

physical layer

guided transmission media

UNIT 1

It is defined as the physical medium through which the signals are transmitted. It is also known as Bounded media.

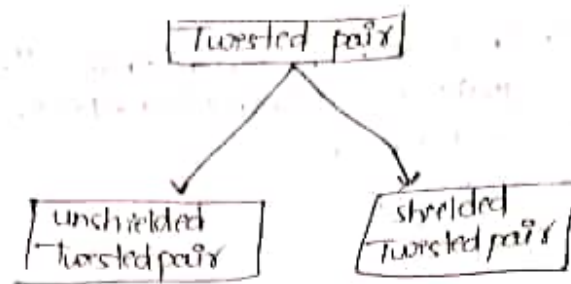
Types of guided media.

Twisted pair

- * Twisted pair is a physical media made up of a pair of cables twisted with each other.
- * A twisted pair cable is cheap as compared to other transmission media.
- * Installation of the twisted pair cable is easy and it is lightweight.
- * The frequency range of twisted pair cable is from 0 to 35 KHz.
- * A twisted pair consists of two insulated copper wires arranged in a regular spiral pattern.
- * The degree of reduction in noise interference is determined by the number of turns per foot. Increasing the number of turns per foot decreases noise interference.



Types of twisted pairs



unshielded twisted pair

An unshielded twisted pair is widely used in telecommunication.

- 1) It is used for telephone lines that have low speed data.
- 2) It can support up to 4mbps
- 3) It can support up to 20mbps
- 4) It can support up to 200mbps

Advantages

- * It is cheap.
- * Installation of the unshielded twisted pair is easy.
- * It can be used for high-speed LAN.

Disadvantages

This cable can only be used for shorter distances because of attenuation.

Shielded-twisted pair

A shielded-twisted pair is a cable that contains the mesh surrounding the wire that allows the higher transmission rate.

Characteristics

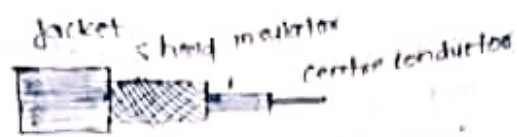
- * Installation of STP is easy
- * It has higher capacity as compared to unshielded-twisted pair cable.
- * It has a higher attenuation.

Disadvantages

- * It is more expensive as compared to UTP and coaxial cable.
- * It has a higher attenuation rate.

* Coaxial cable

- * Coaxial cable is very commonly used transmission media, for example, TV wire is usually a coaxial cable.
- * The coaxial cable contains two conductors parallel to each other.
- * It has a higher frequency as compared to twisted pair cable.
- * The inner conductor of the coaxial cable is made up of copper, the outer side made up of mesh.
- * The middle core is responsible for the data transferring whereas the copper mesh prevents from the EMI (electromagnetic interference).



Types of coaxial cable

1) Baseband transmission

It is defined as the process of transmitting a single signal at high speed.

2) Broadband transmission

It is defined as the process of transmitting multiple signals simultaneously.

Advantages of coaxial cable

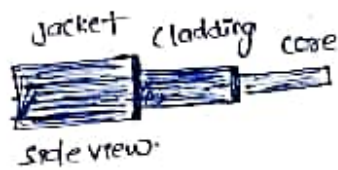
- * The data can be transmitted at high speed.
- * It has better shielding as compared to twisted pair cable.
- * It provides higher bandwidth.

Disadvantages of coaxial cable

- * It is more expensive as compared to twisted pair cable.
- * If any fault occurs in the cable causes the failure in the entire network.

Fibre optic

- * fibre optic cable is a cable that uses electrical signal for communication.
- * fibre optic is a cable that holds the optical fibres coated in plastic that are used to send the data by pulses of light.
- * The plastic coating protects the optical fibres from heat, cold, electromagnetic interference from other types of wiring.
- * fibre optics provide faster data transmission than copper wires.



Elements in a Fibre optic cable

Core = The optical fibre consists of a narrow strand of glass or plastic known as a core.

* A core is a light transmission area of the fibre.

* The more area of the core, the more light will be transmitted into the fibre.

Cladding

The concentric layer of glass is known as cladding.

* The main functionality of the cladding is to provide the lower refractive index in

core interface as to cause the reflection within the core so that the light waves are transmitted through the fibre jacket.

