

Data Communication & Computer Networks

Q-1 What is Computer Networks? What are the applications of Computer Networks?

Ans -

- Computer Networks → A network is a set of devices & nodes (computer) connected by communication links.

A node can be computer, printer or any other device capable of sending and receiving data whereas computer network is a set of ~~auton-~~ autonomous computer interconnected together through communication medium to facilitate communication between them.

For ex → Internet

The category of network can be categorized by its size, scale, distance it cover, physical architecture, technology, etc.

→ A computer network is a group of computer connected with each others through a transmission medium such as cable, wire etc. In this guide, we will discuss

- Computer Network Applications are network software applications that utilize the Internet or other networks hardware infrastructure to perform useful functions for example file transfers within a network. They help us

to transfer data from one point to another within the network.

There are 2 types of computer network applications →

(1) Pure Network Applications

(2) Standalone Network Applications

(A) Pure Network Applications →

These are applications created to be used in networks, using pure network applications on a single computer doesn't make sense. They help us to transfer data & communicate within a network. Such applications have a separate & distinct user interface that users must listen for instance.

(1) Email programs →

They allow users to type messages at their local nodes & then send to someone on the network. It is a fast and easy way of transferring mail from one computer to another. Examples of electronic mails are →

- Outlook Express
- Fox Mail
- Opera
- Pace Mail
- Windows Mail, etc.

(2) File Transfer Protocol (FTP) →

This application facilitates transfer of files from one computer to another e.g. from a client to a server.

There are 2 common processes involved in FTP →

- ⇒ Downloading → This is the process of obtaining files from a server to workstation or a client.
- ⇒ Uploading → This is obtaining of files from a workstation to a server.

(3) Terminal Emulation (TELNET) →

It allows a workstation to access the server for an application program. This enables you to control the server on the network.

The workstation appears as a dumb terminal that is directly attached to the server. TELNET enables PCs and workstations to function as dumb terminals in sessions with hosts on inter-networks.

(4) Groupware →

These applications are used to automate the administrative functions of a modern office for instance video conferencing & chatting. They facilitate the work of groups & may improve on their productivity; they can be

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used to communicate, co-operate, coordinate, solve problems, compete, negotiate among others.

(B) Stand Alone Applications →

These are applications that run on stand-alone computers (computers not connected to any other). In order to extend their activity, they are rebuilt to run on network environments e.g. word processors, spreadsheets, demos, presentation graphics, project management, etc. They function even when the computer is offline.

Q-2 Explain OSI Reference Model? Write functioning of each layer.

Ans

• The OSI Reference Model →

The OSI model stands for Open System Interconnection. This model is based on a proposal developed by International Standards Organization (ISO) as a first step toward international standardization of the protocols used in the various layers (Bay and Zimmermann, 1983). It was revised in 1995. The model is called the ISO-OSI Reference Model because it deals with connecting open systems - that is, system that are open for communication with

