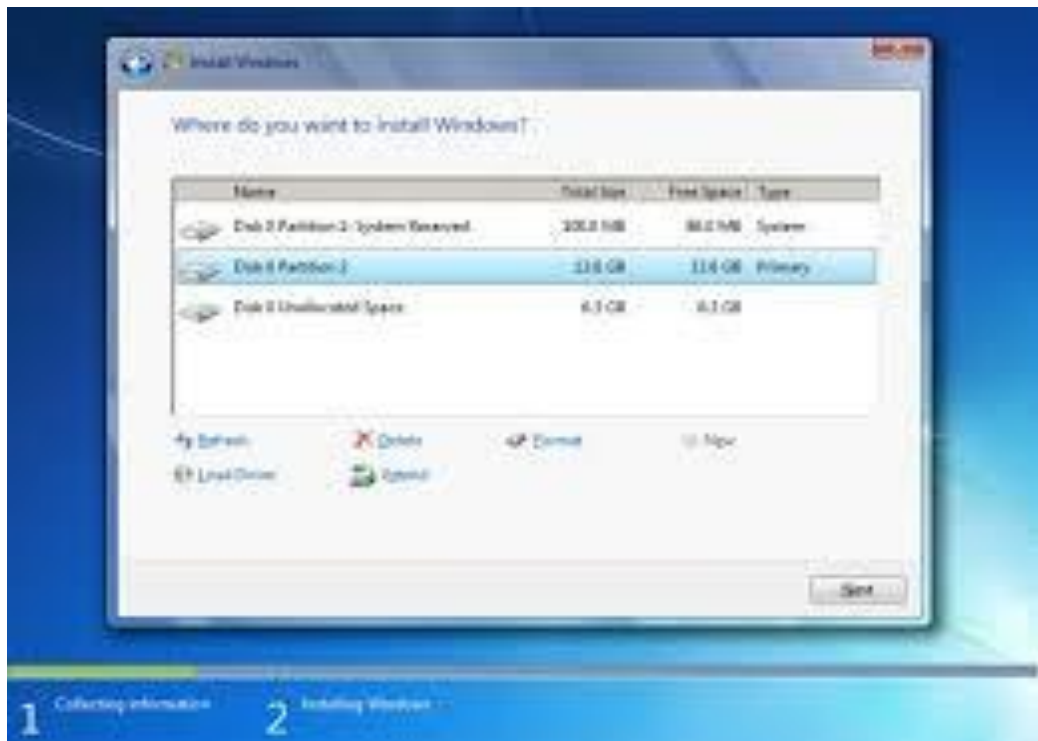
3.6.1. Formatting, partitioning and installation of O/S

The steps given below are followed to format, partition and install XP or higher version operating system.

1. Check whether the system meets the minimum requirements to run windows7.
2. Collect the windows 7 product key.
3. Select the primary boot device CDROM in the BIOS.



4. After a brief delay, the typical Microsoft blue installation screen displayed at the top and at the bottom of the screen the information, that **setup is loading files, all type of device drives.**
5. It will state is starting windows and will display after a short delay the **windows 7 professional setup** and press **Enter**.



6. Select to **setup windows 7** now and press **enter**.
7. The windows 7 licensing agreement is displayed on the screen; accept it by pressing the F8 – key as indicated on the bottom screen.
8. Setup will now display the partitioning of the disk. If the system has already an operating system installed. It will be them listed.
9. A simple disk manger is displayed, allowing the user to create and delete partitions.
10. Select either an existing partition or un – partitioned space to define, the partition to install windows 7, press enter.
11. Select the type of disk formatting FAT or NTFS and press **enter**. It is recommended to select NTFS. This is because NTFS supports large amount of disk space per partition than FAT.
12. Setup will start formatting the disk, and will then start copying files from the CD-ROM to the disk.
13. The system will then reboot.
14. After reboot, windows 7 starts for the first time with the Graphics User Interface (GUI).

15. Setup will continue to copy files and install devices.
16. Adjust the regional setting by using **customize** button to configure proper keyboard.
17. Personalize the system by entering your name and organization.
18. Enter the “product key”(25 character, provided by Microsoft along with the CD- ROM)
19. Define the name of the computer and the password for the administrator account.
20. Based on the organization, setup creates a name for the computer, with complex name.
21. If you enter a password for the administrator account given, make sure to remember it.
22. Click the “Date and Time” settings, allowing to check / define / correct the date and time zone
23. Setup will continue to install other devices and peripherals connected to the system and reboots.
24. After reboot, click OK to change the visual settings to improve the quality.
25. If there is a network card in the system, then it will ask to select whether to install a typical configuration or to make a special settings like defining IP address.
26. Setup does “finalising Installation” nothing to do by the user.
27. The system will reboot again.
28. Setup will configure.
29. The system will try to connect via the internet to the Microsoft website, select “Skip”.

3.6.2. Troubleshooting laptop hardware problems

The following are some common problems and its troubleshooting.

Problem – Laptop won't power up

Solution

- ❖ Check whether the power cable is plugged firmly into the wall socket. If so check whether the power cable firmly connected to laptops power supply outlet.
- ❖ Unplug all the external devices from the system .if the system power on without the devices, add the external devices one by one at a time until the faculty device is identified.
- ❖ Switch on the system using the internal power source.
- ❖ If all the above checks fails replace the battery.

Problem – laptop freezes

Solution

- ❖ Never give the password information to anyone.
- ❖ Update the antivirus and anti – spyware software.
- ❖ Update all the hardware drivers to latest versions.
- ❖ Don't click a link to the websites.
- ❖

3.6.3. Preventive maintenance techniques for laptops

The following are the important preventive maintenance for laptop.

- (i) Don't bump, jar, shake the system while using.
- (ii) Don't place any heavy luggage on the top of the laptop.
- (iii) Don't store the system below 5⁰C and above 35⁰C.
- (iv) Don't use the system on a blanket or other soft surface because these may cover the cooling vents and cause overheating.
- (v) Don't place the system near the electrical devices such as TV, motors etc. that generates a strong magnetic field.
- (vi) Don't pickup or hold the system by the LCD panel, which may damage the display and hinges.
- (vii) Don't place the system near the radio transmitters, which may induce currents and voltages causing failures.
- (viii) Don't spill liquids on the system.
- (ix) Use vacuum cleaner to below the dust from the keyboard keys.
- (x) Clean the system regularity using non oily liquid.

REVIEW QUESTIONS

PART - A

1. Define: BIOS.
2. List out the types of adapter.
3. Give the types of RAM.
4. What is CMOS?
5. What is POST? List out the tests performed by POST.
6. What are the types of error messages?
7. Give an example for anti-virus software.
8. What is ESD?
9. What are the signatures of viruses?
10. What is firewall?

PART – B

1. Explain Power Management.
2. How will you upgrade BIOS?
3. Write about SMD Components.
4. Write down the steps involved in OS installation.

PART – C

1. Explain about advanced chipset features.
2. Explain the IPL hardware and POST test sequence.
3. Draw the block diagram of laptop motherboard and explain it.
4. Explain about troubleshooting laptops.

UNIT IV - COMPUTER NETWORK DEVICES AND OSI LAYERS

4.1 Data Communication:

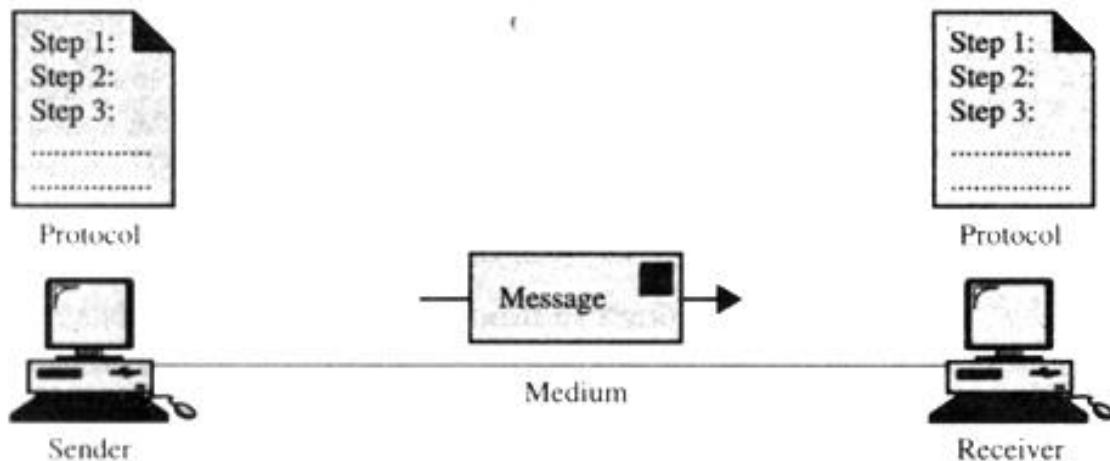
Data communication is the exchange of data (in the form of 1s and 0s) between two devices via some form of transmission medium (such as a wire cable).

For data communication to occur, the communicating devices must be part of a communication system made up of combination of hardware and software. The effectiveness of a data communication system depends on three fundamental characteristics:

1. **Delivery:** The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.
2. **Accuracy:** The system must deliver data accurately. Data that have altered in transmission and left uncorrected are unusable.
3. **Timeliness:** The system must deliver data in a timely manner. Data delivered late are useless. In the case of audio, video and voice data, timely delivery means delivering data as they are produced. This kind of delivery is called real-time transmission.

4.1.1 Components of a data communication:

A data communication is made up of five components. See figure below.



Components of a data communication

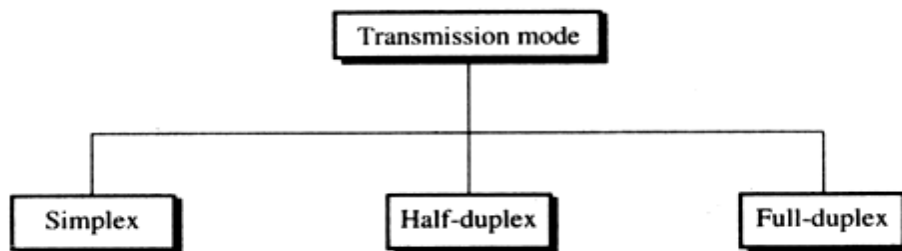
1. **Message:** The message is the information (data) to be communicated. It can consist of text, numbers, pictures, sound or video or any combination of these.
2. **Sender:** The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera and so on.

3. **Receiver:** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, video camera and so on.
4. **Medium:** The transmission medium is the physical path by which a message travels from sender to receiver. It can consist of twisted pair wire, coaxial cable, fiber-optic cable, laser or radio waves (terrestrial or satellite microwave).
5. **Protocol:** A protocol is a set of rules that govern data communication. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected, but not communicating.

4.2 Data flow:

Data flow or transmission mode is used to define the direction of signal flow between two linked devices. There are three types of transmission modes:

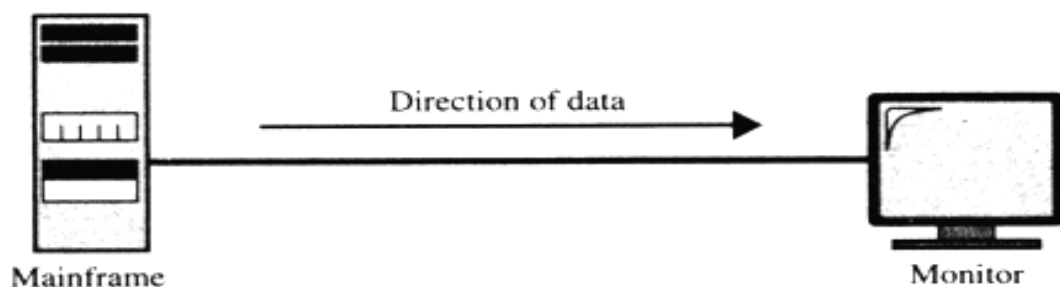
1. Simplex
2. Half duplex and
3. Full duplex.



Types of transmission modes

4.2.1 Simplex:

In simplex mode, the communication is unidirectional. Only one of the two stations on a link can transmit and the other can only receive. See figure below.

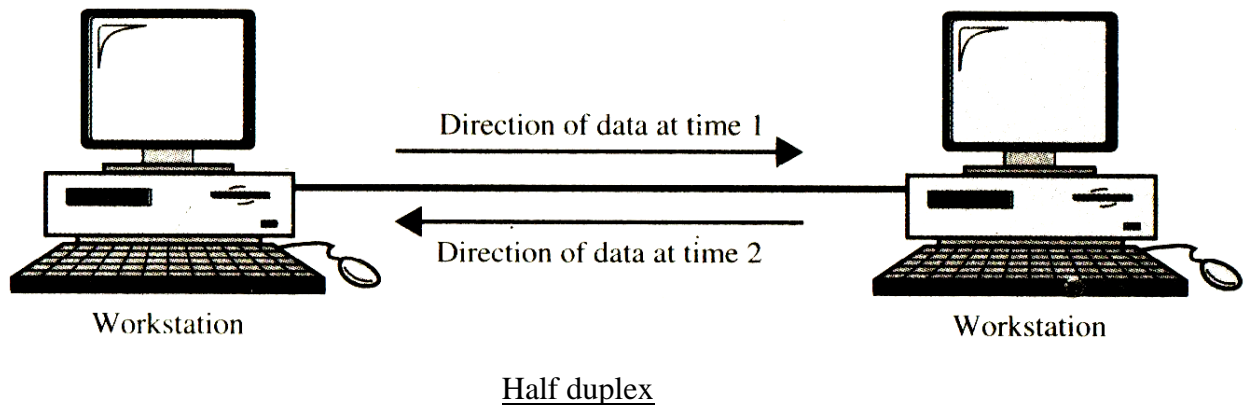


Simplex

Example: Keyboard and monitor

4.2.2 Half duplex:

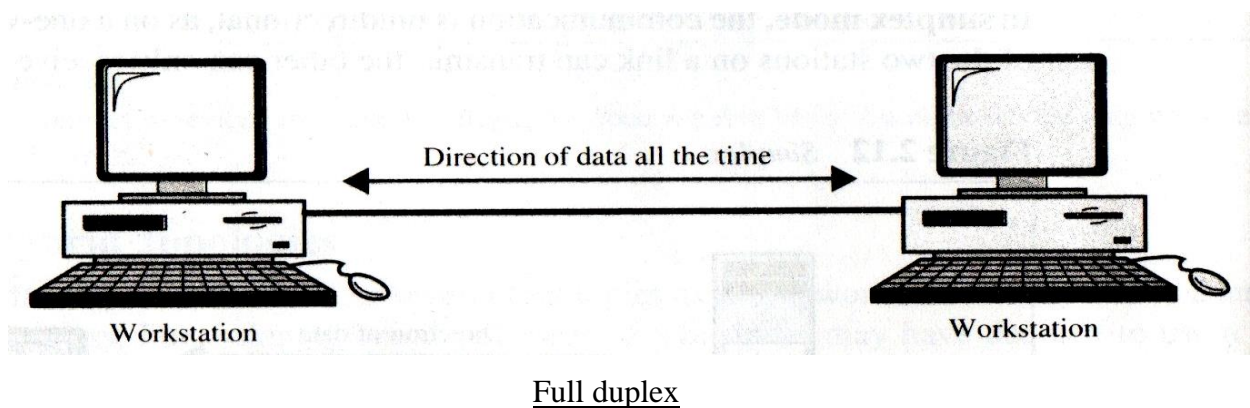
In half duplex mode, each station can both transmit and receive, but not in the same time. When one device is sending, the other can only receive and vice versa (See figure). In a half duplex transmission mode, the entire capacity of a channel is taken over by the transmitting device.



Example: Walkie-talkies.

4.2.3 Full duplex:

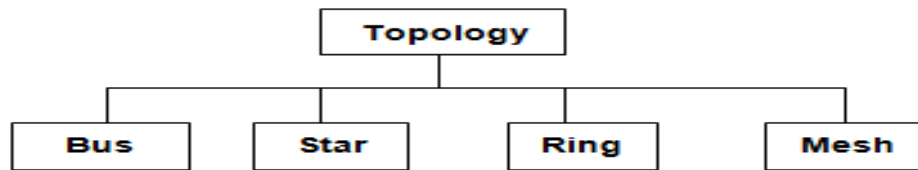
In full duplex mode, also called duplex, both stations can transmit and receive simultaneously. In this mode, signals going in either direction share the capacity of the link. This sharing can occur in two ways : either the link must contain two physically separate transmission paths, one for sending and the other for receiving, or the capacity of the channel is divided between the signals travelling in opposite directions. See figure below.



Example: Telephone network.

4.3 Topologies:

The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to each other. There are four basic topologies possible: bus, star, ring and mesh. See figure below.



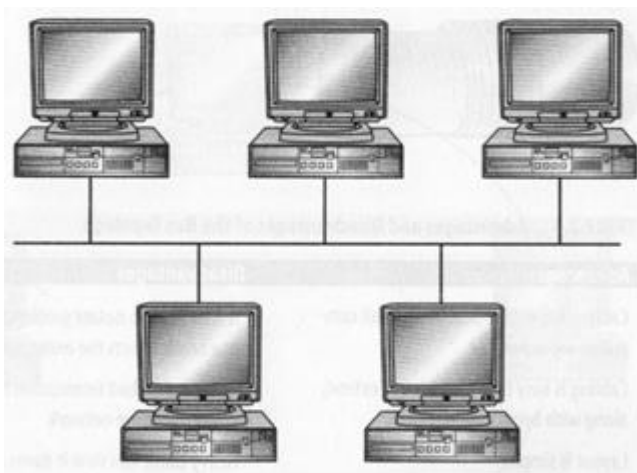
Basic topologies

These topologies describe how the devices in a network are interconnected rather than their physical arrangement. When choosing a topology, we have to consider the relative status of the devices to be linked. i.e. whether the devices share the link equally (peer to peer) or one device controls the traffic and others must transmit through it (primary-secondary). Ring and mesh topologies are peer to peer transmission, star is primary-secondary. A bus topology is equally convenient for either.

4.3.1 Bus topology:

The bus topology consists of computers connected by a single cable called a backbone as in figure below. All the computers on the bus share in its capacity. This is the simplest method for connecting computers. In a bus environment, 10Base2 or 10Base5 cable is used, and because all devices share the same bandwidth, the more devices, the slower the network. In fact, it is probably not feasible for use with more than 10 workstations.

Bus topology



In a bus topology, the computers only listen for data being sent to them, they do not forward the data. This is called a **passive topology**. A generated signal moves from one end of the bus to the other end. To prevent the signal from bouncing back and forth, a terminator is located at each end of the cable.

Because all the computers are connected by the same cable, if one segment has a problem, the whole network is down.

Advantages:

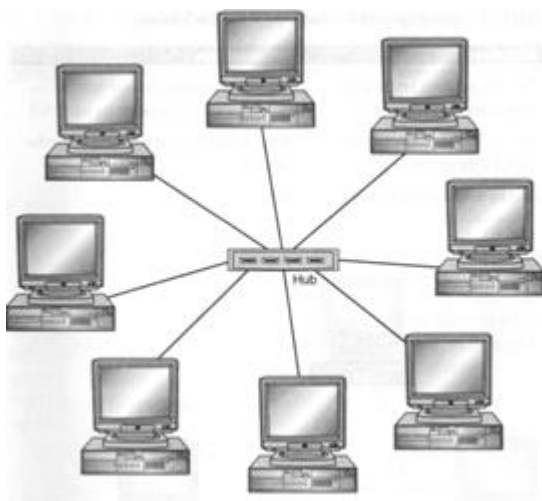
1. Cabling is easy to work with and extend with less cost.
2. Less cabling because all computers are in one line.
3. Layout is simple.

Disadvantages:

1. Fault isolation is difficult because one break affects the entire network.
2. One break or bad termination brings down the entire network.
3. Heavy traffic can slow it down because all machines share same bandwidth.