The protective coating consisting of plastic, known as a jacket. The main purpose of a jacket is to preserve the fibre strength, absorb shock and extra fibre protection.

Advantages of fibre optics

Greater Bandwidth

The fibre optic cable provides more bandwidth as compared to copper. Therefore, the fibre optic carries more data as compared to copper cable.

Faster speed.

Fibre optic cable carries the data in the form of light.

Longer distances.

The fibre optic cable carries the data at a longer distance as compared to a copper cable.

Better reliability

The fibre optic cable is more reliable than the copper cable as it is immune to any temperature changes while it can cause abstract in the connectivity of copper cable.

Thinner and sturdier

Fibre optic cable is thinner and lighter in weight so it can withstand more pull pressure than copper cable.

Wireless transmission

- * Wireless transmission is a form of unguided media.
- * Wireless communication involves no physical link established between two or more devices, communicating wirelessly.
- * Wireless signals are spread over in the air and received and interpreted by appropriate antennas.
- * When an antenna is attached to electrical circuit of a computer or wireless device it converts the digital data into wireless signal and spread all over within its frequency range.
- * A little part of electromagnetic spectrum can be used for wireless transmission.

Radio waves	microwaves	infrared	visible light	x-rays	gamma rays
10^0	10^{-1}	10^{-3}	10^{-5}	10^{-7}	10^{-9}

visible light

Radio transmission

- * Radio frequency is easier to generate and because of its large wave length it can penetrate through walls and structures alike.
- * Radio waves can have wave length from 1mm - 100000km and have frequency ranging from 3Hz - 300GHz.
- * The power of low frequency waves decreases sharply as they cover long distance, high frequency radio waves have more power.
- * Lower frequencies such as VLF, LF, MF bands can travel on the ground up to 1000 kilometers over the earth surface.

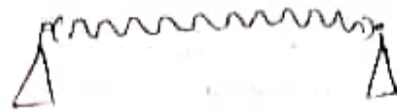


microwave transmission

Electromagnetic waves above 100MHz tend to travel in a straight line and signals over them can be sent by beaming those waves towards one particular station.

Because microwaves travel in straight lines, both sender and receiver must be aligned to be strictly in line of sight.

* microwaves can have wavelength ranging from 1mm - 1meter and frequency ranging from 300MHz to 300GHz



* microwave antennas concentrate the wave making a beam of it.

* microwaves have higher frequencies and do not penetrate wall like obstacles.

* microwave transmission depends highly upon the weather conditions and the frequency it is using.

Infrared transmission

infrared wave lies in between visible light spectrum and microwaves

* It has wavelength of 700nm to 1mm and frequency ranges from 300-GHz to 430THz.

* infrared wave is used for very short range communication purposes such as television and its remote.

* infrared travels in a straight line hence it is directional by nature. Because of highly frequency range cannot cross wall-like obstacles

Light transmission

highest most electromagnetic spectrum which can be used for data transmission is light or optical signaling. This is achieved by means of LASER.

Because of frequency light uses, it tends to travel straight in straight line.
Hence the sender and receiver must be in the line of sight.

Because laser transmission is unidirectional, both ends of communication the laser and the photodetector need to be installed.

Laser cannot penetrate obstacles such as walls, rain, and thick fog.

Network hardware

Networking hardware is also known as network equipment or computer networking devices, are electronic devices which are required for communication and interaction between devices on a computer network.

Network cables

Network cable are the transmission media to transfer data from one device to another.
A commonly used network cable is category 5 cable with RJ-45 connector.

Routers

A router is a connecting device that transfers data packets between different computer networks.

* They are used to connect a pc or an organization's LAN to a broadband internet connection.

Repeaters, Hubs, and switches

Repeaters, hubs and switches connect network devices together so that they can function as a single segment.

* A repeater receives a signal and regenerates it before re-transmitting so that it can travel longer distances.

* A hub is a multipoint repeater having several input/output ports, so that input at any port is available at every other port.

* A switch receives data from a port, uses packet switching to resolve the destination device and then forwards the data to the particular destination, rather than broadcasting it as a hub.

Bridges

A bridge connects two separate ethernet network segment.

* It forwards packets from the source network to the destined network.

Gateways

A gateway connects entirely different network that work upon different protocols. It is the entry and the exit point of a network and controls access to other network.

Network Interface cards

Network interface cards is a component of the computer to connect it to a network.
Network cards are of two types external network and internal network cards.