Other systems -

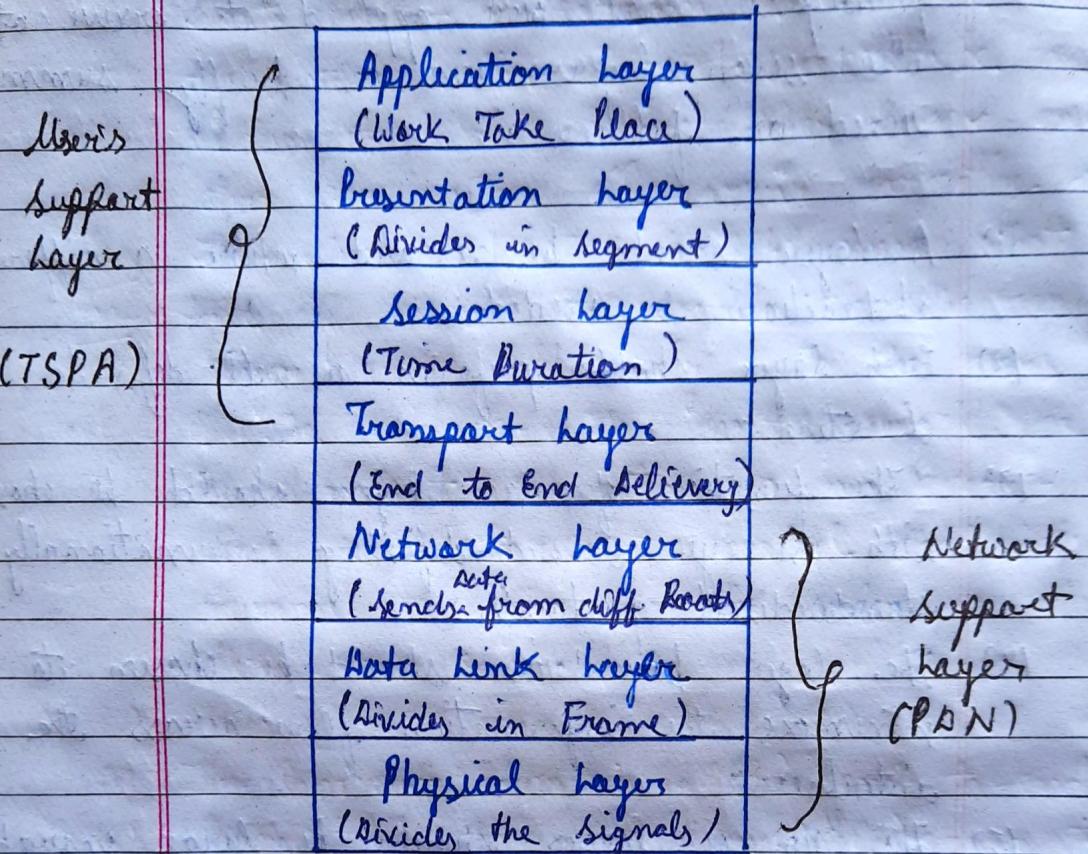
The OSI model has seven layers. The principles that were applied to arrive at the seven layers can be briefly summarized as follows →

- (1) A layer should be created where a different abstraction is needed.
- (2) Each layer should perform a well-defined function.
- (3) The function of each layer should be chosen with an eye toward defining internationally standardized protocols.
- (4) The layer boundaries should be chosen to minimize the information flow across the interfaces.
- (5) The no. of layers should be large enough that distinct functions needed not to be thrown together in the same layer out of necessity & small enough that the architecture does not become unwieldy.

- Types of layers → There are seven types of layers in the OSI Reference Model →

- (1) Physical layer
- (2) Data link layer
- (3) Network layer
- (4) Transport layer
- (5) Session layer

- (6) presentation layer
 (7) Application layer.



(1) Physical layer →

The Physical layer is concerned with transmitting raw bits over a communication channel. The design issues have to do with making sure that when one side sends a 1 bit, it is received by the other side as a 1 bit, not as a 0 bit.

(2) Data link layer →

The main task of the data link layer

is to transform a raw transmission facility into a line that appears free of undetected transmission errors to the network layer. It accomplishes this task by having the sender break up the input data into data frames (typically a few hundred or a few thousand bytes) and transmits the frames sequentially. If the service is reliable, the receiver confirms correct receipt of each frame by sending back an acknowledgement frame.

(3) Network layer →

The network layer controls the operation of the subnet. A key design issue is determining how packets are routed from source to destination. Routers can be based on static tables that are "wired into" the network & rarely changed. They can also be determined at the start of each connection:

If too many packets are present in the subnet at the same time, they will get in one another's way, forming bottlenecks. The control of such congestion also belongs to the network layer. More generally, the quality of service provided is also a network layer issue.

(4) Transport Layer →

The basic function of the transport layer is to accept data from above, split it up into smaller units if need be, pass these to the network layer, and ensure that the pieces all arrive correctly at the other end. It also determine what type of service to provide to the session layer, and, ultimately, to the users of the network. The most popular type of transport connection is an error-free point-to-point channel that deliver messages or bytes in the order in which they were sent.

The transport layer is a true end-to-end layer, all the way from the source to the destination. In other words, a program on the source machine carries on a conversation with a similar program on the destination machine, using the message headers & control messages.

(5) Session layer →

The session layer allow users on different machines to establish sessions between them. Sessions offer various services, including dialog control (keeping track of whose

turn it is to transmit), token management (preventing two parties from attempting the same critical operation at the same time), and synchronization (check pointing long transmissions to allow them to continue from where they were after a crash).

(6) Presentation layer →

The presentation layer is connected with the syntax & semantics of the information transmitted. In order to make it possible for computers with different data representations to communicate, the data structure to be exchanged can be defined in an abstract way, along with a standard encoding to be used "on the wire". The presentation layer manages these abstract data structures and allows higher-level data structures (ex: banking records), to be defined & exchanged.