4.3.2 Star topology:

In star topology, the computers are connected to a centralized hub by a cable segment as in figure. They require more cabling than ring or bus topologies, but each computer is connected to the hub by its own cable. Therefore if one computer connection goes down, it does not affect the rest of the network. Because each workstation has its own connection, it is much easier to move them around or connect them to other networks. 10BaseT-100BaseFX can be used a star topology. A star topology can support up to 1024 workstations, but it may not be feasible to connect them all to the same logical network.

**Advantages:**

1. The entire network is not disrupted when adding or removing computers.
2. If one computer fails, it does not affect the rest of the network.
3. It is easy to manage and monitor.

Disadvantages:

1. It requires more cabling because each machine needs a separate connection to the central hub.
2. If the central hub fails, it brings down the entire network.

Star topology

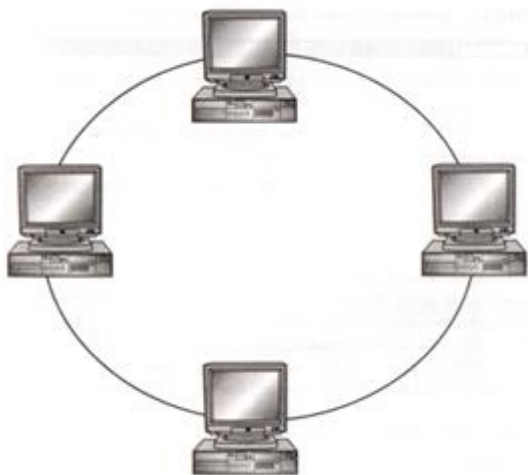
4.3.3 Ring topology:

In ring topology, each computer connects directly to the next one in line, forming a circle as shown in figure below. Data travels in a clockwise direction and each computer accepts the information intended for it and passes on the information for other computers. It uses a **token**, which is actually a small packet, to send information. Every computer in the ring is responsible for either passing the token or creating a new one. **Token passing** uses the token, or series of bits, to grant device permission to transmit over the network. When a computer has information to send, it modifies the token and passes it on. After the token reaches its final destination, it lets the sender know it has arrived safely, the sender then makes a new token, and the process starts over. Most ring networks use fiber or twisted pair as the medium.

This is known as **active topology** because each workstation is responsible for sending on the token. Currently many ring networks implement a dual-ring network or small hub to address this problem.

Advantages:

1. Network performance is consistent due to token passing.
2. The length of the cable required is short.
3. Equal access is granted to all computers.



Disadvantages :

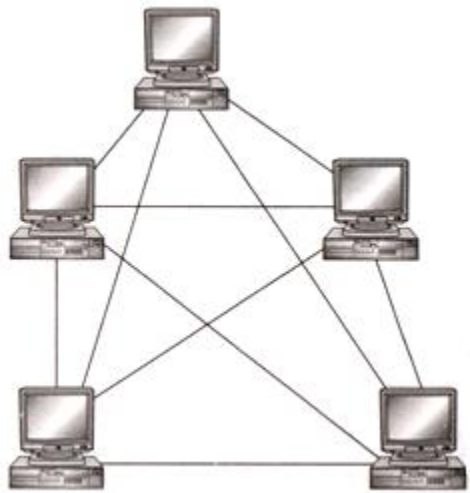
1. Unidirectional traffic.
2. If one computer fails, it brings down the entire network.
3. The entire network is disrupted when adding or removing computers.

Ring topology

4.3.4 Mesh topology:

In a mesh topology, all devices are connected to each other more than once to create fault tolerance as in figure below. A single device or cable failure will not affect the performance because the devices are connected by more than one means. This is more expensive as it requires more hardware and cabling. This type of topology can also be found in enterprise-wide networks with routers connected to other routers for fault tolerance.

So, a mesh topology is usually implemented in a limited fashion, for example, as a backbone connecting the main computers of a hybrid network that can include several other topologies.



Advantages :

1. The use of dedicated links guarantees that each connection can carry its own data load.
2. In mesh topology, if one link becomes unusable, it does not affect the entire system.
3. Another advantage is privacy or security. When every message sent travels along a dedicated line, only the intended recipient sees it.
4. The point-to-point links make fault identification and fault isolation easy.

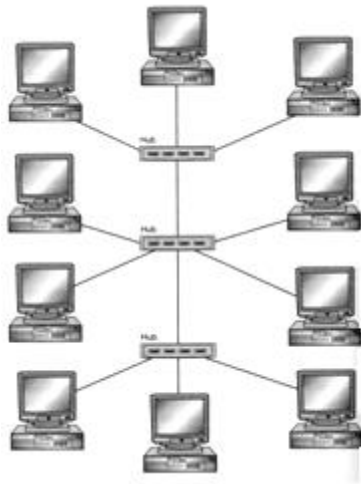
Mesh topology

Disadvantages:

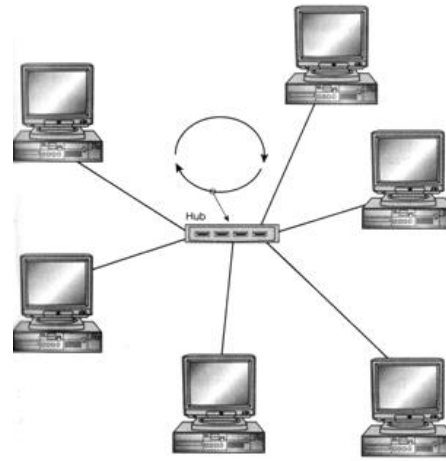
1. Because, every device must be connected to every other device, installation and reconfiguration are difficult.
2. The sheer bulk of the wiring can be greater than the available space.
3. The hardware required to connect each link can be prohibitively expensive.

4.3.5 Hybrid topology:

A network that combines several other topologies as subnet works linked together in a large topology. For instance, in **star bus topology**, computers are connected to hubs in a star formation and then the hubs are connected via bus topology. Refer figure below. Although it is more expensive to implement, longer distances can be covered and networks can be isolated more easily.



star bus topology



star ring topology

In a **star ring topology**, data is sent in a circular motion around the star. Refer figure above. This eliminates the single point of failure that can occur in a ring topology. It uses **token passing** data transmission with the physical layout of a star.

Large networks are typically organized as hierarchies. A hierarchical organization provides advantages such as ease of management, flexibility and a reduction in unnecessary traffic. In a hierarchical network structure, a high-speed backbone of Fiber optic cable usually connects the servers.

Advantages:

1. Fault detection and trouble shooting is easy.
2. It is easy to add new devices or network.

Disadvantages:

1. It is difficult to design.
2. The hubs used to connect two different networks are very expensive

Comparison of LAN topologies:

Topology	Reliability	Hardware cost	Performance
Bus	A cable fault may affect the entire network; locating the fault is difficult	Limited cabling; low cost; Easy installation	Shared medium, limited performance

Star	Fault in one computer does not affect others; Easy to locate the fault. Failure of hub affects the entire network	High cost of wiring and central hub	Sharing, or switching possible; Easy expansion :addition new nodes without disturbing the network
Ring	One failure affects entire network; difficult to locate the fault	Single cable with repeaters	Single medium limits performance
Mesh	Individual cable problem does not affect the network. Alternate routes are available in case of failure of one node	Heavy wiring; expensive	Good; Alternative routes

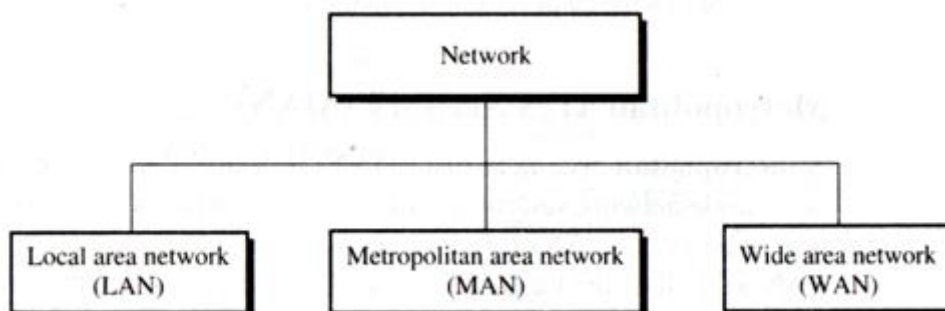
4.4 Networks:

4.4.1 Definition

A network is a group of computers that can communicate with each other to share information. When computers communicate with each other, they can share **resources**. These resources can be data, applications or hardware. We can connect two computers together with a cable, which results in a simple network.

4.4.2 Types of Networks:

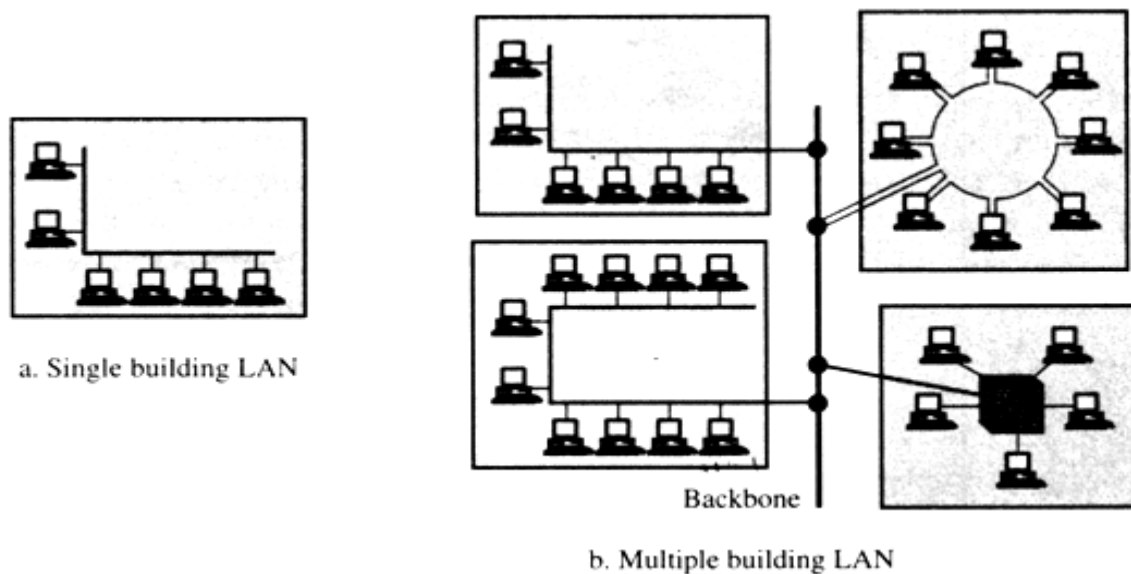
There are primarily three categories of networks namely Local Area Networks (LAN), Metropolitan Area Network (MAN) and Wide Area Network (WAN). The category of a network is determined by its size, ownership, the distance it covers and its physical architecture.



Types of Networks

4.4.2.1 LAN:

A local area network (LAN) is usually owned and links the devices in a single office, building or campus.



Depending on the needs of an organization and type of technology used, a LAN can be as simple as 2 PCs and a printer in someone's home office or it can extend throughout company and include voice sound and video peripherals. Currently LAN's size is limited to few kilometres.

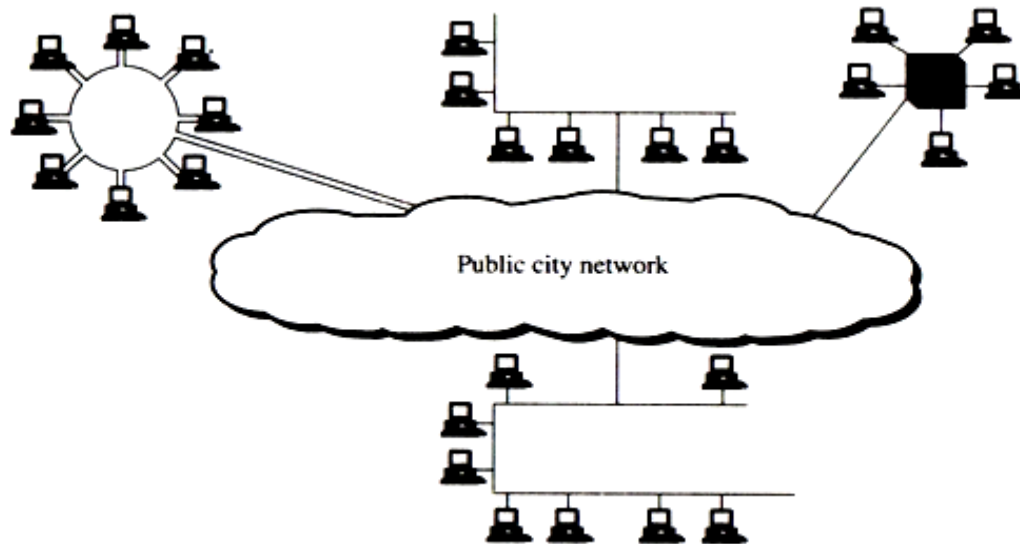
LANs are designed to allow resources to be shared between PCs or workstations. The resources to be shared can include hardware (e.g. a printer), software (e.g. a application program) or data.

In addition to size, LANs are distinguished from other types of networks by their transmission media and topology. In general, a given LAN will use only one type of transmission medium. The most common LAN topologies are bus, ring and star.

Traditionally, LANs have data rates in 4 to 16 Mbps range. Today, the speeds are increasing and can reach 100 Mbps with gigabit systems in development.

4.4.2.2 MAN:

A Metropolitan area network (MAN) is designed to extend over an entire city. It may be a single network such as a cable television network or it may be a means of connecting a number of LANs into a large network so that resources may be shared LAN- to-LAN as well as device-to-device. For example, a company can use MAN to connect the LANs in all its offices throughout a city.



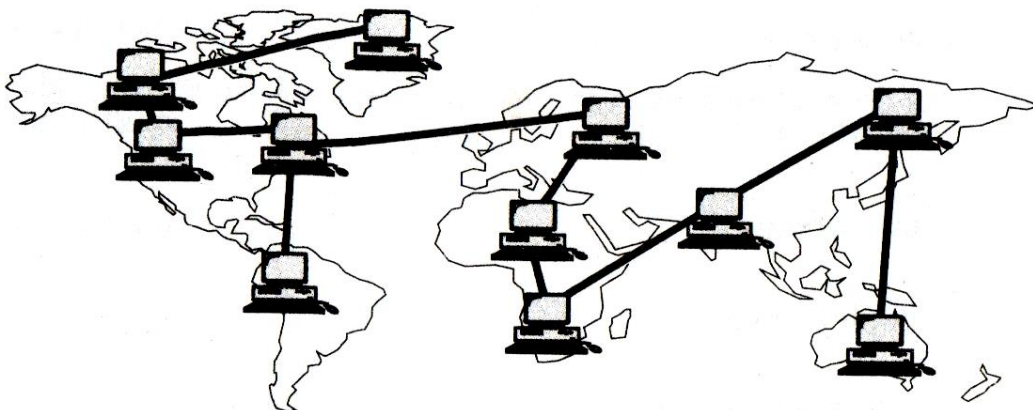
Metropolitan area network

A MAN can be wholly owned and operated by a private company or it may be a service provided by a public company such as a local telephone company.

4.4.2.3 WAN:

A wide area network (WAN) provides long distance transmission of data, voice, image and video information over large geographical areas that may comprise a country, continent or even the whole world.

In contrast to LANs (depend on their own hardware for transmission), WANs may utilize public, leased or private communication devices, usually in combinations and can therefore span unlimited number of miles. A WAN that is wholly owned and used by single company is often referred to as an enterprise network.



Wide area network

In addition to the above three categories of network, a user can use other types of networks as required by his application. Some of them are

CAN: Controller Area Network – used in automobiles

HAN: Home Area Network – networking of home appliances

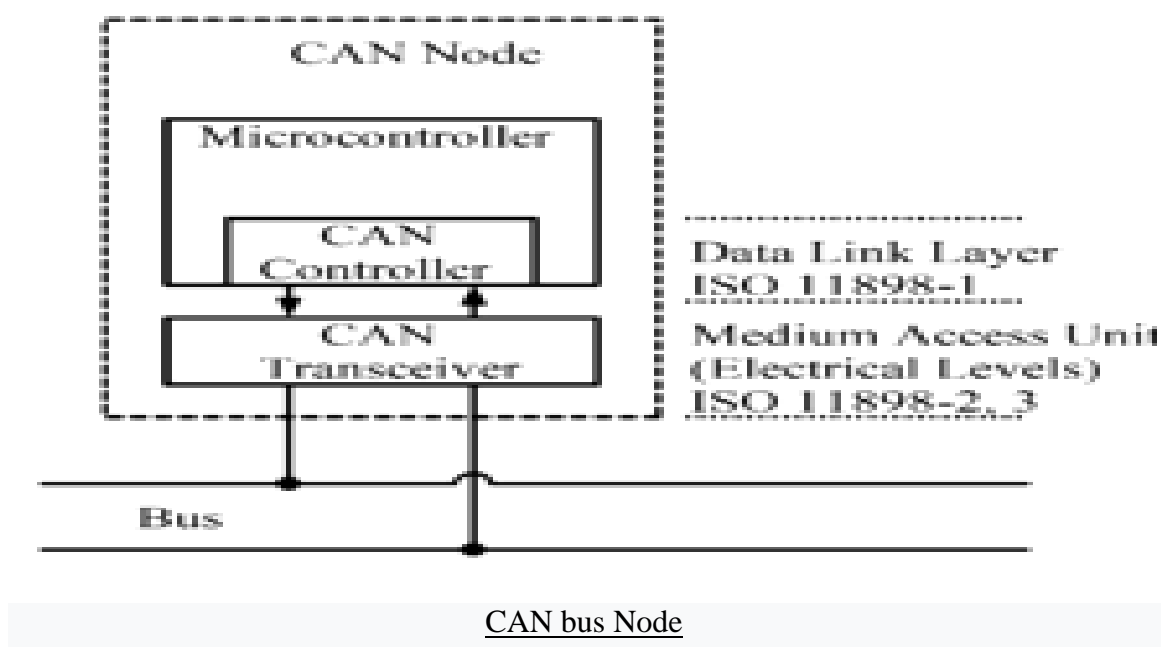
SAN: Networking of servers used for storing same information around the world.

4.4.2.4 CAN:

A Controller Area Network (CAN bus) is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other in applications without a [host computer](#). The devices that are connected by a CAN network are typically sensors, actuators, and other control devices. These devices are connected to the bus through a host processor, a CAN controller, and a CAN transceiver.

CAN is a [multi-master serial bus](#) standard for connecting Electronic Control Units [ECUs] also known as nodes. Two or more nodes are required on the CAN network to communicate. The complexity of the node can range from a simple I/O device up to an embedded computer with a CAN interface and sophisticated software. The node may also be a gateway allowing a standard computer to communicate over a USB or Ethernet port to the devices on a CAN network.

All nodes are connected to each other through a two wire bus. High speed CAN is usually used in automotive and industrial applications where the bus runs from one end of the environment to the other.



Each node requires:

- Central processing unit, microprocessor, or host processor
- CAN controller
- CAN Transceiver

Each node is able to send and receive messages, but not simultaneously. A message or Frame consists primarily of the ID (identifier), which represents the priority of the message, and up to eight data bytes. A CRC, acknowledge slot [ACK] and other overhead are also part of the message.

4.4.2.5 HAN:

A Home Area Network (HAN) contained within a user's home that connects a person's digital devices, from multiple computers and their peripheral devices to telephones, VCRs, televisions, video games, home security systems, smart appliances, fax machines and other digital devices that are wired into the network.

This can be used to increase the quality of life inside the home in a variety of ways, such as automation of repetitious tasks, increased personal productivity, enhanced home security, and easier access to entertainment.

The components required for Home Area Network are:

1. A **modem** exposes an Ethernet interface to a service provider's native telecommunications infrastructure.
2. A **router** manages network layer connectivity between a WAN and the HAN.
3. A **network switch** is used to allow devices on the home network to talk to one another via Ethernet.
4. A **wireless access point** is required for connecting wireless devices to a network.
5. A **home automation controller** is used to connect the devices such as light bulbs and locks.