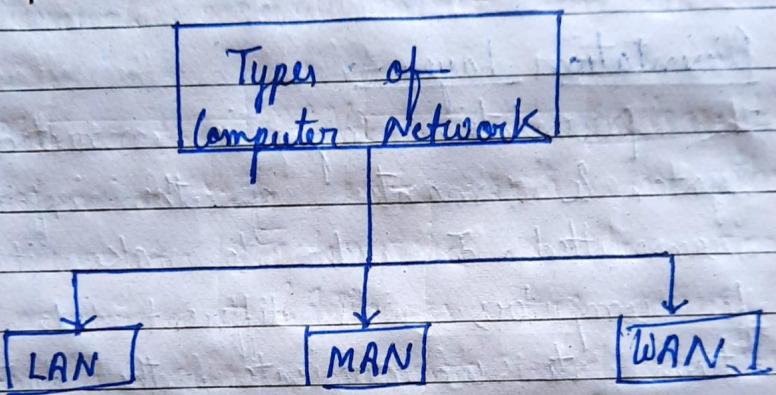
(7) Application Layer →

The application layer contains a variety of protocols that are commonly needed by users. One widely-used application protocol is HTTP (HyperText Transfer Protocol), which is the basis for the World Wide Web. When a browser wants a web page, it

sends the name of the page it wants to the server using HTTP. The server then sends the page back. Other application protocols are used for file transfer, electronic mail, & network news.

Q-3 Explain LAN, MAN & WAN.

Ans-



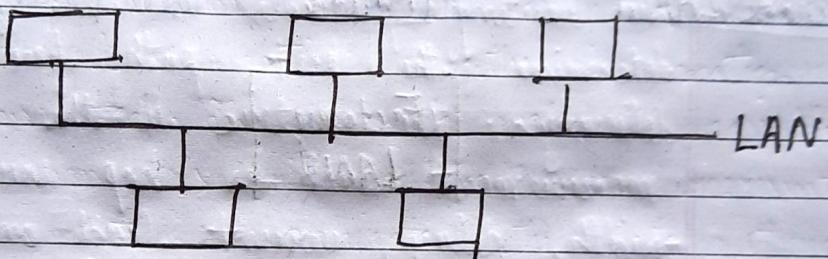
- (1) Local Area Network (LAN)
- (2) Metropolitan Area Network (MAN)
- (3) Wide Area Network (WAN)

(1) Local Area Network (LAN) →

LAN stands for Local Area Network. It means a network that connects a group of computers in a small geographical area. The ownership of network in LAN is private. The design and maintenance is easy in LAN. The speed is high in it. The short propagation delay in this LAN. It is more

tolerant. It is less congestion. It allows single pair of devices to communicate. It is used for college, school, hospital and any organisation etc. Simply, we can say that the networking in any organisation is called LAN. In this twisted pair cable is used. The length of this is in some meters i.e. speed in same KB's.

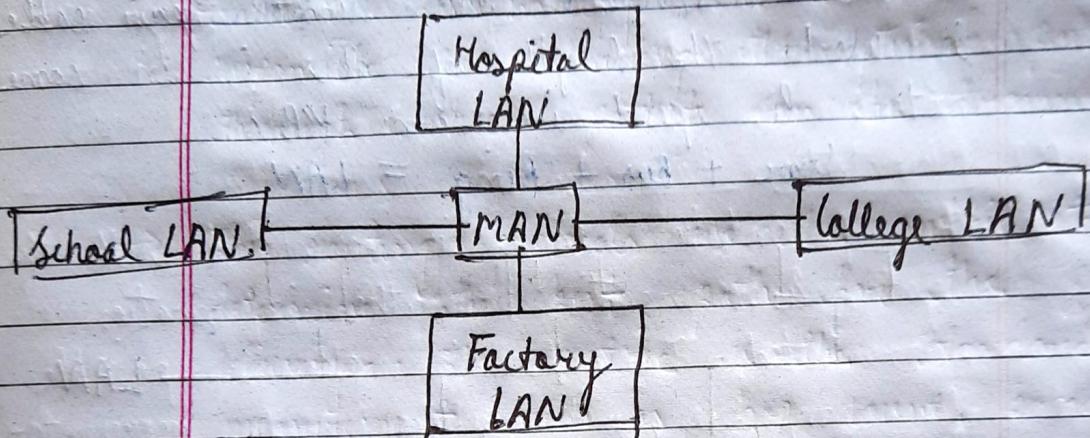
$$\text{Star} + \text{Bus} + \text{Ring} = \text{LAN}$$