4.4.3 Concepts on Internet, Intranet and Extranet:

4.4.3.1 Internet:

Internet is a worldwide, publicly accessible computer network of interconnected computer networks (internetwork) that transmit data using the standard Internet Protocol (IP). Internet is the world's largest Internetwork. The Internet is a collection of interconnected

computer networks, linked by copper wires, fiber-optic cables, wireless connections, etc. The services accessible via the Internet include World Wide Web, email, file sharing, remote administration, e-banking, online gaming, online shopping and education etc.

1. Work on the internet was started in the late 80s but it started to get popular in the world in early 90s.
2. There is no central governing body of the internet and it comprises the various autonomous networks that operate as a medium of interconnection.
3. Internet is a clustered system of interrelated computer networks that uses a standard Internet protocol (IP) or transmission control protocol (TCP) network.
4. It is a global network of millions of private, public and organizational network. It carries a massive range of informational resources and data in form of HTTP (Hypertext Markup language) documents and applications through World Wide Web (WWW).
5. At present, the one-third population of the world is using the internet directly or indirectly.

4.4.3.2 Intranet:

An intranet is a private network that is contained within an enterprise. It may consist of many interlinked local area networks and use any Wide Area Network (WAN) technologies for network connectivity. The main purpose of an intranet is to share company information and computing resources among employees. Intranet is a private Internetwork, which is usually created and maintained by a private organization. The content available inside Intranet is intended only for the members of that organization (usually employees of a company).

1. Intranet is a computer network system which refers to the network of a specific organization.
2. It is a private network where authenticated users of the organization can access the database system, search engines, directory and can distribute documents and workflow.
3. Employees can make interactive communication in shape of chatting, audio and videoconferencing, groupware and teleconferencing.

4. The benefit of Intranet is that low development and maintenance cost. It is also the type of internet that is restricted to the internal environment of an organization only.
5. Intranet started to grow across the world after the internet when some large organizations started to develop their own internal internet system that was later on named as an intranet. The main aim of the intranet is to ensure the secure collaboration, communication and team working in any organization.

4.4.3.3 Extranet:

An extranet can be viewed as part of a company's intranet that is extended to users outside the company like suppliers, vendors, partners, customers, or other business associates. Extranet is required for normal day-to-day business activities. For example, placing order to registered vendors, Billing & Invoices, Payments, Joint Ventures, Product Brochures for Partners, Discounted price lists for partners etc.

1. Extranet is a kind of computer network that allows the outside users to access the Intranet of organization.
2. This system basically allows the outside users of an organization, like partners, suppliers, vendors and other stakeholders to remain in touch with the activities of organization. Information and data access are performed through a proper account or link system.
3. This is a best network system to keep in touch with market position and share a large amount of data to partners in a timely manner.
4. Also, conducting new training programs and discussing the products catalogs with partners can be easily done without bearing too much cost of travelling.
5. After setting the extranet, the users can then send private messages by using the public network system through the most enhanced encryption and security technologies. The information in all way is accessible through the intranet of an organization.

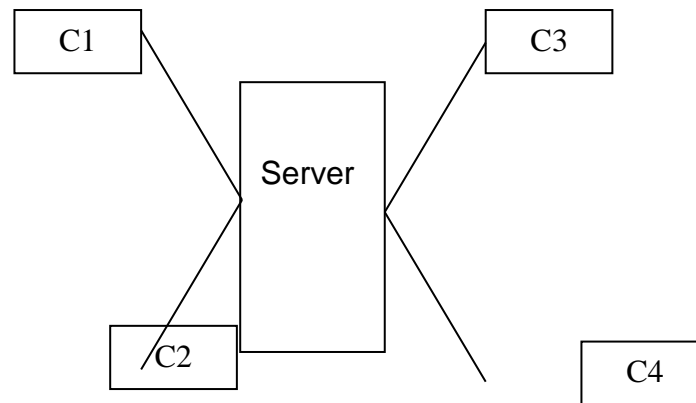
4.4.3.4 Client-Server network:

In this type of network, there are two components namely

1. client and
2. server

Client:

A client is a program running on the local machine requesting service from a server. A client program is finite, which means it is started by the user or another application program and terminates when the service is complete.

Client-Server network**Server:**

A server is a program running in the remote machine providing service to the client. When it starts, it opens the door for incoming requests from clients, but it never initiates a service until it is requested to do so. A server program is an infinite program. When it starts, it runs infinitely unless a problem arises. It waits for the incoming requests from clients. When a request arrives, it responds to the request.

Advantages:

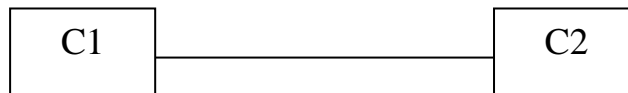
1. Centralized resources
2. Excellent security

Disadvantages:

1. Expensive – Dedicated server
2. Dependency – When server fails entire network crashes

4.4.3.5 Peer to Peer Networks:

A peer-to-peer network is a simple type of network. In a peer-to-peer network, all computers are equal and share resources and use resources from each other (file sharing, peripheral sharing etc). Peer-to-peer networks are used mainly for small and medium LANs.



Peer to Peer Networks

Advantages:

1. Economical – No dedicated server
2. Simple installation setup

Disadvantages:

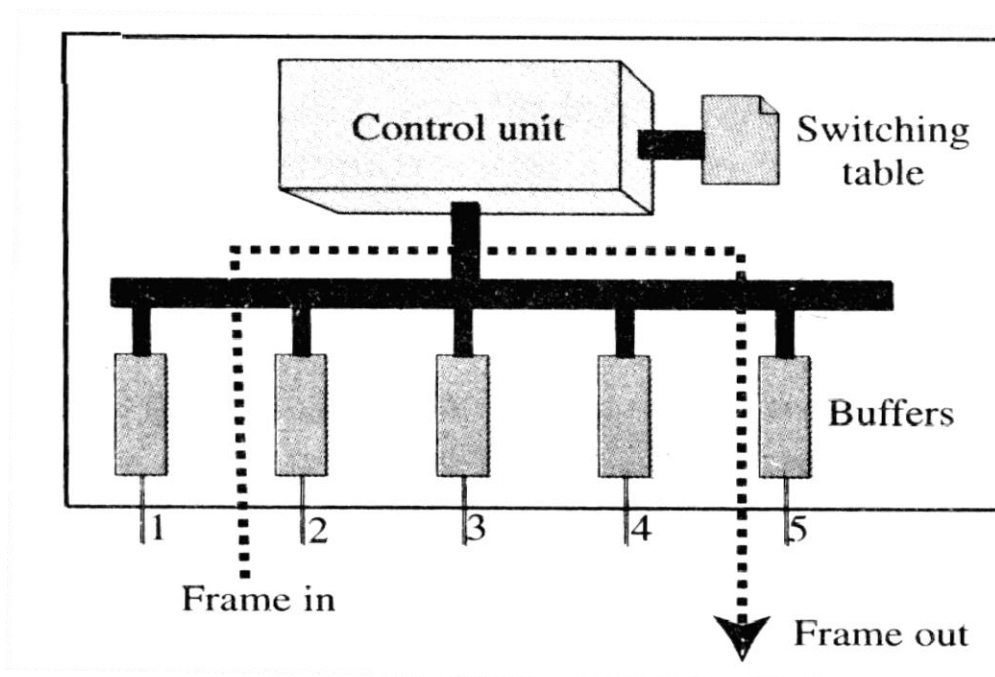
1. No central backup for files
2. Poor security

4.5 Network devices:

4.5.1 Switches:

Switches are becoming popular than hubs when it comes to connecting desktops. Switches operate at the Data Link Layer of the OSI model. Their packet-forwarding decisions are based on MAC addresses. That is, a switch simply looks at each packet and determines from a physical address (MAC address) which device a packet is intended for and then switches it out toward that device.

Switches allow LANs to be segmented, thereby increasing the amount of bandwidth that goes to each device. The basic functions of a switch include filtering and forwarding frames, learning media access control (MAC) addresses and preventing loops.



Switch

A frame arrives at port 2 and is stored in the buffer. The CPU and control unit, using the information in the frame, consult the switching table to find the output port. The frame is then sent to port 5 for transmission.

Switches are made based on two different strategies :

1. Store-and-forward and
2. Cut-through.

A **store-and-forward switch** stores the frame in the input buffer until the whole packet has arrived. Hence the data transfer is delayed.

A **cut-through switch**, on the other hand, forwards the packet to the output buffer as soon as the destination address is received. So the data transfer is not delayed.

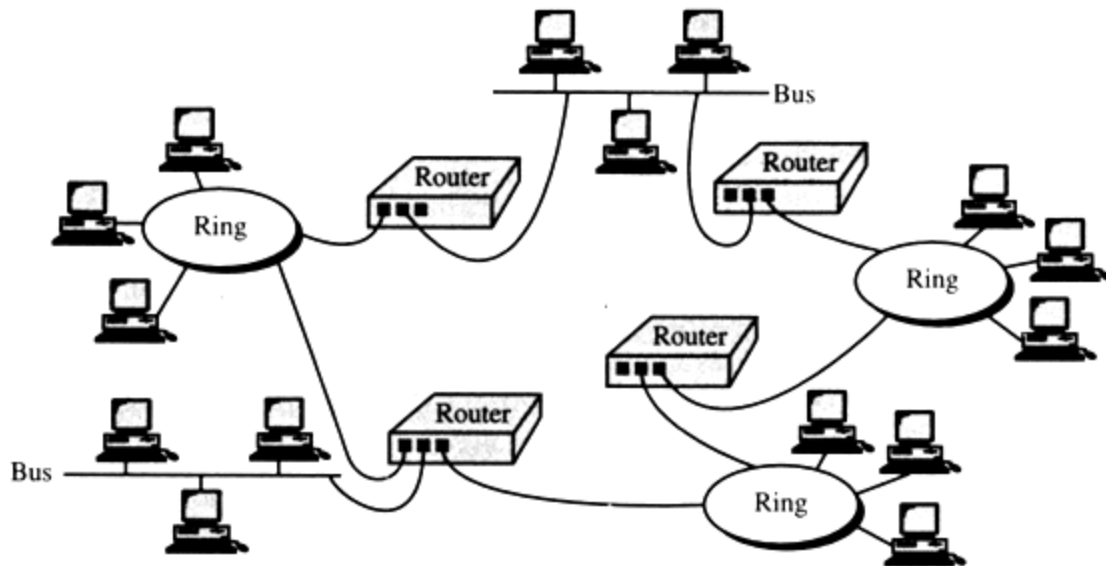
Features:

- (i) Switches increase the bandwidth of available network.
- (ii) Switches reduce the workload on individual computers.
- (iii) Switches increase the network performance.
- (iv) Switches decrease data packet collision.
- (v) Switches have their own operating system.

4.5.2 Routers:

Routers operate at the Network layer of the OSI model. They forward information to its destination on the network or the Internet. Routers maintain tables that are checked each time a packet needs to be redirected from one interface to another. The routes may be added manually to the routing table or may be updated automatically using various protocols.

Routers are primarily used to segment traffic but they have additional useful features. One of the best is its ability to filter packets either by source address, destination address, protocol or port. A router may create or maintain a table of the available routes and their conditions and then use this information along with distance and cost algorithms to determine the best route for a given packet.



Router

On the Internet, a router is a device that determines the next network point to which a packet should be forwarded toward its destination. The router is connected to at least two networks and decides which way to send each information packet based on its current understanding of the state of the networks to which it is connected.

A router is located at any gateway, including each internet point of presence. Many times the connection from a router to the internet is through a device called Channel Service Unit/Data Service Unit (CSU/DSU). The router is then internal, connected to a LAN port on a switch.

Types of routers:

Routers are divided into two categories:

1. Wired and
2. Wireless.

Wired Routers:

Wired routers can be used to do several different types of things. They can be used to connect two different computers or to connect two computers to the Internet. They can also be used to create a phone connection. If we are using Voice over IP (VoIP) technology, then we will need a broadband router to connect Internet to phone. These are often a special type of modem that will have both Ethernet and phone jacks. Usually we must purchase the router from the company in order to obtain the service.

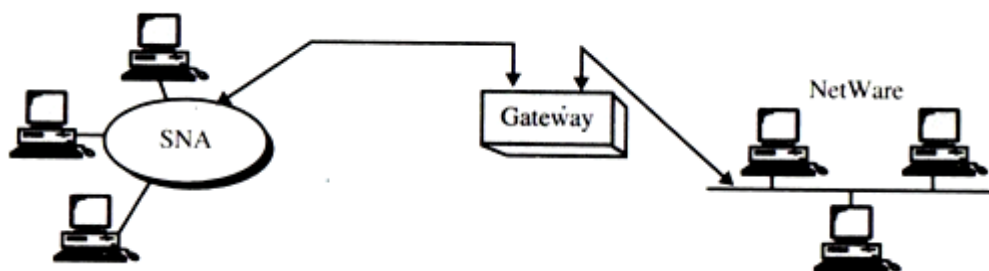
Wireless Routers:

Wireless routers connect to the modem and create a wireless signal in home or office. So, any computer within range can connect to the wireless router and use broadband Internet for free. The only way to keep anyone from connecting to the system is to secure the router by using the security key.

4.5.3 Gateways:

Gateways potentially operate in all seven layers of the OSI model. A gateway is a protocol converter. A route by itself transfers, accepts and relays packets only across networks using similar protocols. A gateway on the other hand can accept a packet formatted for one protocol (e.g. AppleTalk) and convert it to a packet formatted for another protocol (e.g. TCP/IP) before forwarding it.

A gateway is generally software installed within a router. The gateway understands the protocols used by each network linked to the router and is therefore able to translate from one to another. In some cases, the only modification necessary are the header and trailer of the packet. In other cases, the gateway must adjust the data rate, size and format as well. The following figure shows a gateway connecting an SNA network (IBM) to a NetWare network (Novell).



Gateway

4.6 Network Models:

4.6.1 Protocol definition:

A protocol is a set of rules that govern all aspects of data communication. A protocol defines what is communicated, how it is communicated, and when it is communicated.

The key elements of a protocol are

1. Syntax
2. semantics
3. Timing

Syntax:

Syntax refers to the structure or format of the data, i.e. the order in which they are presented.

Semantics:

Semantics refers to the meaning of each section of bits.

Timing:

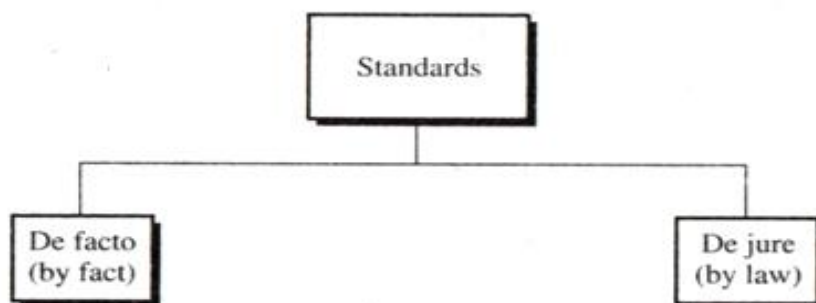
Timing refers to when data should be sent and how fast they can be sent.

4.6.2 Standards:

A standard provides a model for development that makes it possible for a product to work regardless of the individual manufacturer. Standards are essential in creating and maintaining an open and competitive market for equipment manufacturers and in guaranteeing national and international inter-operability of data and telecommunications technology and processes. They provide guidelines to manufacturers, vendors, government agencies and other service providers to ensure the kind of interconnectivity necessary in today's market place and in international communications.

Data communication standards falls into two categories as below:

1. de facto (by fact or by convention)
2. de jure (by law or by regulation)

**Categories of standards**

De jure standards are those that have been legislated by an officially recognized body. Standards that have not been approved by an organized body but have been adopted to standards through widespread use are de facto standards.

De facto standards are often established originally by manufacturers seeking to define the functionality of a new product or technology.

De facto standards can be further subdivided into two classes:

1. Proprietary
2. Nonproprietary.

Proprietary standards are those originally invented by a commercial organization as a basis for the operation of its products. They are called proprietary because they are wholly owned by the company that invented them. These standards are also called closed standards because they close off communications between systems produced by different vendors.

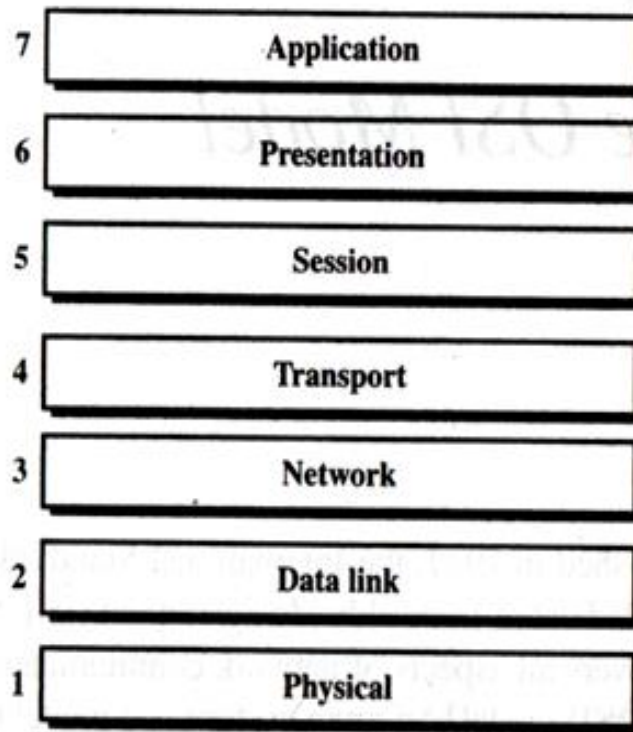
Nonproprietary standards are those originally developed by groups or committees that have passed them into the public domain. They are also called open standards because they open communications between different systems.

4.6.3 OSI Model:

Introduction:

In 1978, the **International Standard Organization (ISO)** developed an architecture that would allow the devices of different manufacturers to work together to communicate with different operating systems. In 1984, the ISO architecture became an international standard known as the **Open System Interconnection (OSI)reference model**. This architecture determines how the hardware, software, topologies and protocols exist and operate on a network. The OSI model is based on seven layers as in figure.

Each layer adds functionality to the previous layer and communicates with layers directly above and below it. Because each layer of the OSI model handles a different part of the communication process, it makes the troubleshooting process a little easier because it provides specifications on how components should function.



Open System Interconnection (OSI) reference model

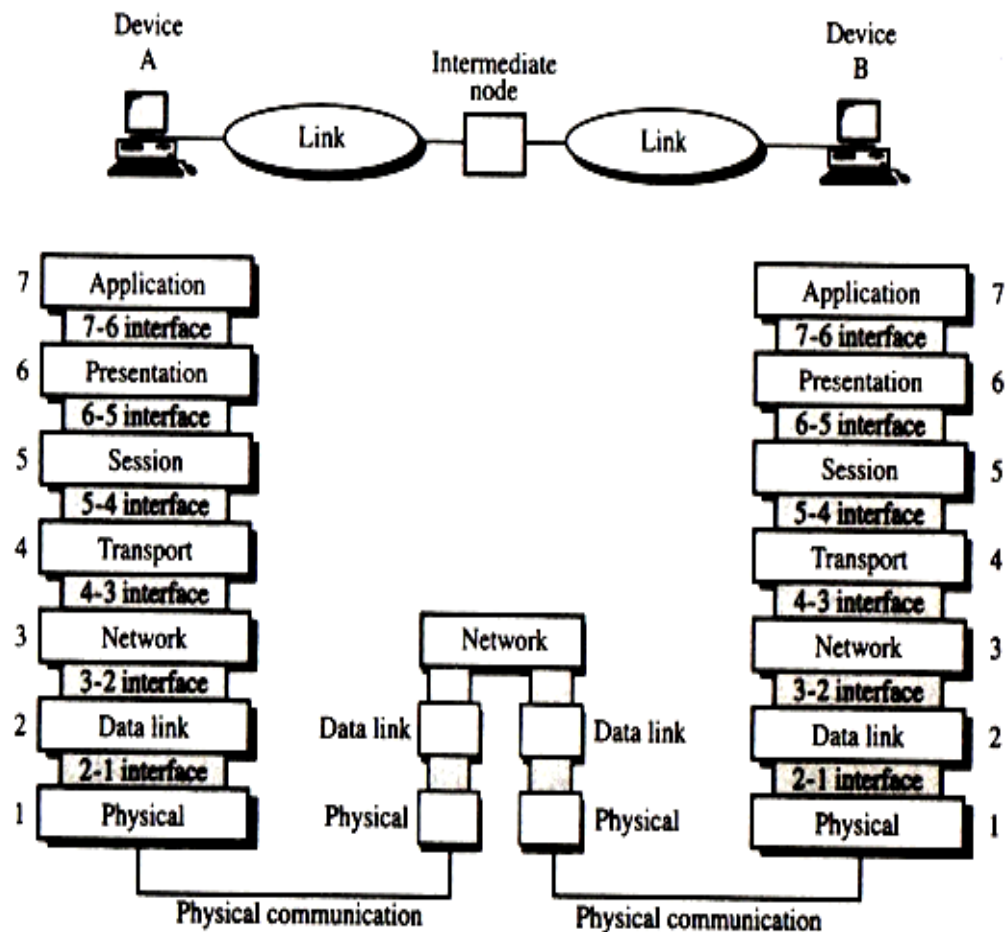
4.6.4 Layered architecture:

The OSI model is built of seven ordered layers:

- Application layer
- Presentation layer
- Session layer
- Transport layer
- Network later
- Data link layer
- Physical layer

Figure below shows the layers involved when a message is sent from device A to device B.

As the message travels from A to B, it may pass through many intermediate nodes. These intermediate nodes usually involve only the first three layers of the OSI model as in figure. The OSI model allows complete transparency between incompatible systems.



Message passing

Function of the layers :

The function of each layer in the OSI model is discussed below.

Application layer:

The application layer enables the user, whether human or software to access the network. It provides user interfaces and support for services such as electronic mail, remote file access and transfer, shared database management, and other types of distributed information services.

Specific responsibilities of the application layer include the following:

- Network Virtual Terminal
- Mail services
- File transfer, access and management
- Directory services

Presentation layer:

The presentation layer is concerned with the syntax and semantics of the information exchanged between two systems.

Specific responsibilities of the presentation layer include the following:

- Translation
- Encryption
- Compression

Session layer:

The services provided by the first two layers are not sufficient for some processes. The session layer is the network dialog controller. It establishes, maintains, and synchronizes the interaction between communicating systems.

Specific responsibilities of the session layer include the following:

- Dialog control
- Synchronization

Transport layer:

The transport layer is responsible for source-to-destination delivery of the entire message. The transport layer ensures that the whole message arrives intact and in order overseeing both error control and flow control at the source-to-destination level.

For added security, the transport layer may create a connection between the two end ports. A connection is a single logical path between the source and destination that is associated with all packets in a message.

Specific responsibilities of the transport layer include the following:

- Service-point addressing
- Flow control
- Segmentation and reassembly
- Error control
- Connection control

Network layer:

The network layer is responsible for the source-to-destination delivery of a packet possibly across multiple networks (links). The network layer ensures that each packet gets from its point of origin to its final destination.

If two systems are connected to the same link, there is usually no need for a network layer. However, if the two systems are attached to different networks, there is often a need for the network layer to accomplish source-to-destination delivery.

Specific responsibilities of the network layer include the following:

- Logical addressing
- Routing

Data link layer:

The data link layer transforms the physical layer, a raw transmission facility to a reliable link and is responsible for node-to-node delivery. It makes the physical layer appear error free to the upper layer (network layer). Specific responsibilities of the data link layer includes the following:

- Framing
- Physical addressing
- Flow control
- Error control
- Access control

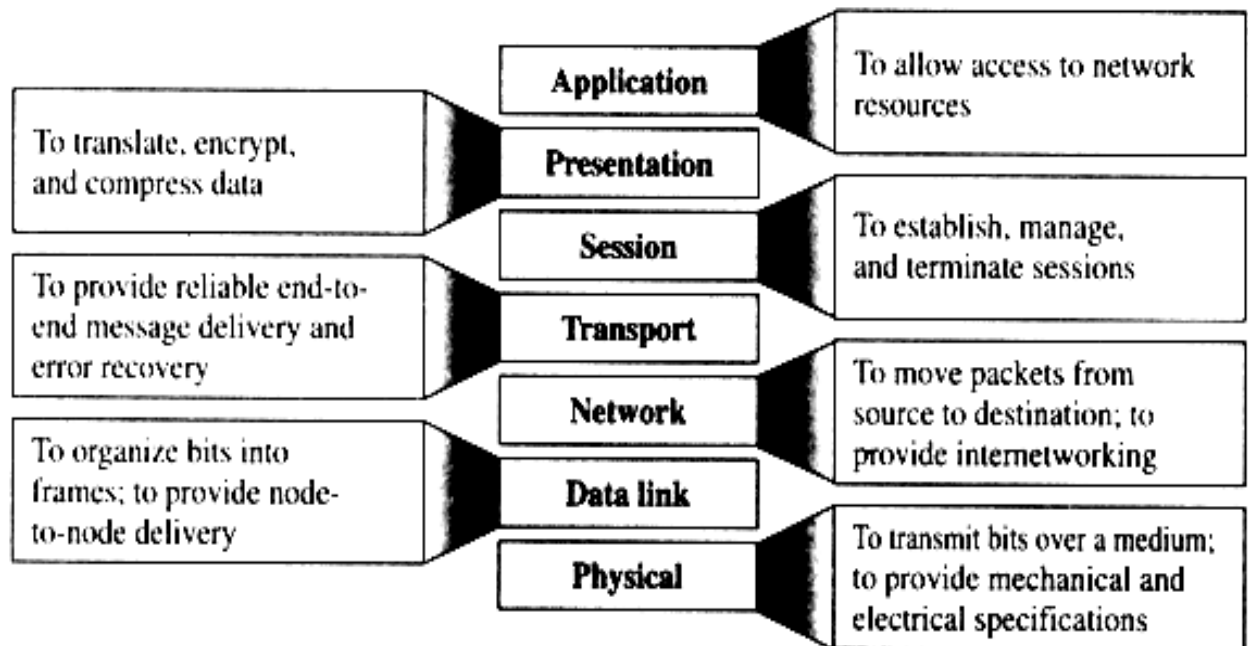
Physical layer:

The physical layer coordinates the functions required to transmit a bit stream over a physical medium. It deals with the mechanical and electrical specifications of the interface and transmission medium. It also defines the procedures and functions that physical devices and interfaces have to perform for transmission to occur. The physical layer is concerned with the following:

- Physical characteristics of interfaces and media
- Representation of bits
- Data rate
- Synchronization of bits
- Line configuration
- Physical topology
- Transmission mode

4.6.5 Summary of layer functions:

The functions of seven layers are summarized in figure below.



REVIEW QUESTIONS

PART – A

1. What is data communication?
2. List the characteristics of data communication.
3. List the components of data communication.
4. What is data flow?
5. List the types of data flow.
6. What is simplex?
7. What is half duplex?
8. What is full duplex?
9. What is topology? List its types.
10. State two disadvantages of bus topology.
11. State two advantages of star topology.
12. State two advantages of ring topology.
13. State two advantages of mesh topology.
14. State two disadvantages of mesh topology.
15. Define : networks

16. List the types of networks.
17. What is internet?
18. What is intranet?
19. What is extranet?
20. What are client and server?
21. What is peer to peer network?
22. State the advantages of client server network.
23. What is wireless router?
24. What is protocol?
25. What are defacto and dejure standards?

PART – B

1. Briefly explain about the components of data communication.
2. What are simplex, half duplex and full duplex modes?
3. What is hybrid topology?
4. Briefly explain about internet, intranet and extranet.
5. What is client server network?
6. Write about data communication standards.

PART – C

1. Explain the bus, star, ring and mesh topologies.
2. Compare the bus, star, ring and mesh topologies.
3. Explain about LAN, WAN and MAN.
4. Write about CAN and HAN.
5. What are internet, intranet and extranet?
6. Explain about the switch, routers and gateway.
7. Explain about the OSI model with diagram.

UNIT – V

802.X AND TCP/IP PROTOCOLS

5.1 Overview of TCP / IP:

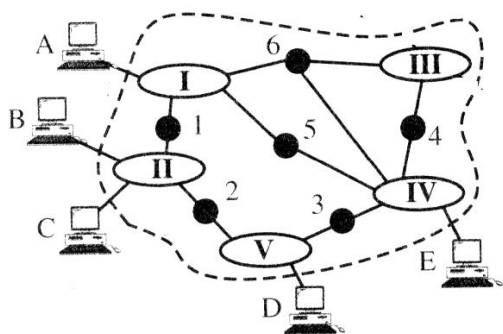
In 1970, a project was funded by the Advanced Research Project Agency (ARPA) of U.S. Department of Defense to establish a packet switching network of computers called Advanced Research Project Agency Network (ARPANET) that provided the basis for networking. The conventions developed by ARPA to specify how individual computers could communicate across that network became TCP/IP. The adaptability of TCP/IP and expansion of ARPANET became the backbone of today's Internet.

5.1.1 TCP/IP:

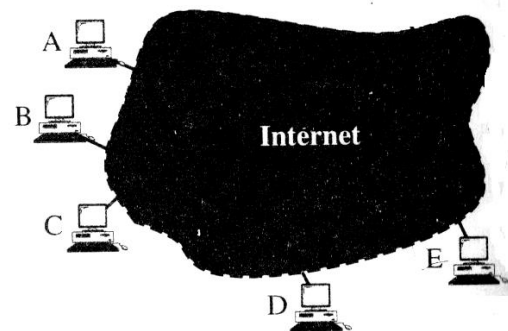
The Transmission Control Protocol/Internetworking Protocol is a set of protocols or a protocol suite that defines how all transmissions are exchanged across the internet.

TCP/IP and the Internet:

An internet under TCP/IP operates like a single network connecting many computers of any size and type. Internally the Internet is an interconnection of independent physical networks linked together by internetworking devices. Figure shows the topology of a possible internet. In this example, the letters A, B, C and so on represent hosts. A host in TCP/IP is a computer. The solid circles in the figure numbered 1, 2, 3 and so on are routers or gateways. The larger ovals containing numerals represent separate physical networks.



a. An actual internet



b. An internet seen by TCP/IP

TCP/IP and the Internet

TCP/IP considers all interconnected physical networks to be one huge network. It considers all the hosts to be connected to this larger logical network rather than to other individual physical networks.

TCP/IP and OSI :

TCP/IP's implementation of the OSI model makes functionality simpler by mapping the same seven layers of the OSI model to a four layer model. Unlike the OSI reference model, the TCP/IP model focuses more on delivering the internet connectivity than on functional layers. It does this by acknowledging the importance of a structured hierarchical sequence of functions, yet leaves the protocol designers with the flexibility for implementation. The OSI reference model is much better at explaining the mechanics of intercomputer communications, but because TCP/IP has become the internetworking model of choice, this model is more commonly used.

The table below compares the OSI and TCP/IP models.

OSI Reference model	TCP/IP Networking model
Application layer	Application Layer
Presentation Layer	
Session Layer	
Transport Layer	Transport Layer
Network Layer	Internet Layer
Data Link Layer	Network Interface Layer
Physical Layer	

Comparison of OSI reference model and TCP/IP Networking model

- **Application Layer:** Maps to Layer 5 (Session), Layer 6 (Presentation) and Layer 7 (Application) of the OSI model. This is how applications and certain services access the network.
- **Transport Layer:** Maps to Layer 4 (Transport) of the OSI model. It accepts data and segments it for transport across the network, making sure that the data is delivered error-free and in the proper sequence.
- **Internet Layer:** Maps to Layer 3 (Network) of the OSI model. It manages the routing of packets that are to be forwarded on to different networks, relying on routable protocols for delivery.
- **Network Access Layer:** Maps to Layer 1 (physical) and Layer 2 (Data Link) of the OSI model. It is responsible for the delivery of datagrams by creating a frame for the network type and then sending the data to the wire.

TCP/IP is a suite of protocols and applications that enable a computer to communicate with other computers in a network. It doesn't matter what operating system the computers are using as long as each system supports TCP/IP. The computers then communicate and share information.

5.1.2 Connection oriented and Connectionless Services:

A transport layer protocol can either be connectionless or connection-oriented.

Connectionless service:

In a connectionless service, the packets are sent from one computer to another with no need for connection establishment and connection release. The packets are not numbered. They may be delayed, lost or arrive out of sequence. There is no acknowledgment either.

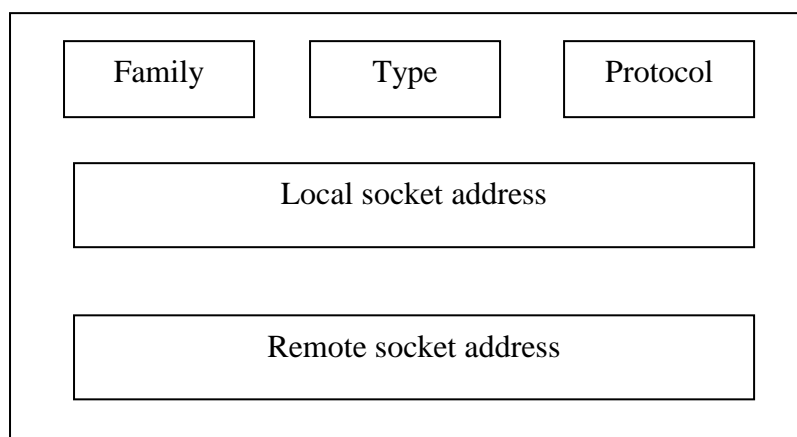
UDP is a connectionless protocol.

Connection oriented Service:

In a connection-oriented service, a connection is first established between the sender and the receiver. Then, data are transferred. At the end, the connection is released. **TCP is a connection-oriented protocol.**

5.1.3 Sockets:

A socket is an internal end point for sending/receiving at a single node in a computer network. Two processes need a socket at each end to communicate with each other.



Socket structure

The above figure shows a simplified socket structure. The fields are discussed below:

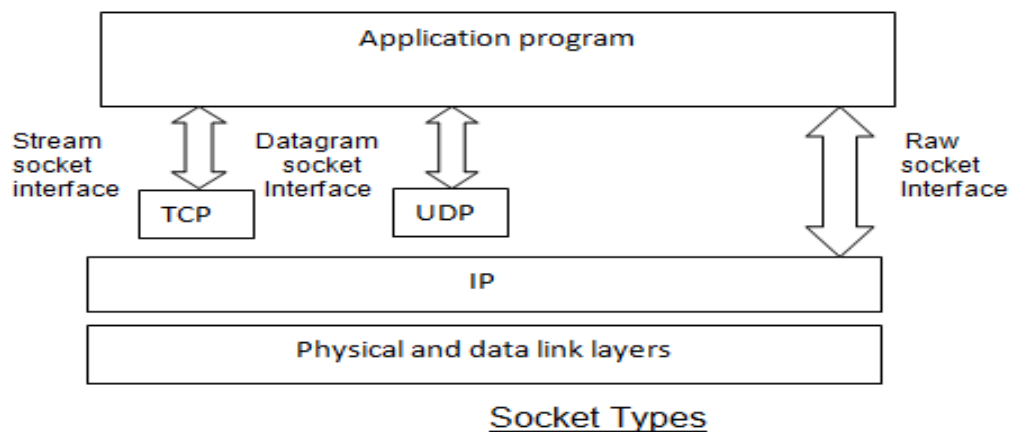
- **Family** : This field is used for defining the protocol group such as IPv4 or IPv6, Unix domain protocol etc.
- **Type** : This field is used for defining the type of socket such as stream socket, packet socket or raw socket.
- **Protocol** : This field is usually set to zero for TCP and UDP.
- **Local socket address** : It is used for defining the local socket address. This address is a combination of local IP address and the port address of the local application program.
- **Remote socket address** : It is used for defining the remote socket address which is a combination of remote IP address and the port address of the remote application program.

Socket types:

The socket interface defines three types of sockets:

1. Stream socket
2. Packet socket and
3. Raw socket

All these sockets are used in TCP/IP environment. Let us discuss them one by one.



Stream socket:

This is designed for the connection oriented protocol such as TCP. The TCP uses a pair of stream sockets for connecting one application program to the other across the Internet.

Datagram socket:

This type of socket is designed for the connectionless protocol such as UDP. UDP uses a pair of datagram sockets for sending a message from one application program to another across the internet.

Raw socket:

Raw sockets are designed for the protocols such as ICMP, because these protocols do not use either stream packets or datagram sockets.

5.1.4 TCP/IP Transport layer's Protocols:

The protocol layer above the Internet layer is the Transport layer. It is responsible for providing end-to-end data integrity. It also provides a reliable communication service so that an extended two-way conversation may take place.

It consists of two protocols TCP and UDP.

TCP provides connection oriented data transmission, can support multiple data streams and provides for flow and error control. It uses sequence numbers and acknowledgments to guarantee delivery. UDP does not provide either sequencing or acknowledgements. It is a connectionless protocol that is used in telephony traffic and the Remote Procedure Call (RPC).

The major difference between TCP and UDP is reliability. TCP is highly reliable and UDP is a best effort simple delivery method. One of the main functions of TCP and UDP is as a port manager for the applications that are in the top layer. The destination port number is placed in the header and is used to pass traffic to the correct application.

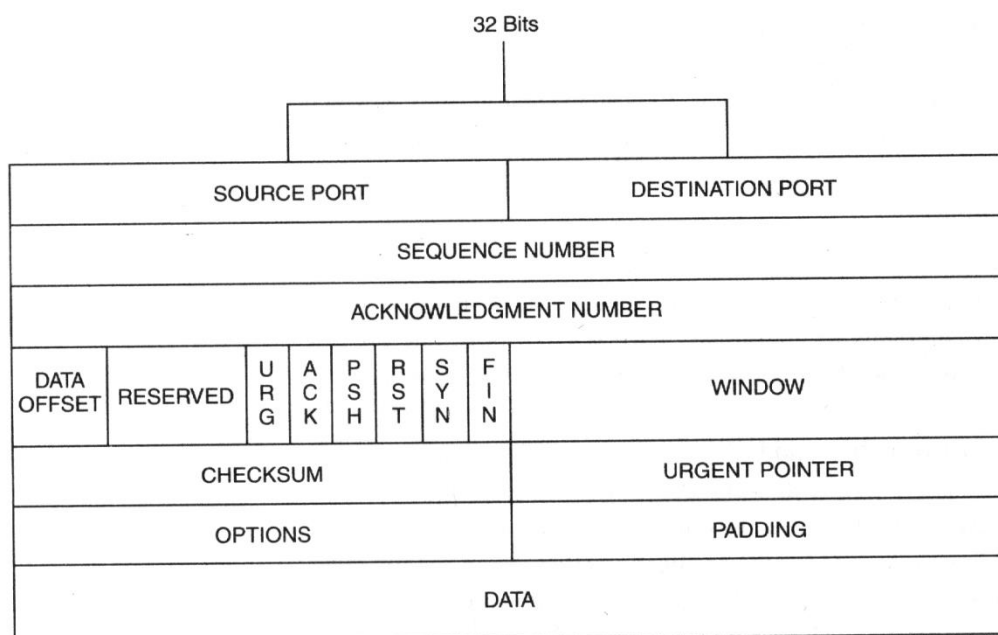
Transmission Control Protocol (TCP):

TCP is the part of the protocol suite that provides functionality for packets and error checking. Applications that require reliable data delivery use TCP because it verifies that data are delivered accurately and in the proper sequence. It also ensures that data are resubmitted when transmission results in an error and also enables hosts to maintain multiple, simultaneous connections.