12) Metropolitan Area Network (MAN) →

MAN stands for Metropolitan Area Network. This means that it covers relatively large region such as cities, towns, etc. The ownership of this network is private or public. The design and maintenance of MAN is difficult. Propagation delay is moderate in MAN. The speed is moderate in MAN. It is less tolerant. It is more congestion. It allows the multiple computers to simultaneously interact. It is used for the small towns and city etc. Simply, we can say that the networking

in city to city is called MAN. The length of this is in some Km's and speed in some MB's. The coaxial cable is used in it.

$$1 \text{ LAN} + 1 \text{ LAN} = 1 \text{ MAN}$$


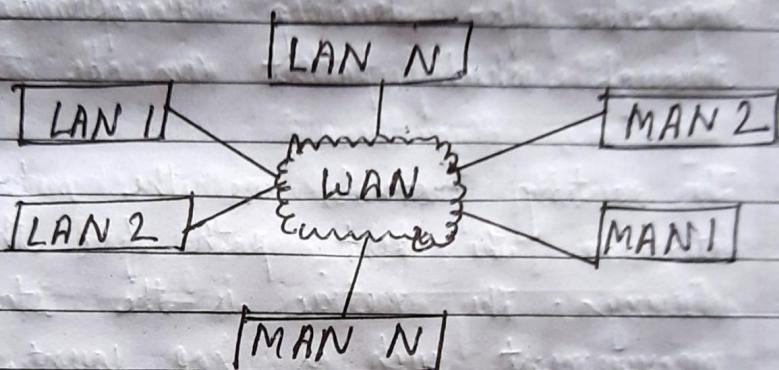
(3) Wide Area Network (WAN) →

WAN stands for the Wide Area Network. It means that it spans large locality and connects countries together.

Example - Internet. The ownership of network in WAN is private or public. The design and maintenance of WAN is difficult. The propagation delay is long in WAN. The speed is low of WAN. It has less tolerance. It has more congestion. It allows a huge group of computers communicate at the same time. It is used for country / continent. Simply, we can say that

The networking in country its country is called WAN. The length of it is 30 km to 10,000 km & the speed is in some Gbps. The optical fibre is used in WAN.

$$\text{MAN1} + \text{MAN2} + \text{MAN3} = \text{WAN}$$



Q-4 What is Routing? And Explain Algorithm to calculate the shortest path.

Ans-

- Routing → A Router is a process of selecting path alone which the data can be transferred from source to the destination. Routing is performed by a special device known as Router.
- A Router works at the network layer in the OSI model and internet layer in TCP/IP model.
- A Router is networking device that forwards the packet based on the information

available in the packet header and forwarding table.

- The routing algorithms are used for routing the packets. The routing algorithm is nothing but a software responsible for deciding the optimal path through which packet can be transmitted.
- The routing protocols use the metric to determine the best path for the packet delivery. The metric is the standard of measurement such as hop count, bandwidth, delay, current load on the path, etc. used by the routing algorithms to determine the optimal path to the destination.

- Algorithm to calculate the shortest path (Routing Algorithm) →

Routing Algorithm is responsible for deciding the output line port over which the packet is to be sent.

Here, we described the properties of routing algorithm which is helpful to choose the shortest path. These are given below



- (1) Optimality → Optimality means how much efficiency of the output
- (2) Fairness → Fairness means equality (everything has equal chance) and clarity!
- (3) Robustness → Robustness means not complex so regeneration means the transfer is robust
- (4) Stability → Stability means conditions of error is less and it is stable.
- (5) Correctness → Correctness means the solution is correct and optimal.

The Routing Algorithms can be divided into Non-Adaptive means static algorithm and adaptive means dynamic algorithm.

Here, we used the routing algorithm to calculate the shortest path. Here, we discuss about the Dijkstra's algorithm. This is the best example of shortest path algorithm.

Shortest Path Algorithm : Dijkstra's Algorithm

Dijkstra's algorithm is used for computing the shortest path from the root node.