Sockets make up a TCP connection. A socket consists of an IP address and a port number. Connections are determined by the IP addresses and the socket numbers of the two computers trying to communicate. To establish a connection, a machine needs to know the IP address and the port number on which the application communicates. When the application first starts using TCP, the receiver's computer sets up a buffer large enough to accommodate traffic for the data from the application. An acknowledgement (ACK) is periodically sent to

the sender. If TCP receives ACKs that indicate a missing segment, it resends the missing segment and any segments sent after that to ensure that all the data was sent. The two TCP end points hold state information that in essence forms a virtual circuit. The virtual circuit is full duplex, meaning that data can go in both directions simultaneously. This virtual circuit consumes resources in both TCP endpoints; therefore it requires more CPU and network bandwidth.

The two most typical network applications that use TCP are File Transfer Protocol (FTP) and Telnet. Telnet uses port 23 and FTP uses port 21. Clients can find the desired server simply by connecting to port 23 or 21 of TCP on the specified computer. The TCP protocol header is illustrated if figure below.



TCP protocol header

The TCP protocol header is a minimum of 20 octets and contains the following fields

∴

- **Source port** : This that contains the port number of the application requesting the connection.
- **Destination port** : This contains the port number of the application called in the connection.
- **Sequence number** : This is used to reconstruct the data back into its original form at the destination number.

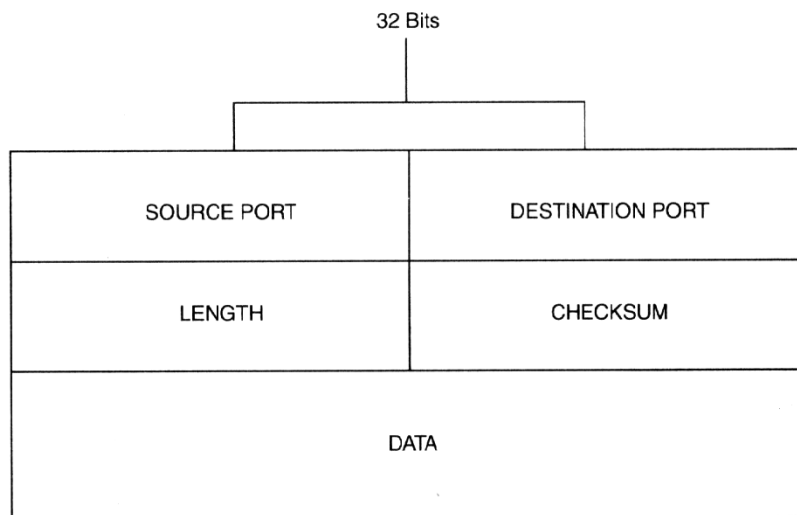
- **Acknowledgement number** : This identifies each sequence number of the packet being acknowledged. It contains the sequence number of the next expected octet.
- **Header length (HLEN)** : The field indicates the number of 4 byte words in the TCP header.
- **Reserved** : This is a 6-bit field reserved for future use.
- **Control** : This field defines 6 flags that are used to specify services and operations during the session.
 - **URG** :Significant urgent pointer field
 - **ACK** :Significant acknowledgement field
 - **PSH** : Use the push function
 - **RST** : Reset connection
 - **SYN** : Synchronize sequence numbers
 - **FIN** : Data has finished sending
- **Window size** : This defines the size of the sliding window.
- **Checksum** : This contains the checksum and used in error detection.
- **Urgent pointer** : This 16-bit field, which is valid only if the urgent flag is set. It is used when the segment contains urgent data. the number is added to the sequence number of the last urgent byte in the data section of the segment.
- **Options and padding**: These are used to convey additional information to the receiver or for alignment purposes.

5.1.5 User Datagram Protocol (UDP):

User Datagram Protocol (UDP) is the other main protocol that resides on top of IP. UDP is a connectionless datagram service that does not guarantee delivery and does not maintain an end-to-end connection. It merely pushes the datagram out and accepts incoming datagram. UDP adds to what IP provides by multiplexing information between application based on port number. In other words, UDP gives application programs direct access to a datagram via ports. This direct access allows applications to exchange messages over the network with a minimum of protocol overhead.

If the amount of data being transmitted is small, the overhead of creating connections and ensuring reliable delivery may be greater than the work of retransmitting the entire datagram. Other applications provide their own techniques for reliable data delivery and do not require that service from the Transport layer protocol. Imposing another layer of

acknowledgement is redundant. Some applications have a query/response mechanism. The response can be used as an acknowledgement to the query thereby verifying the connection. UDP can also be used for exchanges of data that do not require any of the functionality that TCP provides. The UDP protocol header is given in figure below



UDP protocol header

The fields are as follows:

- **Source port number:** This contains the port number of the application requesting the connection.
- **Destination port number:** This contains the port number of the application called in the connection.
- **Message length:** It defines the length of the user datagram, header plus data.
- **Checksum:** It is field used to detect errors over the entire user datagram.

Example network applications that use UDP are Network File System (NFS) and Simple Network Management Protocol (SNMP).

Applications of UDP:

The following are some uses of UDP.

1. UDP is suitable for a process that requires simple request-response communication with little concern for flow and error control. It is not usually used for a process that needs to send bulk data, such as FTP.
2. UDP is suitable for process with internal flow and error control mechanisms. For example, the Trivial File Transport Protocol (TFTP) includes flow and error control. It can easily use UDP.

3. UDP is a suitable transport protocol for multicasting. Multicasting capabilities are embedded in the UDP software but not in the TCP software.
4. UDP is used for some routing update protocols such as Routing Information Protocol (RIP).

Comparison of TCP and UDP:

S.No.	TCP	UDP
1.	Applications that send continuous streams of data at a steady rate use TCP.	Applications that do not want a continuous flow but send data occasionally in the form of bursts use UDP
2.	TCP establishes a connection before any data is actually transferred and data can be sent only when the connection is active. The TCP layer at both the ends maintain state information about the connection.	UDP does not set up any connection before transmitting the data. So, it does not maintain any state information.
3.	TCP puts at least 20 bytes in the header, thus more overhead in the network traffic	UDP adds 8 bytes in the header and thus less overhead over the actual data.
4.	TCP takes care of errors that occur during data transfer.	UDP does not offer this facility.
5.	TCP controls flow of data.	UDP does not control flow of data.

5.2 802.X Protocols:

IEEE 802 is a family of IEEE standards dealing with local area networks and metropolitan area networks. These standards are restricted to networks carrying variable-size.

The services and protocols specified in IEEE 802 map to the lower two layers (Data Link and Physical) of the seven-layer OSI networking reference model. In fact, IEEE 802 splits the OSI Data Link Layer into two sub-layers named logical link control (LLC) and media access control (MAC).

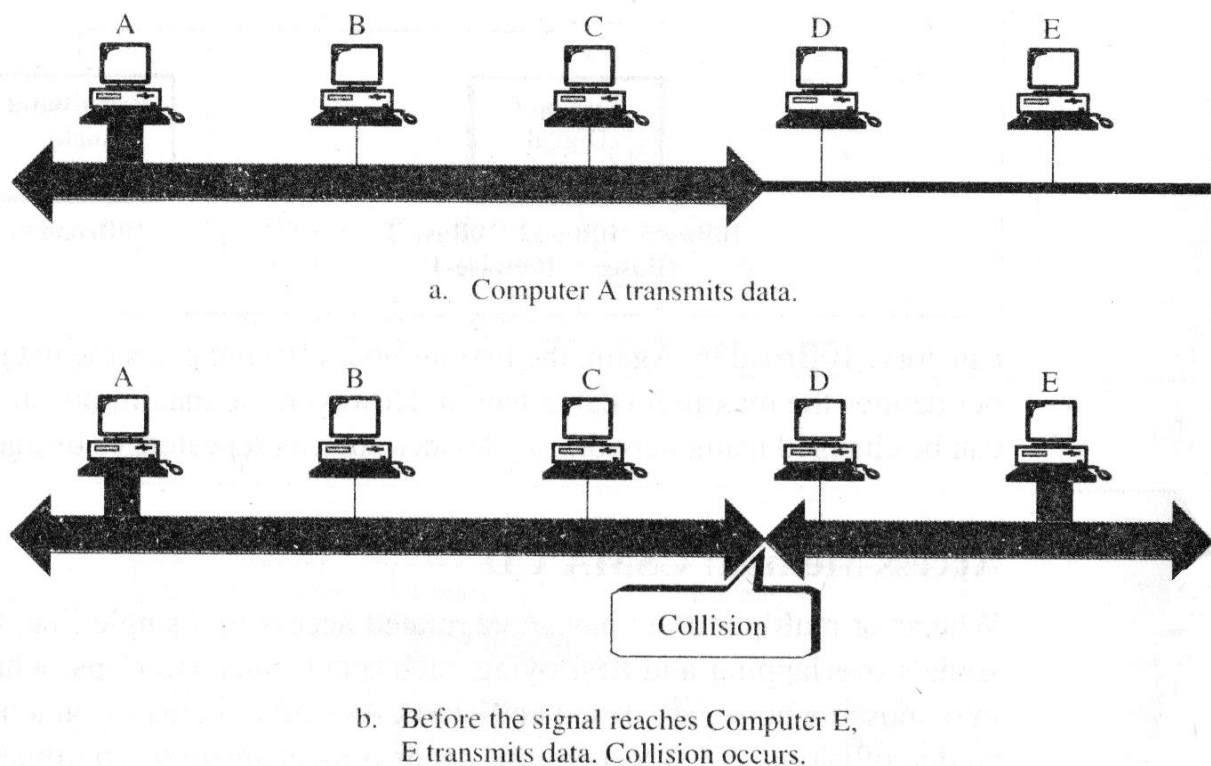
5.2.1 Concepts and PDU format of CSMA/CD (802.3):

Ethernet networks use carrier sense multiple access (CSMA) to improve performance and reduce traffic. When a node has data to transmit, it first listens on the cable using a transceiver to check whether a signal is being transmitted by another node. This is done by monitoring the current flowing in the cable. Data is transmitted when there is no

current present and the physical medium is idle. CSMA is a fundamental advance in access and performance because it check whether the medium is active before sending a packet. If the channel is sensed as idle, it transmits. If the channel is sensed as busy, it holds off the transmission until it can sense that the medium is idle.

At a time, if two stations are waiting to transmit, they will send, as soon as each sense the medium is idle, causing a collision. Obviously, if a collision happens, we want to detect and resolve it. The method that can be used to solve collision issues is exponential backoff. In this method, when a collision occurs, a timeout is randomly chosen and the transmission resumes/backoff after timeout.

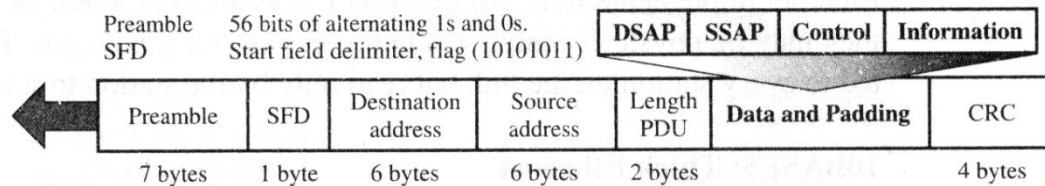
During this process, the node must continuously monitor the collision detection logic to detect whether a collision occurs. If it does, it stops sending bits within a few bit periods , starts the collision procedure by sending a jam signal, and then calculates a retransmission time. This causes the other nodes to discard the frame and ensure that all stations are aware of a collision so that they can increment a timeout range.



Collision in CSMA/CD

Frame format:

IEEE 802.3 specifies one type of frame containing seven fields: Preamble, SFD, DA, SA, length/type of PDU, 802.2 frame and the CRC. The format of the MAC frame in CSMA/CD is shown in figure.



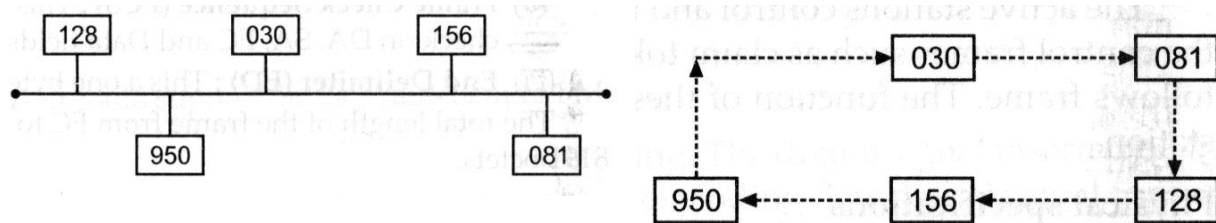
802.3 MAC frame

- **Preamble:** It contains 7 bytes of alternating 0s and 1s to provide an alert and timing pulse.
- **Start Frame Delimiter (SFD):** The second field (1 byte : 10101011) of the frame signals the beginning of the frame..
- **Destination Address (DA):** This field contains the physical address of the packet's next destination.
- **Source Address (SA):** This field contains the physical address of the sender or last device forwarding the packet.
- **Length/type of PDU:** This field is the length or type field.
- **Data and Padding:** This field carries data encapsulated from the upper-layer protocols
- **CRC:** The last field contains error detection information.

5.2.2 Token bus (802.4):

The IEEE802.4 standard for media access control is known as Token bus. It is used in factory automation and process control as it combines the physical configuration of Ethernet and the collision free (predictable delay) feature of token ring. Token bus is a physical bus that operates as a logical ring using tokens.

Token bus is a linear or tree shaped cable through which different stations are interconnected. Logically, the interconnected stations form a ring as shown in figure below. The physical topology is also shown in figure. Each station knows its own identification number and the identity of the stations preceding and following it. The sequence number and the physical location of a station on the bus are not related to each other.



Physical topology in token passing Logical sequence of token passing

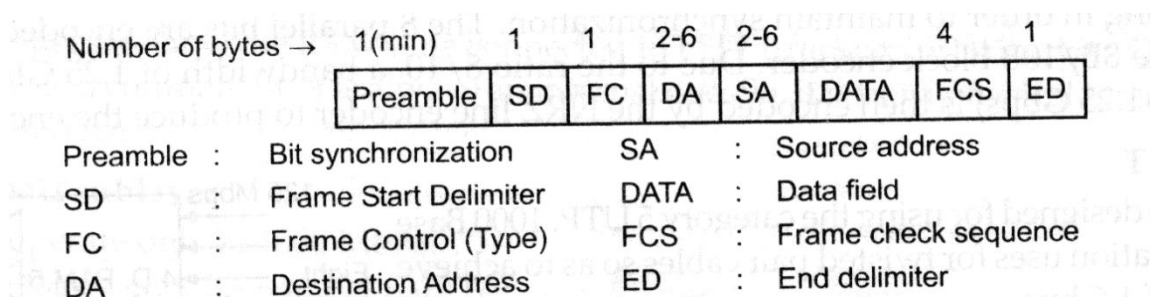
A look at the sequence of stations in the logical sequence of token passing shows that the stations connected in a bus are arranged in a logical sequence.

After initialization of the logical ring, the station bearing the highest number sends out the first frame. After doing so, it passes permission to its neighboring station so that it can send its frame. This permission is passed by sending a special control frame called Token.

The operation of token bus takes place as follows :

- i) At any time, the station which holds the token only can transmit its data frames on the bus. Every frame contains source and destination addresses.
- ii) All other stations are ready to receive these data frames.
- iii) As soon as the transmission time of a station is over, it passes the token to the next station in the logical sequence. The transmission is then taken over by the next station.
- iv) In one cycle of operation, each station gets an opportunity to transmit once. The same station can get more number of chances to transmit in one cycle if more than one addresses are assigned to it.

The frame format as specified by IEEE802.4 is shown in figure.



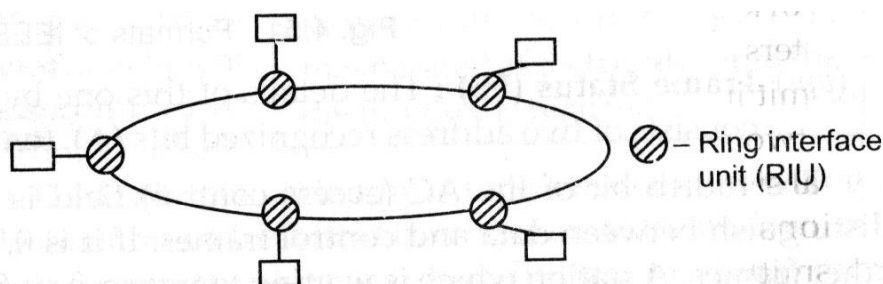
The frame consists of the following fields :

- **Preamble:** Preamble is used for bit synchronization.
- **Start delimiter (SD):** It marks the beginning of a frame.
- **Frame control (FC):** It indicates the type of frame as data frame or control frame. Token is a control frame.
- **Destination Address (DA):** It contains the destination address
- **Frame Check Sequence (FCS):** This field contains a CRC code
- **End Delimiter (ED):** This marks the end of the frame.

The active stations control and manage the token. Each one of them can initiate and respond to the control frames such as claim token frame, solicit successor frame, set successor frame and who follows frame. The function of these frames is to initialize the bus and for adding or removing a station.

5.2.3 Token ring (802.5):

A token ring system is shown in figure below. It consists of a number of stations connected to the ring through a Ring Interface Unit (RIU). The Ring Interface Unit is a repeater and therefore it regenerates the received data frames and sends them to the next station after some delay.



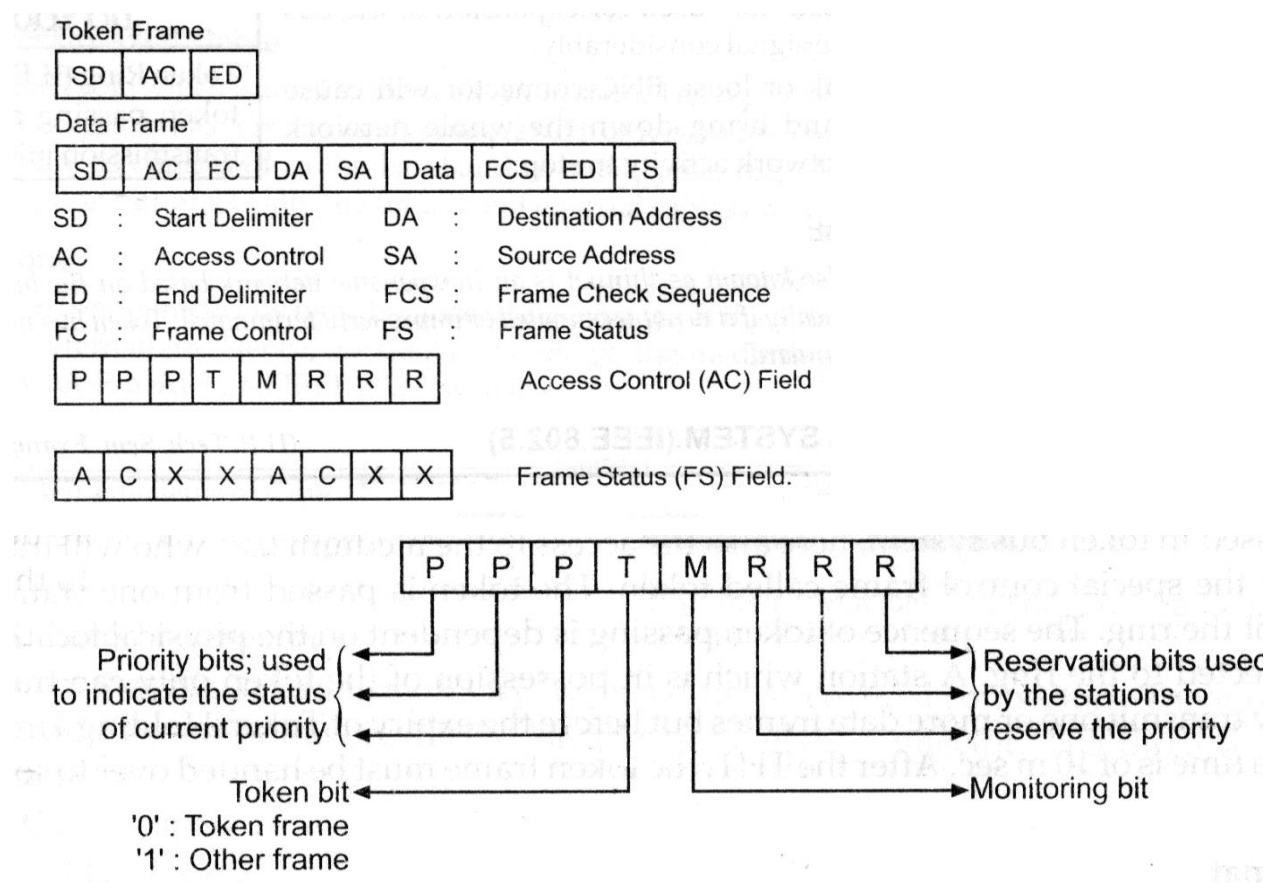
Token ring

Here the access to the medium is controlled by the special control frame called token. The token is passed from one station to the other along the ring. The sequence of token passing is dependent on the physical location of the stations connected to the ring. A station which is in possession of the token only can transmit frames. It may transmit one or more data frames but before the expiry of Token Holding Time (THT) which may be 10ms. After the holding time, the token frame must be handed over to some other station.

The data frame proceeds around the ring, being regenerated by each station. Each intermediate station examines the destination address, finds that the frame is addressed to another station and relays it to its neighbor. The intended receiver recognizes its own address, copies the message, checks for errors and changes 4 bits in the last byte of the frame to indicate address recognized and frame copied. The full packet then continues around the ring until it returns to the station that sent it.

The sender receives the frame and recognizes itself in the source address field. It then examines the address-recognized bits. If they are set, it knows the frame was received. The sender then discards the used data frame and releases the token back to the ring.

IEEE802.5 has standardized the formats for the token frame and data frame as in figure below.



Format of 802.5 frames

The token frame and data frame contain the following fields :

- **Start delimiter (SD)** : It marks the beginning of a token or data frame.
- **Access Control (AC)** : This consists of the Priority bits (P), token bits (T), monitoring bits (M) and reservation bits.
- **Frame control (FC)** : It indicates the type of frame as data frame or control frame.

- **Destination Address (DA) :** It contains the destination address.
- **Source Address (SA) :** It contains the source address.
- **Data Field (DF) :** There is no limitation on the size of this field. The token holding time will decide the maximum size of the data field.
- **End Delimiter (ED) :** This marks the end of the frame.
- **Frame Status (FS) :** It consists of two address recognized bits (A), two frame copied bits (C) and reserved bits (X).

The fourth bit of the AC (access control) field is called token bit. A station which is waiting to transmit its frame, waits for the token bit. As soon as the token bit is found to be 0 (indicates a token frame) it seizes the token by disconnecting the ring at RIU. The station then inserts a 1 in place of 0 and continues with the rest of the data frame. Hence this station has grabbed the token and hence can transmit its data frames on the ring.

Regarding **priority management**, the first three bits in the AC field are priority bits. The last three bits (R bits) are called **reservation bits**. They are used to reserve the priority level.

In the ring, one of the stations acts as an active **monitoring station**. If the token does not appear on the allotted time, it is presumed to be lost and the monitor generates a new token and introduces it to the ring.

5.2.4 Types of Ethernet:

Several schemes have been devised to improve the performance of Ethernet LANs. Two of them are

1. Fast Ethernet
2. Gigabit Ethernet.

Fast Ethernet:

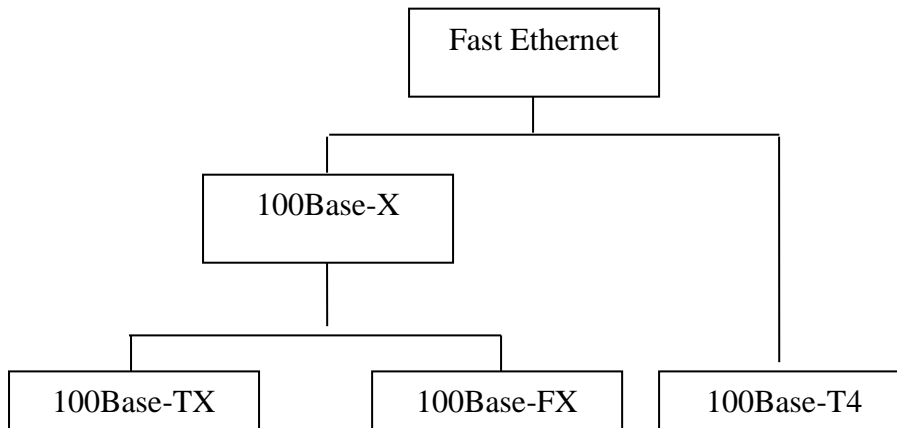
With new applications such as CAD, image processing and real time audio and video being implemented on LANs, there is a need for a LAN with a data rate higher than 10 Mbps. Fast Ethernet is a version of Ethernet with a 100 Mbps data rate. There is no change in the frame format and in the access method. The only two changes in the MAC layer are the data rate and the collision domain. The data rate is increased by a factor of 10.

In the physical layer, IEEE has designed two categories of Fast Ethernet:

1. 100Base-X and
2. 100Base-T4.

The first uses two cables between the station and the hub. The second one uses four. 100Base-X itself is divided into two types:

1. 100Base-TX and
2. 100Base-FX



Categories of Fast Ethernet implementations

100Base-TX :

The 100Base-TX uses two category 5 unshielded twisted-pair (UTP) or two shielded twisted-pair (STP) cables to connect a station to the hub. One pair is used to carry frames from the station to the hub and the other to carry frames from hub to the station. The encoding is 4B/5B to handle the 100 Mbps, the signaling is NRZ-I. The distance between the station and the hub should be less than 100 meters.

100Base-FX :

This design uses two optical fibers, one to carry frames from the station to the hub and the other from the hub to the station. The encoding is 4B/5B and signaling is NRZ-I. The distance between the station and the hub (or switch) should be less than 2000 meters.

100Base-T4 :

This scheme was designed in an effort to avoid rewiring. It requires four pairs of category 3 (voice grade) UTP that are already available for telephone service in most

buildings. Two of the four pairs are bidirectional and the other two are unidirectional. This means that in each direction, three pairs are used at the same time to carry data. Because a 100 Mbps data rate cannot be handled by a voice grade UTP, the specification splits the 100 Mbps flow of data into three 33.66Mbps flows. To reduce the baud rate of transmission, a method called 8B/6T is used in which each block of 8 bits is transformed into 6 bauds of three voltage levels (positive, negative and zero).

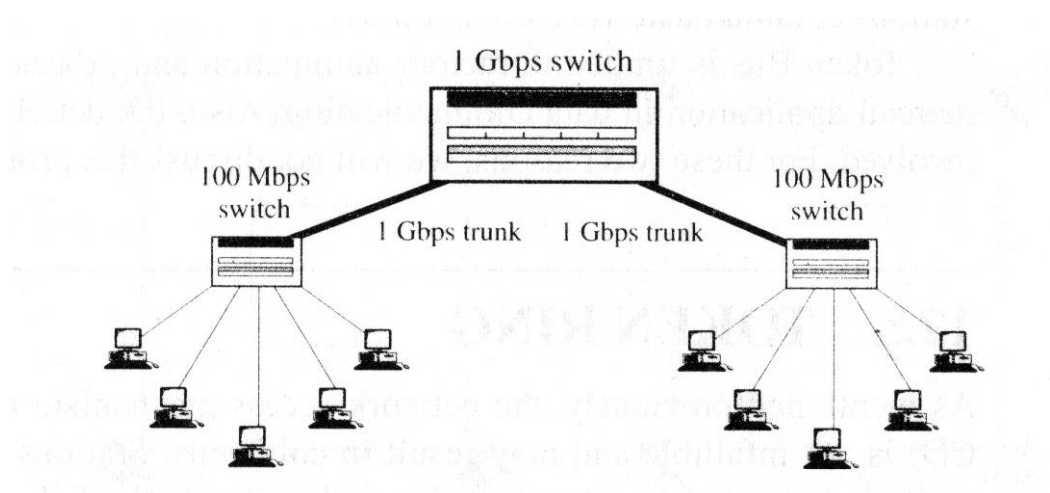
Gigabit Ethernet :

The migration from 10Mbps to 100 Mbps encourages the IEEE802.3 committee to design Gigabit Ethernet, which has a data rate of 1000 Mbps or 1 Gbps. The strategy is the same. The MAC layer and the access method remain the same, but the collision domain is reduced. In the physical layer, the transmission media and the encoding system change. Gigabit Ethernet is mainly designed to use optical fiber, although the protocol does not eliminate the use of twisted pair cables. Gigabit Ethernet usually serves as a backbone to connect Fast Ethernet networks.

Four implementations have been designed for Gigabit Ethernet :

1. 100Base-LX
2. 100Base-SX
3. 100Base-CX and
4. 100Base-T.

The encoding is 8B/10B, which means a group of 8 binary bits are encoded into a group of 10 binary bits.



Use of Gigabit Ethernet

5.2.5 Comparison between 802.3, 802.4 and 802.5:

Standard specification	802.3	802.4	802.5
Structure	Size of the frame format is 1572 bytes	Size of the frame format is 8202 bytes	Variable size.
Size of the data field	0-1500 bytes	0-8182 bytes	No limit
Priority	No priorities	Supports priorities	Priorities are possible.
Frame requirement	Minimum frame required is 64 bytes	It can handle short minimum frames	It supports short frames
Efficiency and throughput	Efficiency decreases when speed increases and collision affects the throughput.	Throughput and efficiency at high load are excellent	Throughput and efficiency at high load are excellent
Modem	Modems are not required	Modems are required	Modems are required
Protocol	Protocol is simple	Protocol is extremely complex	Protocol is moderately complex.

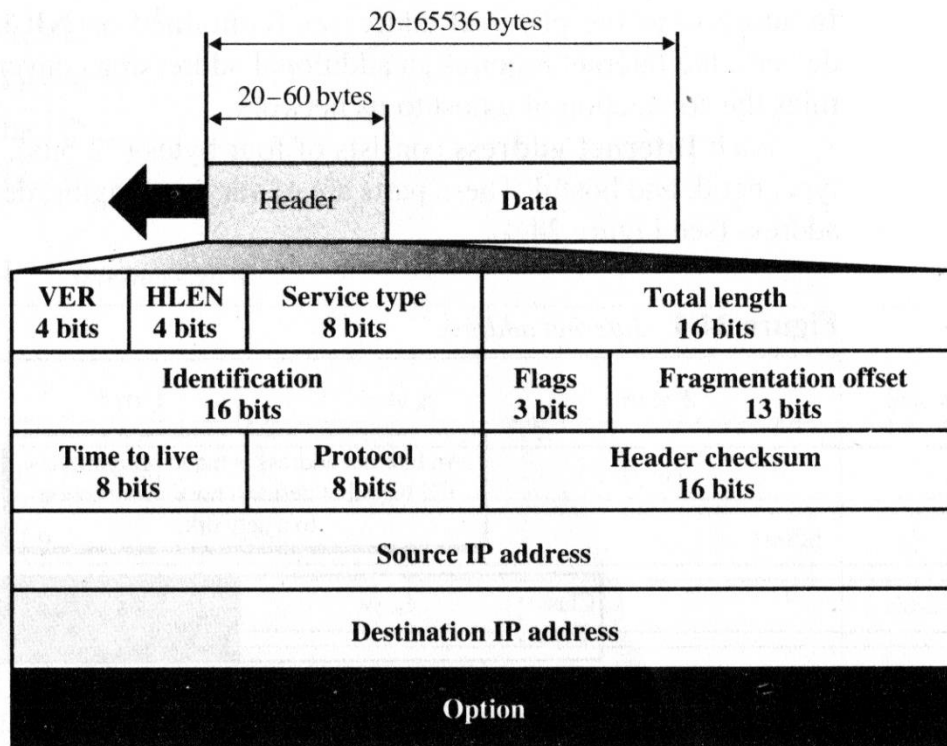
5.3 Network Layers Protocol: IP

The Internet Protocol (IP) is the host-to-host network layer delivery protocol for the Internet. IP is an unreliable and connectionless datagram protocol – a best effort delivery service. It means that IP provides no error control or flow control. IP uses only an error detection mechanism and discards the packet if it is corrupted. IP does its best to deliver a packet to its destination, but with no guarantees.

5.3.1 Datagram:

Packets in the IP layer are called datagrams. Figure below shows the IP datagram format. A datagram consists of two parts : header and data. The header can be 20 bytes to 60 bytes and contains information essential to routing and delivery. A brief description of each field is in order.

- **Version (VER) :** It defines the version number of the IP.
- **Header length (HLEN) :** It defines the length of the header in multiples of 4 bytes.
- **Service type :** It defines how the datagram should be handled.
- **Total length :** It defines the total length of the IP datagram.



IP datagram

- **Identification** : This field is used in fragmentation.
- **Flags** : The bits in the flags field deal with fragmentation
- **Fragmentation offset** : The fragmentation offset is a pointer that shows the offset of the data in the original datagram
- **Time to live** : It defines the number of hops a datagram can travel before it is discarded.
- **Protocol** : This field defines which upper layer protocol data are encapsulated in the datagram (TCP, UDP, ICMP etc)
- **Header checksum** : This field used to check the integrity of the header alone.
- **Source address** : It identifies the original source of the datagram.
- **Destination address** : It identifies the final destination of the datagram.
- **Option** : The Option field can carry fields that control routing, timing, management and alignment.

5.3.2 Interior Gateway Protocols: (IGMP, ICMP, ARP, RARP Concept only).

In the Internet model or the TCP/IP suite, there are five network layer protocols : ARP, RARP, IP, ICMP and IGMP.

The main protocol in this layer is IP, which is responsible for host-to-host delivery of datagram from a source to a destination. However, IP needs the services of other protocols.

IP needs a protocol called ARP to find the MAC (physical) address of the next hop. This address must be passed to the data link layer, with the IP datagram, to be inserted into the encapsulating frame.

During datagram delivery, IP needs the services of ICMP to handle unusual situations such as the occurrence of an error.

IP is designed for unicast delivery, one source to destination. Multimedia and other new applications in the Internet need multicasting delivery, one source to many destinations. For multicasting, IP uses the services of another protocol called IGMP.

Introduction:

The Internet is made of a combination of physical networks connected by devices such as routers. A packet starting from a source host may pass through several different physical networks before finally reaching the destination host.

IP address:

The hosts and routers are recognized at the network level by their IP addresses. An IP address is an internetwork address.

MAC address:

At the physical network, the hosts and routers are recognized by their MAC addresses. A MAC address is a local address. Its jurisdiction is a local network

The delivery of a packet to a host or a router requires two levels of addressing : IP address and MAC address. Two protocols are used to find the other address if one type of address is known.

They are

1. Address Resolution Protocol (ARP) and
2. Reverse Address Resolution Protocol (RARP)

The ARP maps an IP address to a MAC address, whereas the RARP maps a MAC address to an IP address.

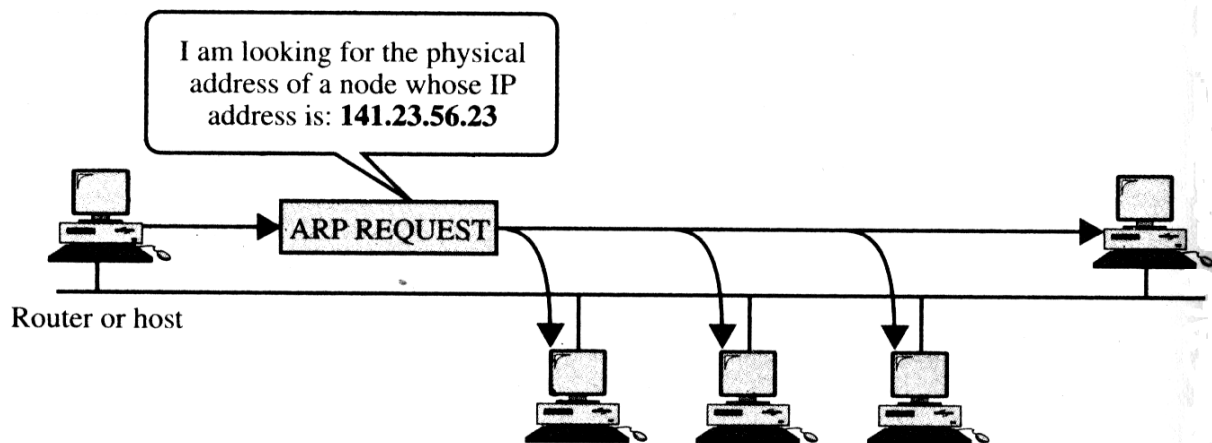
Address Resolution Protocol (ARP):

The Address Resolution Protocol associates an IP address with the MAC address. On a typical physical network, such as a LAN, each device on a link is identified by a physical or station address usually imprinted on the network interface card (NIC).

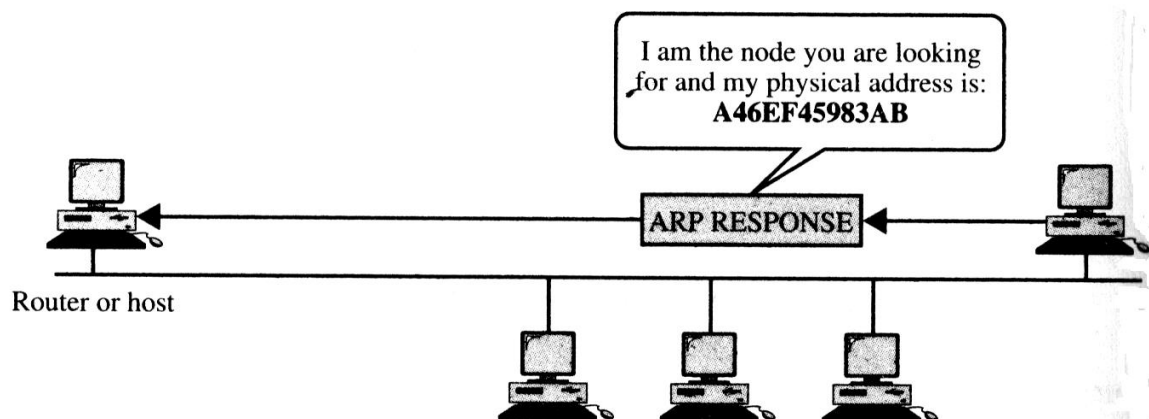
Anytime a host or a router needs to find the physical address of another host on the network, it sends an ARP query packet. The packet includes the physical and IP address of the sender and the IP address of the receiver. Because the sender does not know the physical address of the receiver, the query is broadcast over the network. See figure below.

Every host or router on the network receives and processes the ARP packet, but only the intended recipient recognizes its internet address and sends back an ARP response packet. The response packet contains the recipient's IP and physical addresses. The packet is unicast directly to the inquirer using the physical address received in the query packet.

In the figure below, the system on the left (A) has a packet that need to be delivered to another system (B) with IP address 141.23.56.23. System A needs to pass the packet to its data link layer for the actual delivery, but it does not know the physical address of the recipient. It uses the services of ARP to send an ARP request packet to ask for the physical address of a system with an IP address of 141.23.56.23.



a. ARP request



b. ARP response

This packet is received by every system on the physical network, but only system B will answer it as in figure. System B sends an ARP reply packet that includes its physical

address. Now system A can send all the packets to this destination using the physical address it received.