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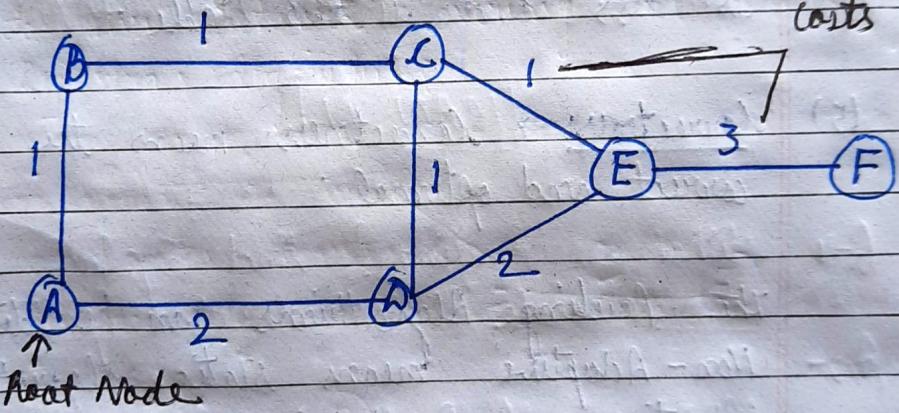
to every other node in the network.

It means it helps to decide the minimum path from root node.

Here, we take an example to understand the Dijkstra's algorithm.

The example for the network below, show the computations at node A using Dijkstra's Algorithm.

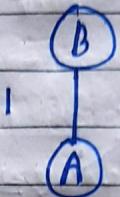
These are the costs



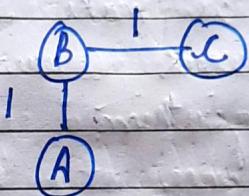
In the example here, A, B, C, D, E & F are the nodes and 1, 2, 3 are the costs. Here, A is root node and with the help of this A we find the shortest path by using Dijkstra's Algorithm. Here, we make shortest path by covering all nodes.

- * Step-1 → A is root node & it consider 2 neighbour ring D & B which takes neighbour distance 2 & 1. The minimum

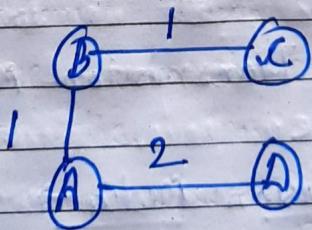
distance of 1 of B node. So, consider the minimum node which take 1 distance.



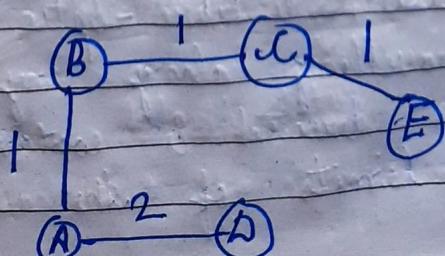
- * Step 2 → Here, we consider the node C because it take minimum distance from node A.



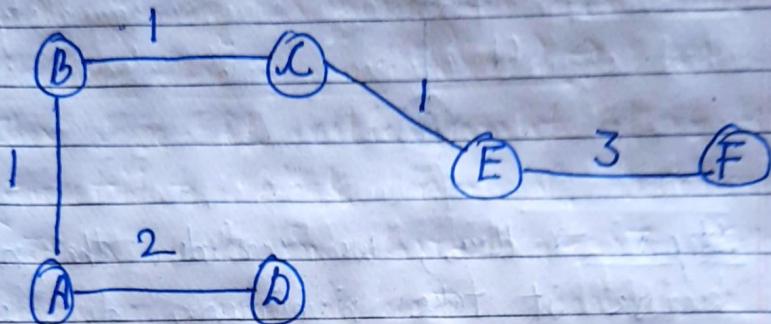
- * Step 3 → Here, we consider the path A to D node because it take distance 2 if we consider the path $A \rightarrow B \rightarrow C \rightarrow D$ the it take distance 3. So, we take minimum distance



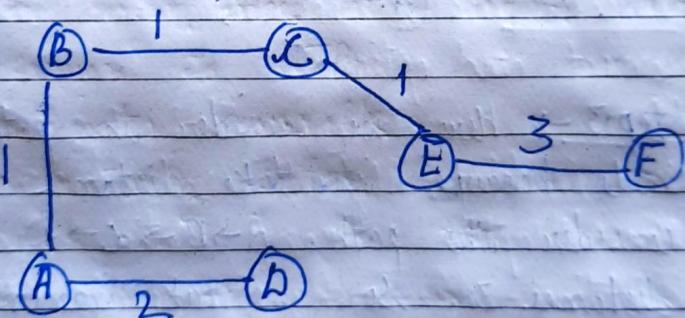
- * Step 4 → Here, we consider the path C to E because it take minimum distance 1.