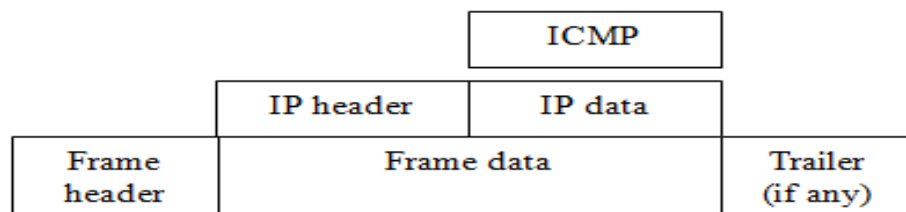
Reverse Address Resolution Protocol (RARP):

The Reverse Address Resolution Protocol allows a host to discover its internet address when it knows only its physical address. A host is supposed to have its internet address stored on its hard disk. So, this will be in the case of diskless computer or computer is being connected to the network for the first time or a new computer with old NIC.

RARP works much like ARP. The host wishing to retrieve its internet address broadcasts an RARP query packet that contains its physical address to every host on its physical network. A server on the network recognizes the RARP packet and returns the host's internet address.

Internet Control Message Protocol (ICMP):

The Internet Protocol (IP) provides unreliable and connectionless datagram delivery. However, it has two deficiencies : lack of error control and lack of assistance mechanisms.



ICMP encapsulation

The **Internet Control Message Protocol (ICMP)** has been designed to compensate for the above two deficiencies. It is a companion to the IP. ICMP itself is a network layer protocol. However, the messages are not passed directly to the data link layer. Instead, the messages are first encapsulated inside IP datagrams before going to the lower layer as in figure above.

The value of the protocol field in the IP datagram is 1 to indicate that the IP data are an ICMP message.

Applications:

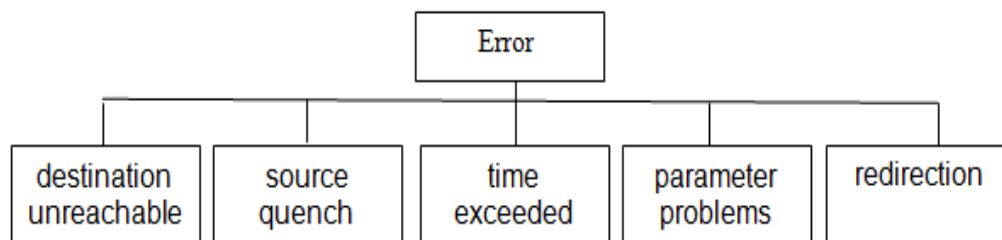
The **ping** command uses ICMP as a probe to test whether a station is reachable. Ping packages an ICMP echo request message in a datagram and sends it to the selected destination. The user chooses the destination by specifying its IP address on the command line in a form such as

ping 100.50.25.1

When the destination receives the echo request messages, it responds by sending an ICMP echo reply message. If a reply is not returned within a set time, ping regards the echo request several more times. If no reply arrives, ping indicates that the destination is unreachable.

Another utility that uses ICMP is **tracert** (trace route), which provides a list of all the routers along the path to a specified destination.

Five types of errors are handled by ICMP. The five error reporting messages are given below.



Error- reporting messages

Internet Group Message Protocol (IGMP):

The IP protocol can be involved in two types of communication : unicasting and multicasting. Unicasting is the communication between one sender and one receiver. It is a one-to-one communication. However, sometimes, processes need to send the same message to a large number of users simultaneously. This is called multicasting, which is a one-to-many communication.

IP addressing supports multicasting. All 32-bit addresses that start with 1110 (class D) are multicast addresses. With 28 bits remaining for the group address, more than 250 million addresses are available for assignment.

The Internet Group Message Protocol (IGMP) is a companion of the IP protocol. It is a protocol that manages group membership. In any network, there are one or more multicast

routers that distribute multicast packets to hosts or other routers. IGMP gives multicast routers information about the membership status of hosts or routers connected to the network.

A multicast router may receive thousands of multicast packets every day for different groups. If a router has no knowledge about the membership status of the hosts, it must broadcast all these packets. This creates a lot of traffic and consumes a lot of bandwidth. A better solution is to keep a list of groups in the network for which there is at least one loyal member. IGMP helps a multicast router create and update a list of loyal members related to each router interface.

5.4 IP Addressing:

In addition to the physical addresses (contained on NICs) that identify individual devices, an identifier used in the network layer of the Internet model to identify each device connected to the Internet is called the Internet address or IP address. An IP address in the current version of the protocol is a 32-bit binary address that uniquely and universally defines the connection of a host or a router to the Internet.

However, if a device has two connections to the Internet, via two networks, it has two IP addresses. The IP addresses are universal in the sense that the addressing system must be accepted by any host that wants to be connected to the Internet.

There are two common notations to show an IP address : binary notation and dotted decimal notation.

Binary notation:

In binary notation, the IP address is displayed as 32 bits. To make the address more readable, one or more spaces is usually inserted between each octet (8 bits). Each octet is referred to as a byte. So the IP address is referred to as a 32-bit address, a octet address or a 4 byte address. The following is an example of an IP address in binary notation :

01110101 10010101 00011101 11101010

5.4.1 Dotted Decimal Notation :

To make the IP address more compact and easier to read, Internet addresses are usually written in decimal form with decimal point separating the bytes. The following figure shows an IP address in dotted decimal notation. Because each byte is only 8 bits, each number in the dotted-decimal notation is between 0 and 255.

10000000	00001011	00000011	00011111
128.11.3.31			

Dotted decimal notation

Classful Addressing :

IP addresses, when started, used the concept of classes. This architecture is called classful addressing. In the mid 1990s, a new architecture called classless addressing was introduced which will eventually supersede the original architecture. However most of the Internet is still using classful addressing and the migration is slow.

In classful addressing, the IP address space is divided into five classes :

1. Class A
2. Class B
3. Class C
4. Class D
5. Class E

Each class occupies some part of the whole address space. We can find the class of an address when the address is given in binary notation or dotted decimal notation.

Finding the class in binary notation :

If the address is given in binary notation, the first few bits can immediately tell us the class of the address as in figure below.

	byte 1	byte 2	byte 3	byte 4
Class A	0			
Class B	1 0			
Class C	1 1 0			
Class D	1 1 1 0			
Class E	1 1 1 1			

Finding the class in binary notation

Finding the class in dotted-decimal notation :

If the address is given in dotted decimal notation, then we need to look only at the first byte (number) to determine the class of the address. Each class has a specific range of numbers. This is given in the figure below.

	First byte	Second byte	Third byte	Fourth byte
Class A	0 to 127			
Class B	128 to 191			
Class C	192 to 223			
Class D	224 to 239			
Class E	240 to 255			

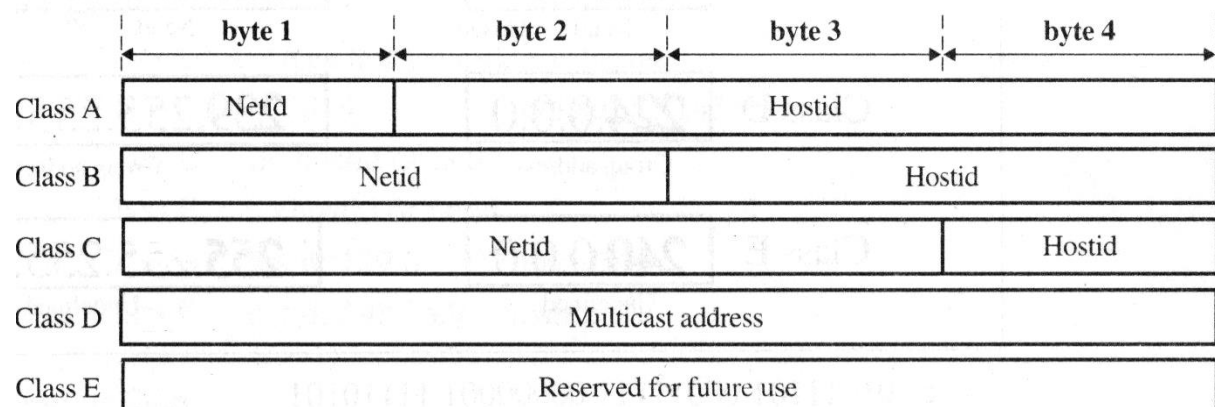
Finding the class in decimal notation

This means that if the first byte (in decimal) is between 0 and 127 inclusive, the class is A. If the first byte is between 128 and 191 inclusive, the class is B and so on.

Net-id and Host-id:

In classful addressing, an IP address in classes A, B and C is divided into net-id and hosted. These parts are of varying lengths, depending on the class of the address. The figure below shows the net-id and hosted in bytes.

In class A, one byte defines the net-id and the three bytes define the hosted. In class B, two bytes define the net-id and two bytes define the hosted. In class C, three bytes define the net-id and one byte defines the host-id.



Net-id and host-id

Looking at the first byte of an address in decimal form allows us to determine at a glance to which class a particular address belongs. See fig below.

From	To	
0.0.0.0	127.255.255.255	Class A
128.0.0.0	191.255.255.255	Class B
192.0.0.0	233.255.255.255	Class C
224.0.0.0	239.255.255.255	Class D
240.0.0.0	255.255.255.255	Class E

5.4.2 Subnets:

As the number of networks increased, the available number of network IDs in different IP address classes became insufficient. In addition, the networks needed to be divided into small networks for better performance. This is because on a network with large number of nodes, the network traffic increases and the network performance decreases. As a result, the concept of subnetting was introduced.

Benefits of subnetting:

1. Reduced network traffic
2. Optimized network performance
3. Simplified network management
4. Facilities spanning large geographical distances

Subnetting:

Subnetting is the process of dividing a given network into smaller networks. The IP addresses are divided into two parts, the network number and the host number. For a Class B network, you can connect $2^{16}-2$ hosts on a network. In this case, if you want a small number of hosts in a network, you will have many IP addresses left unused resulting in inefficient usage of the IP address space. Subnetting alleviates this problem by borrowing additional bits from the host address and using that as part of the network address. For example, for a Class B network, you could include 8 bits out of 16 bits of the host address to create 2^8-2 or 254 subnets, each having 2^8-2 or 254 hosts.

Figure below shows Class B IP address before subnetting and after using 8 bits of the host address for subnetting.

Class B IP address without Subnetting



Class B IP address with 8-bit Subnetting



8-Bit subnet for a Class B IP address

Any number of bits from the host fields can be used for subnetting. Class A IP addresses use byte1 and byte2 for the network address and byte3 and byte4 for subnetting.

Subnet masks :

A subnet mask is a 32-bit number similar to an IP address. It determines how an IP address is split into the network and host portions. Subnetting is internal to a network. To the outside world, only the network part of the IP address is applicable. The other hosts on the Internet are not aware of the subnetting used inside a network.

Subnet masks are used to extract the subnet and host information from an IP address. Subnet masks are used to perform logical AND operations with the IP address received in a packet to determine the subnet to which these packets belong. However, if this Class B network has 8 bits for subnetting, the subnet mask will be 255.255.255.0 and the logical AND with the IP address will yield 128.3.4.0, in which 128.3 is the network address and .4 is the subnet address.

The table below shows a list of Class B subnets and a variable number of bits being used for subnetting and the resulting number of networks and maximum possible number of hosts for this that network.

Number of Subnet Bits	Format of Subnet Bits (Byte3.Byte4)	Subnet Mask	Number of Subnets	Number of Hosts
2	XX000000.00000000	255.255.192.0	2	16382
3	XXX00000.00000000	255.255.224.0	6	8190
4	XXXX0000.00000000	255.255.240.0	14	4094

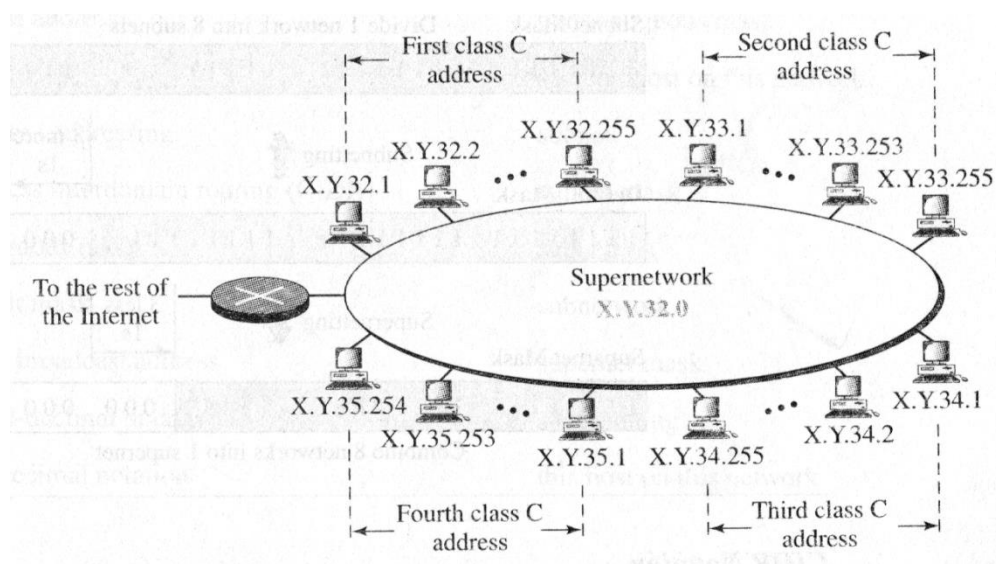
5	XXXXX000.00000000	255.255.248.0	30	2046
6	XXXXXX00.00000000	255.255.252.0	62	1022
7	XXXXXXX0.00000000	255.255.254.0	126	510
8	XXXXXXXX.00000000	255.255.255.0	254	254
9	XXXXXXXXX.X0000000	255.255.255.128	510	126
10	XXXXXXXXX.XX000000	255.255.255.192	1022	62
11	XXXXXXXXX.XXX00000	255.255.255.224	2046	30
12	XXXXXXXXX.XXXX0000	255.255.255.240	4094	14
13	XXXXXXXXX.XXXXX000	255.255.255.248	8190	6
14	XXXXXXXXX.XXXXXXX0	255.255.255.252	16382	2

Class B Network Subnetting table

5.4.3 Supernetting:

The size of a class C block with a maximum number of 256 addresses may not satisfy the needs of an organization. Even, a mid size organization may need more addresses.

One solution is **supernetting**. In supernetting, an organization can combine several class C blocks to create a larger range of addresses. In other words, several networks are combined to create a supernet. By doing this, an organization can apply for a set of class C blocks instead of just one. For example, an organization that needs 1000 addresses can be granted four class C blocks. The organization can then use these addresses in one supernet as in figure below.



supernetwork

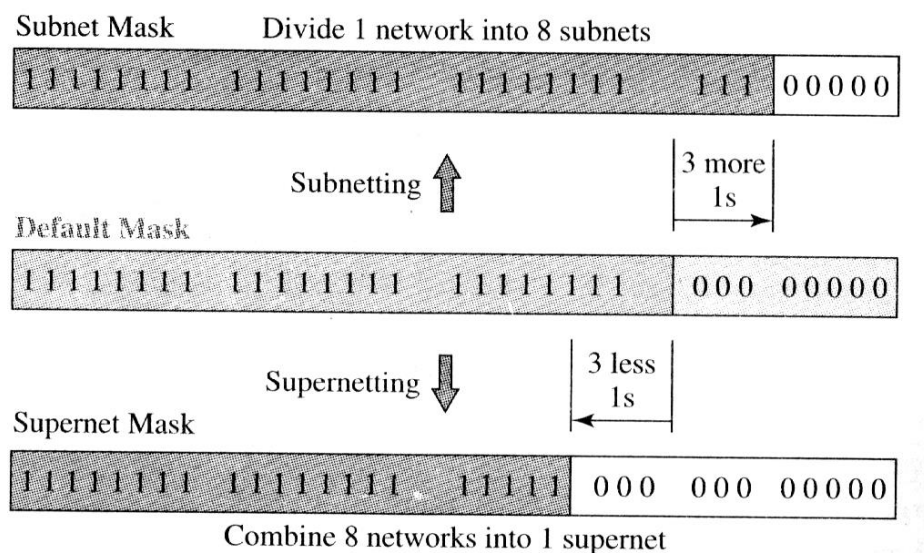
Supernetmask :

When an organization divides its block into subnets, the first address in the subblock and the subnet mask completely define the subblock (the range of addresses). In this case, however, the first address alone is not enough; we must have the subnet mask.

Similarly, when an organization combines several blocks into a superblock, we need to know the first address in the block and the supernet mask. **In supernetting, we need know the first address of the supernet and supernet mask to define the range of addresses.**

A **Supernet mask** is the reverse of a subnet mask. A subnet mask for class C has more 1s than the default mask for this class. A supernet mask for class C has less 1s than the default mask for this class.

The following figure shows the difference between a subnet mask and a supernet mask. A subnet mask that divides a block into eight subblocks has three more 1s ($2^3 = 8$) than the default mask; a supernet mask that combines eight blocks into one superblock has three less 1s than the default mask.



Comparison of subnet, default and supernet masks

CIDR notation can also be used when we have supernets. An address in a supernet can be easily defined using this notation. For example the notation 141.14.192.3/24 shows a class C address, but the address 141.14.192.3/21 shows that the address belongs to a supernet with the mask 255.255.248.0.

5.5 Application Layer Protocols:

5.5.1 File Transfer Protocol (FTP) :

File Transfer Protocol (FTP) is the standard mechanism provided by Internet for copying a file from one host to another. Transferring files from one computer to another is one of the most common tasks expected from a networking or internetworking environment.

Although transferring files from one system to another seems simple and straight forward, some problems must be dealt with first. For example,

1. Two systems may use different file name conventions.
2. Two systems may have different ways to represent text and data.
3. Two systems may have different directory structures.

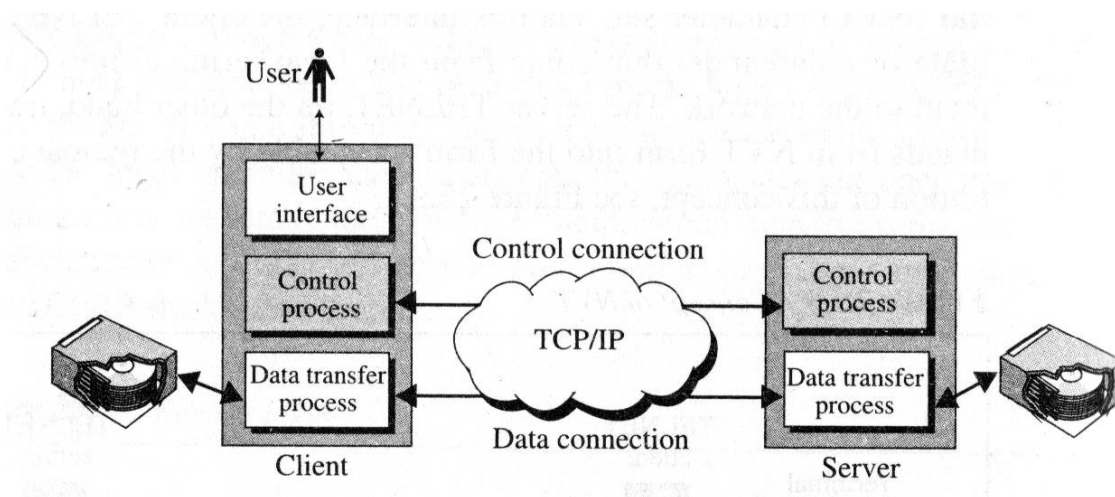
All these problems have been solved by FTP in a very simple and elegant approach.

FTP differs from other client-server applications in that it establishes two connections between the hosts. One connection is used for data transfer, the other for control informations (commands and responses). Separation of commands and data transfer makes FTP more efficient. The control connection uses simple rules of communication. We need to transfer only a line of command or a line of response at a time. The data connection on the other hand, needs more complex rules due to the variety of data types transferred.