* Step-5 → Here, we consider path E to F, F is released only by E. It take distance 3.



So, finally we make the shortest path to this network covering all nodes by Dijkstra's Algorithm



Q-5 Define Guided Transmission media.

Ans-

- Guided Transmission media →

Guided media, which are those that provide a conduit from one device to another, include Twisted-pair cable, Co-axial cable, & Fibre-optic cable. A signal travelling along any of these media is directed & contained by the physical limits of the medium.

It is also referred to as Guided or Bounded transmission media. Signals being transmitted are directed & confined in a narrow path-way by using physical links.

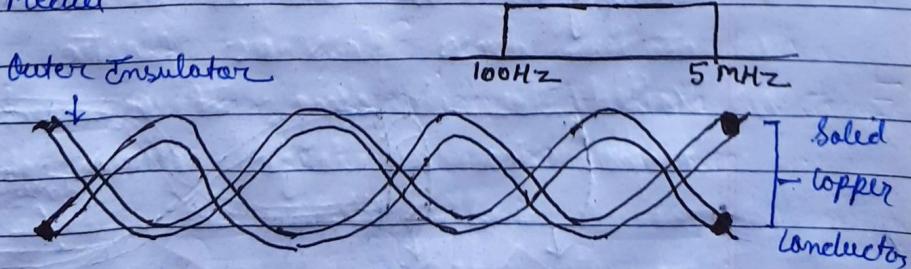
- ★ Features →
 - High Speed
 - Secure
 - Used for comparatively shorter distances.

- There are 3 major types of guided media →

 - (1) Twisted Pair cable.
 - (2) Coaxial cable
 - (3) Optical Fibre cable.

(1) Twisted Pair Cable →

It consist of 2 separately insulated conductor wires wound about each other. Generally, several such pairs are bundled together in a protective sheath. They are the most widely used Transmission Media.



It consist of 2 conductors each surrounded by an end insulating material.

Twisted Pair is of two types →

- (i) Shielded Twisted Pair (STP)
- (ii) Unshielded Twisted Pair (UTP)

(i) Shielded Twisted Pair (STP) →

This type of cable consists of a special jacket to block external interference.

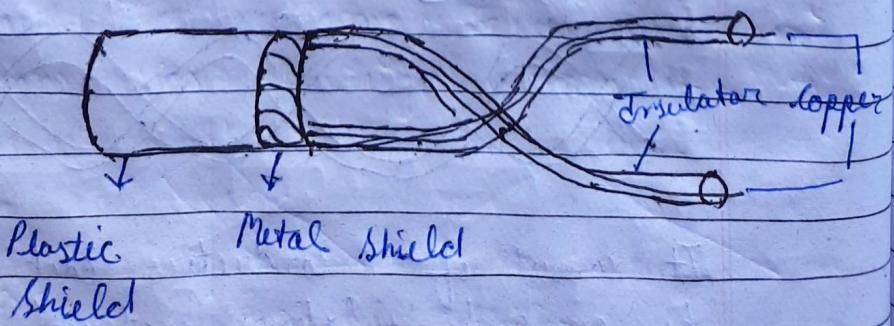
It is used in fast-data-rate Ethernet and in voice & data channels of telephone lines.

* Advantages →

- Better performance at a higher data rate in comparison to UTP.
- Eliminates crosstalk
- Comparatively faster

* Disadvantages →

- Comparatively difficult to install & manufacture.
- More Expensive
- Bulky



(ii) Unshielded Twisted Pair (UTP) →

This type of cable has the ability to block interference & does not depend on a physical shield for this purpose. It is used for telephonic applications.

* Advantages →

- Least Expensive
- Easy to install
- High Speed Capacity

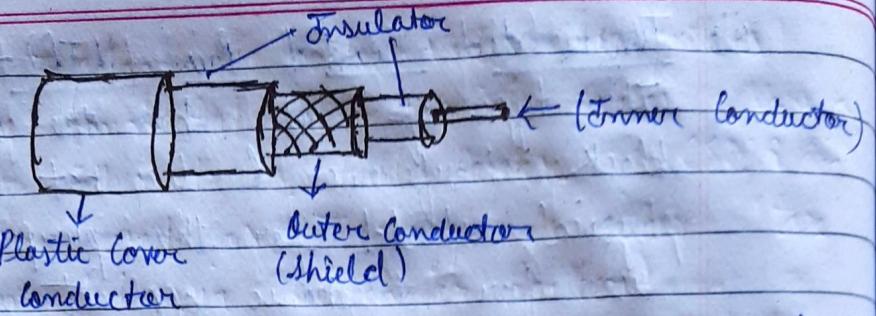
* Disadvantages →

- Susceptible to external interference
- Lower capacity & performance in comparison to S.T.P.
- Short distance transmission due to attenuation

(2) Coaxial Cable →

Coaxial cable has an outer covering containing 2 parallel conductors each having a separate insulated protection cover. Coaxial cable transmits information in two modes Baseband mode (dedicated cable bandwidth) and Broadband mode. (cable bandwidth is split into separate ranges). Cable TV is an analog television networks widely use coaxial cables.





Ethernet RJ-58 used for thin Ethernet and
RJ-59 used for T.V.

* Advantages →

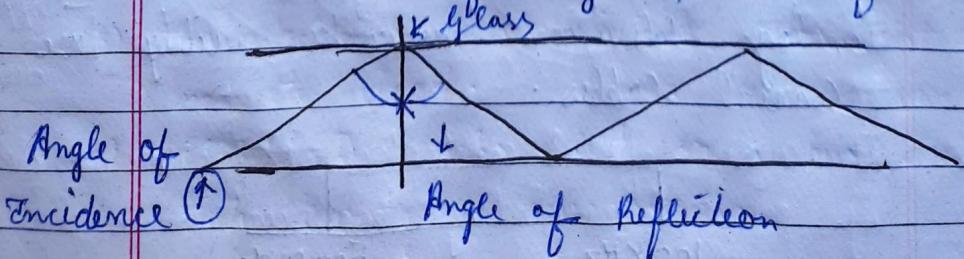
- High Bandwidth
- Better Noise immunity
- Easy to install and expand
- Inexpensive

* Disadvantages →

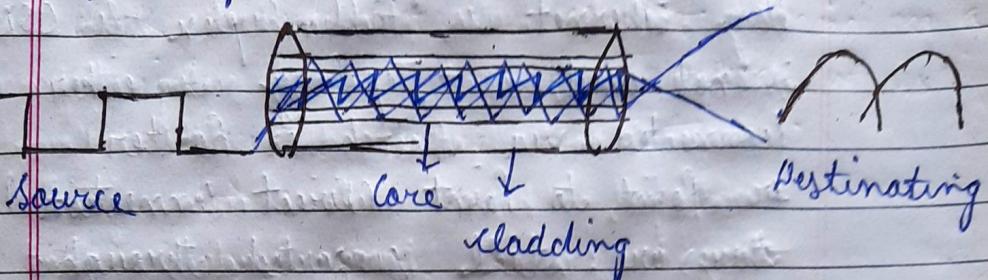
- Single cable failure can disrupt the entire network.

(3) Optical Fibre cable →

It uses the concept of reflection of light through a core made up of glass or plastic. The core is surrounded by a less dense glass or plastic covering called the cladding. It is used for transmission of large volume of data.



The data travel in light form with the speed of 3×10^8 m/sec.



* Advantages →

- Increased capacity & bandwidth
- Light weight
- Less signal attenuation
- Immunity to electromagnetic interference

* Disadvantages →

- Difficult to install & maintain
- High cost
- Fragile
- Unidirectional, i.e. will need another fibre, if we need bidirectional communication

Q-6 Why we use CSMA/CD?

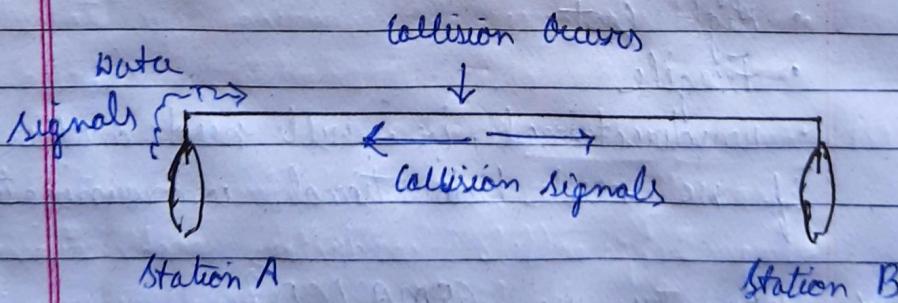
Ans -

* Collision Detection in CSMA/CD →

CSMA/CD (Carrier Sense Multiple Access / Collision Detection) is a media-access control method that was widely used in early Ethernet technology / LAN's. When there used to be shared.