FTP uses two well known TCP ports :

- Port 21 is used for the control connection and
- Port 20 is used for the data connection.

The following figure shows the basic model of FTP.



FTP

The client has three components :

- the user interface
- the client control process and
- the client data transfer process

The server has two components :

- the server control process and
- the server data transfer process.

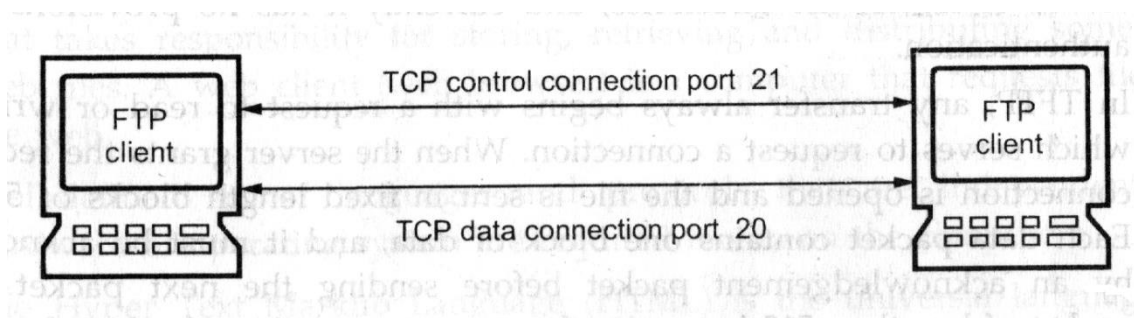
The control connection is made between the control processes. The data connection is made between the data transfer processes.

The control connection remains connected during the entire interactive FTP session. The data connection is opened and then closed for each file transferred. It opens each time commands that involve transferring files are used, and it closes when the file is transferred. In other words, when the user starts an FTP session, the control connection opens. When the control connection is open, the data connection can be opened and closed multiple times if several files are transferred.

Detail steps of FTP:

- FTP client contacts FTP server at port 21 specifying TCP as transport protocol.
- Client obtains authorization over control connection.
- Client browses remote directory by sending commands over control connection.
- When server receives a command for file transfer, the server opens a TCP data connection to the client.
- After transferring one file, server closes connection.
- Server opens a second TCP data connection to transfer another file.
- FTP server maintains state i.e. current directory, earlier authentication

The figure below shows the FTP data connection.



FTP data connection

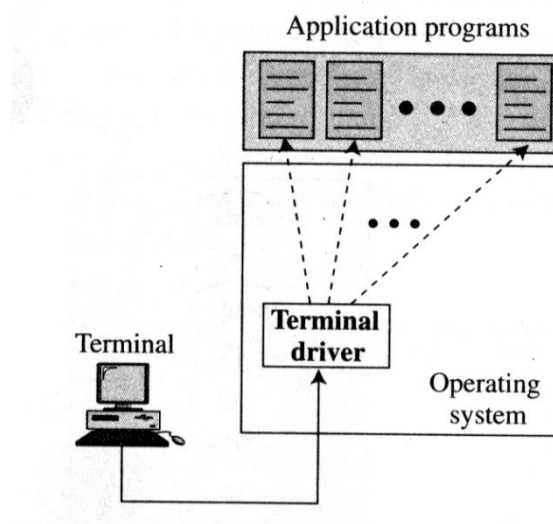
5.5.2 Telnet:

There may be situations, where an user wants to be able to run different application programs at a remote site and create results that can be transferred to their local site. Instead of writing different client-server application programs for each desired service, a better solution is to write a general purpose client-server program that lets a user to log on to a remote computer, use the services available on to a remote computer and transfer the results back to the local computer.

TELNET is a general purpose client-server application program provided by TCP/IP. It is an abbreviation for **TErminaLNETwork**. TELNET enables the establishment of a connection to a remote system in such a way that the local terminal appears to be a terminal at the remote system.

Local login:

When a user logs into a local time-sharing system, it is called local login. As a user types at a terminal or at a workstation running a terminal emulator, the keystrokes are accepted by the terminal driver. The terminal driver passes the characters to the operating system. The operating system in turn interprets the combination of characters and invokes the desired application program or utility. See figure below.

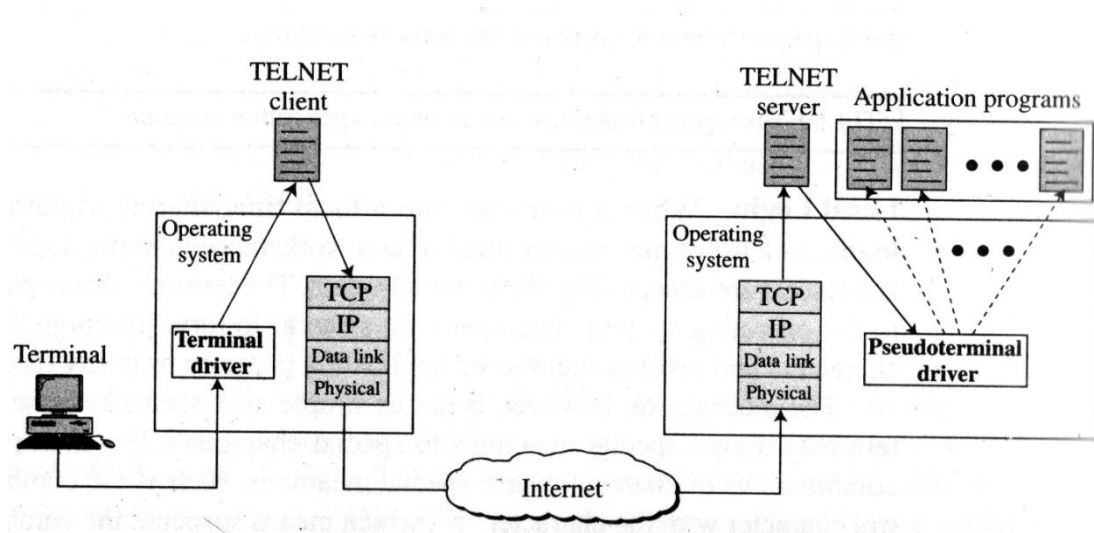


Local login

Remote login:

When a user wants to access an application program or utility located on a remote machine, the TELNET client and server programs come into use. The user sends the keystrokes to the terminal driver where the local operating system accepts the characters and

sent to the TELNET client, which transforms the characters to a universal character set called Network Virtual Terminal characters and delivers them to the local TCP/IP stack.



Remote login

However the characters cannot be passed directly to the operating system because the remote operating system is not designed to receive characters from a TELNET server. It is designed to receive characters from a terminal driver. The solution is to add a piece of software called pseudo terminal driver, which pretends that the characters are coming from a terminal. The operating system then passes the characters to the appropriate application program.

5.5.3 Simple Mail Transfer Protocol (SMTP):

One of the most popular network services is electronic mail (e-mail). Electronic mail is used for sending a single message that includes text, voice, video or graphics to one or more recipients. **Simple Mail Transfer Protocol (SMTP)** is the standard mechanism for electronic mail in the Internet. SMTP provides mail exchange between users on the same or different computers and supports

- Sending a single message to one or more recipients
- Sending messages that include text, voice, video or graphics.
- Sending messages to users on networks outside the internet.

Sending Mail :

To send mail, the user creates mail that looks very similar to postal mail. It has an envelope and a message.

Envelope :

The envelope usually contains the sender address, the receiver address and other information.

Message :

The message usually contains the headers and the body. The headers of the message define the sender, the receiver, the subject of the message and other information. The body of the message contains the actual information to be read by the recipient.

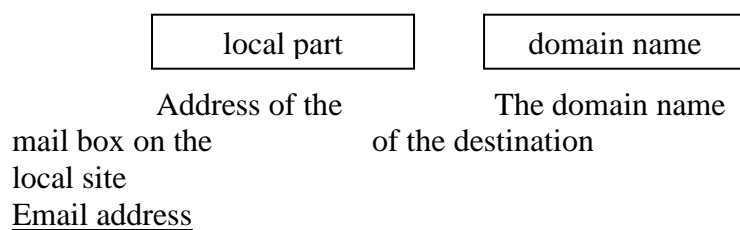
Receiving Mail :

The email system periodically checks the mailboxes. If a user has mail, it informs the user with a notice. If the user is ready to read the mail, a list is displayed in which each line contains a summary of the information about a particular message in the mailbox. The summary usually includes the sender mail address, the subject and the time the mail was sent or received. The user can select any of the messages and display its contents on the screen.

Addresses :

To deliver mail, a mail handling system must use an addressing system with unique addresses. The addressing system used by SMTP consists of two parts : a local part and a domain name, separated by an @ sign.

See figure below.



Example : ramesh1998@gmail.com

Local Part :

The **local part** defines the name of a special file called user mailbox.

Domain Name :

The second part of the address is the **domain name**. An organization usually selects one or more hosts to receive and send s-mail; they are sometimes called **mail exchangers**. The domain name assigned to each mail exchanger either comes from the DNS database or is a logical name (for example, the name of the organization).

User Agent :

The first component of an electronic mail system is the **User Agent (UA)**. A user agent sometimes is called a mail reader.

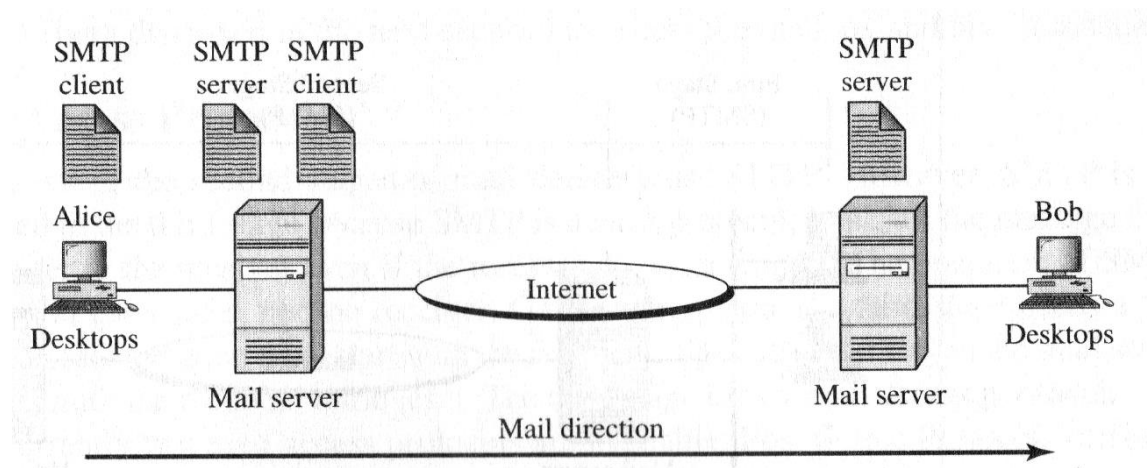
Services provided by a User Agent :

A user agent is a software package (program) that composes, reads, replies to, and forwards the message. It also handles mailboxes. The following are the services of a typical user agent.

1. Composing messages
2. Reading messages
3. Replying to messages
4. Forwarding messages
5. Handling mailboxes

5.5.4 Mail Transfer Agent (MTA) :

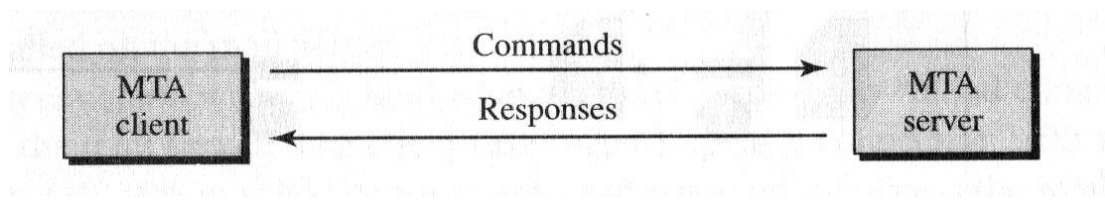
The actual mail transfer is accomplished through **mail transfer agents (MTA)**. To send mail, a system must have a client MTA, and to receive mail, a system must have a server MTA.



MTA client and server

Commands and Responses :

SMTP uses commands and responses to transfer messages between an MTA client and an MTA server. Each command or reply is terminated by a two-character end-of-line token.



Commands and Responses

Mail transfer phases :

The process of transferring a mail message occurs in three phases : connection establishment, message transfer and connection termination.

Connection establishment :

After a client has made a TCP connection to the well known port 25, the SMTP server starts the connection phase.

Message Transfer :

After connection has been established between the SMTP client and server, a single message between a sender and one or more recipients can be exchanged.

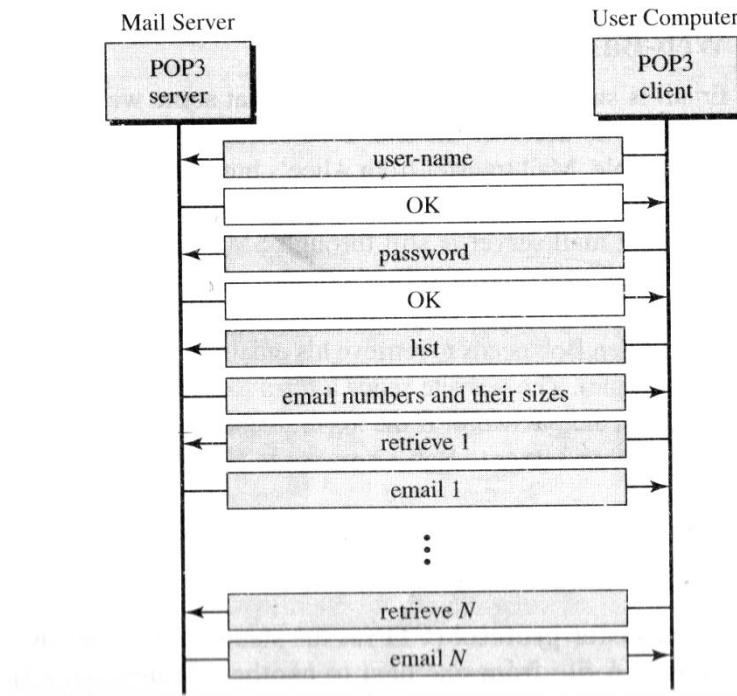
Connection Termination :

After the message is transferred successfully, the client terminates the connection.

5.5.5 Post Office Protocol, version 3 (POP3):

The POP3 is simple, but it is limited in functionality. The client - POP3 software is installed on the recipient computer; the server - POP3 software is installed on the mail server.

Mail access starts with the client when the user needs to download email from the mailbox on the mail server. The client (user agent) opens a connection with the server on TCP port 110. It then sends its user name and password to access the mailbox. The user can then list and retrieve the mail messages, one by one. The figure below shows an example of downloading using POP3.



POP3

POP3 has two modes : the delete mode and the keep mode. In the delete mode, the mail is deleted from the mailbox after each retrieval. In the keep mode, the mail remains in the mailbox after retrieval.

Limitations of POP3 :

1. POP3 does not allow the user to organize mail on the server, the user cannot have different folders on the server.
2. POP3 does not allow the user to partially check the contents of the e-mail before downloading.

5.5.6 Hypertext Transfer Protocol (HTTP) :

The Hypertext Transfer Protocol (HTTP) is a protocol used mainly to access data on the World Wide Web. The protocol transfers data in the form of plain text, hypertext, audio, video and so on. It is called the Hypertext Transfer Protocol because it is used in an environment where there are rapid jumps from one document to another.

5.5.7 Universal Resource Locator (URL) :

The World Wide Web uses Universal Resource Locators (URL) to represent hyper media links and links to network services within HTML documents. It is possible to represent almost any file or service on the Internet with a URL. A URL looks like :

<http://www.microsoft.com>

The first part of the URL (before two slashes) specifies the method of access. The second is typically the address of the computer on which the information or service is to be located. Further parts may specify the name of files, the port to connect to, or text to search for in a database. A URL is always a single line with no embedded spaces.

The URL defines four things : Method, Host computer, Port and Path. The figure below shows the body of a URL.



URL (Uniform Resource Locator)

- The **method** is the protocol used to retrieve the document, for example HTTP.
- The **host** is the computer where the information is located, although the name of the computer can be an alias. Web pages are usually stored in computers and computers are given alias names that usually begin with the characters www. This is not mandatory.
- The URL optionally can contain the **port** number of the server.
- **Path** is the pathname of the file where the information is located.

Following are some examples of URL :

<ftp://www.mcafee.com/pub/readme.txt>

<http://www.prenhall.com/index>

<file://www.oxford.edu/directory/index>

5.5.8 Domain Name System (DNS) :

To identify an entity, TCP/IP protocols use the IP address which uniquely identifies the connection of a host to the internet. However, people prefer to use names instead of addresses. The naming scheme used in the Internet is called the Domain Name System (DNS).

The domain name system does specify values for the most significant segment, which is called the top-level of the DNS. Table below list the possible top-level domains.

Most Significant segment of a domain name (Generic domain labels)

Domain name	Assigned to
com	Commercial Organization
edu	Educational Institution
gov	Government Institution
int	International Organizations
mil	Military groups
net	Network support centers
org	Organization other than those above
Country code	A country

Seven additional top-level domains were proposed in 1997 to further divide the namespace and eliminate the overcrowding which has occurred in the commercial domain. The proposed names include the following :**firm, store, web, arts, rec, info** and **nom**. **Arts** and **rec** were proposed to accommodate organizations such as art museums and recreational web sites; while **nom** was proposed to permit individuals to register their names. For many reasons, however, the new names have not received official approval.

When an organization wants to participate in domain name system, the organization must apply for a name under one of the existing top-level domains. For example, a corporation named “Videsh Sanchar Nigam Limited” might request the domain vsnl under the top-level domain com. If it approves the request, the Internet authority responsible for domain names will assign the domain :

vsnl.com

Once an organization has been assigned a domain, the suffix is reserved for the organization : no other organization will be assigned the same name suffix. To obtain a domain, an organization must register with the Internet authority. A unique domain suffix is assigned to each organization.

Country domains :

The country domain section follows the same format as the generic domains but uses two character country abbreviations (e.g. **in** for India). For example, universities in the United Kingdom and in India register under the domains :

ac.uk

ac.in

where **ac** is an abbreviation for academic and **uk** and **in** are the official country codes for the United Kingdom and India.

REVIEW QUESTIONS

PART – A

1. What is TCP/IP?
2. List the layers in TCP/IP networking model.
3. Give examples for connection oriented service and connectionless services.
4. What are TCP and UDP?
5. Write any two comparisons between TCP and UDP.
6. What is socket?
7. List the 802.X protocols.
8. What is fast Ethernet?
9. What are IP address and MAC address?
10. Give any two applications of ICMP.
11. What is classful addressing?
12. List the classes in classful addressing.
13. What is subnetting?
14. What is subnet mask?
15. List the benefits of subnetting.
16. What is supernetting?
17. What is supernet mask?
18. What is the use of FTP?
19. What is Telnet?
20. State the limitations of POP.
21. What is HTTP?
22. What is URL?
23. What is DNS?

PART – B

24. What is connection oriented service and connectionless services?
25. List the applications of UDP.
26. What is Gigabit Ethernet?
27. What is dotted decimal notation? Give example.

PART – C

28. Explain socket with diagram.
29. Explain about TCP header with diagram.
30. Explain about TCP header with diagram.
31. Compare TCP and UDP.
32. Explain about CSMA/CD.
33. Explain the structure of Token bus.
34. Explain the structure of Token ring.
35. Compare 802.X protocols.
36. Explain the structure of IP datagram.
37. Explain about ARP and RARP.
38. Explain about ICMP and IGMP.
39. Explain about subnetting and supernetting.
40. Explain about Telnet and FTP.
41. Explain about SMTP and POP.
42. Explain about HTTP.
43. Explain about DNS.