Bus Topology & each Nodes (Computers) were connected by coaxial cables. Now a Day Ethernet is Full Duplex & CSMA/CD is not used as Topology is either Star (connected via switch or Router) or Point to Point (Direct connection) but they are still supported through-

CSMA/CD is one such technique where different stations that follows this protocol agree on some terms & collision detection measures for effective transmission. This protocol decides which station will transmit when so that the data reaches the destination without corruption.



* Advantages →

- (1) It has low overhead.
- (2) CSMA/CD control software is relatively simple & produces little overhead.
- (3) This technique is efficient for light to moderate load.
- (4) CSMA/CD works best on a bus technology with bursty transmission.

(5) CSMA/CD is beneficial, because it avoid from a wasteful transmission.

* Disadvantages →

- (1) CSMA/CD protocols are probabilistic and depends on the network (cable) loading.
- (2) Considered unsuitable for channel controlling automated equipment that must have certain control over channel access.
- (3) We can not set priorities to give faster access to some devices.
- (4) Collision degrade network performance.

Q-8 Why we use framing, also the types of framing?

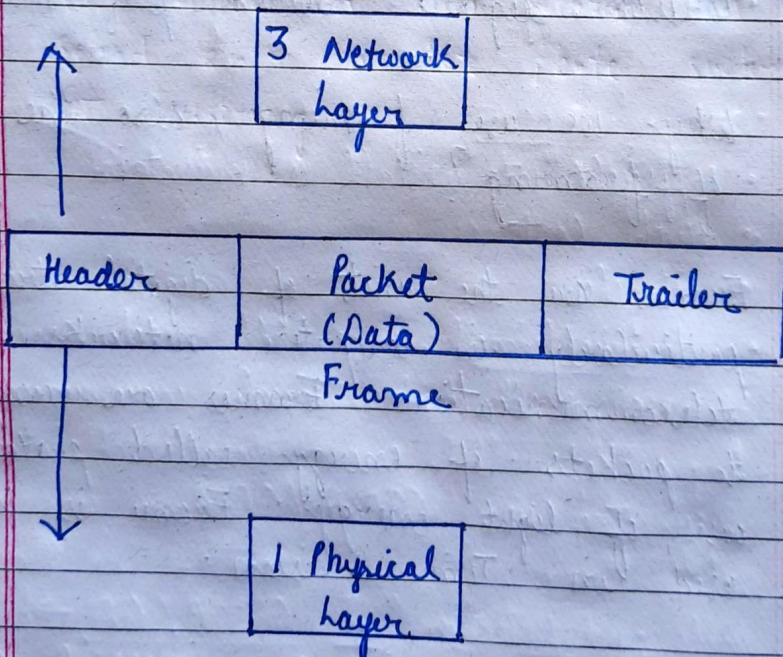
Ans -

Frames are the units of digital transmission particularly in computer networks and telecommunications. Frames are comparable to packets of energy called photons in case of light energy. Frame is continually used in Time Division.

Framing is a point-to-point connection b/w two computers or device consists of a wire on which data is transmitted as a stream of bits. However, these bits must be framed into discernible blocks of information. Framing is a function

of data link layer. It provides a way for a sender to transmit a set of bits that are meaningful to the receiver. Ethernet, tokens ring, frame relay, and other data link layer technologies have their own frame structures. Frame have headers that contain information such as error - checking codes.

Data link layer services →



At data link layer, it extracts message from sender & provide it to receiver by providing sender's & receiver's address.

The advantage of using frames is that data is broken up into recoverable chunks that can easily be checked for corruption.

→ Types of Framing :-

There are two types of framing →

- (1) Fixed size.
- (2) Variable size.

(1) Fixed size → The frame is of fixed size and there is no need to provide boundaries to the frame, length of the frame itself act as delimiter.

- Drawbacks → It suffers from internal fragmentation if data size is less than frame size.
- Solutions → Padding

(2) Variable size → In this there is need to define end of frame as well as beginning of next frame to distinguish. This can be done in 2 ways →

- (a) Length Field (LF)
- (b) End Delimiter (ED)

- (a) Length Field → We can introduce a length field in the frame to indicate the length of the frame used in the Ethernet. The problem with this is that sometimes the length field might get corrupted.
- (b) End Delimiter (ED) → We can introduce an EA (Pattern) to indicate the end of the frame used in Token Ring. The problem with this is that EA can occur in the data; this can be solved by character / byte sufficing and bit sufficing.