Network software

Network software encompasses a broad range of software used for design implementation and operation and monitoring of computer networks.

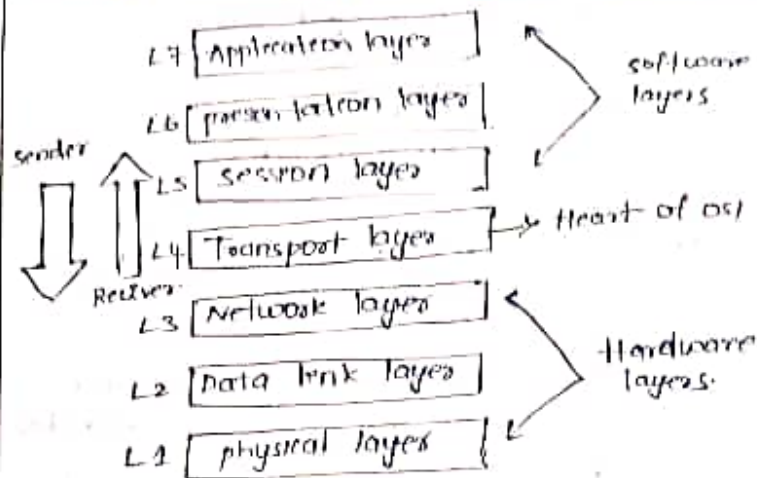
* Network software is a set of tools that helps computers to share information with each other or allows users to share computer programs.

OSI (Open systems interconnection)

OSI stands for open systems interconnection. It has been developed by ISO, international organization of standardization.

* In this OSI model it has 7 models layer architecture.

* All these 7 layers work collaboratively to transmit the data from one person to another across the globe.



1) physical layer

- * The lowest layer of the OSI reference model is the physical layer.
- * It is responsible for the actual physical layer connection between the devices.
- * The physical information contains in the form of bits.
- * It is responsible for transmitting individual bits from one node to next node.
- * The physical layer converts the text into the 0's and 1's and send them to the data link layer which will put the frame back together.

1000 | 0111 | 0011

The functions of physical layer are.

1) Bit synchronization =

The physical layer provides the synchronization of the bits by providing a clock.

2) Bit rate control

The physical layer also defines the transmission rate the number of bits sent per second.

3) physical topologies

physical layer specifies the way in which the data flows between the two connected devices. different, devices/nodes are arranged in a network.

i.e. - bus, star or mesh topology

4) Transmission mode

physical layer also defines the way in which the data flow between the two connected devices.

* The various transmission modes possible are simplex, half duplex & full duplex.

Exe - Hub, Repeater, modem, cables are physical layer devices.

2) Data link layer (DLL)

* The data link layer is responsible for the node to node delivery of the message.

* The main function of this layer is to make sure data transfer is error-free from one node to another, over the physical layer.

DLCL to transmit it to the host using the mac address.

* The data link layers are two types

- 1) Logical link control (LLC)
- 2) Media access control (MAC)

The functions of the data link layer are:

1) Framing

Framing is a function of the data link layer. It provides a way for a sender to transmit a set of bits that are meaningful to the receiver. This can be accomplished by attaching special bit pattern to the beginning and end of the frame.

2) physical addressing

After creating frames, data link layer adds physical address (mac address) of sender and/or receiver in the header of each frame.

3) Error control

Data link layer provides the mechanism of error control in which it detects and retransmits damaged or lost frames.

4) Flow control

The data rate must be constant on both sides else the data may get corrupted. That amount of data that can be sent before receiving acknowledgement.

5) Access control

When a single communication channel is shared by multiple devices, MAC sub-layer of data link layer helps to determine which device has control over the channel at a given time.

3) Network layer (layer 3)

network layer works for the transmission of data from one host to the other located in different networks.

The functions of network layers are:

1) Routing :-

The network layer protocols determine which route is suitable from source to destination.

This function of network layer is known as routing.

2) Logical Addressing

In order to identify each device on internetwork uniquely network layer defines an addressing scheme.

* The sender & receiver's IP address are placed in the header by network layer.

* Such an address distinguishes each device uniquely and universally.

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4) Transport layer (layer 4)

Transport layer provides service to application layer and takes service from network layer.

- * The data in the transport layer is referred to as segments.
- * It is responsible for the end-to-end delivery of the complete message.

At sender's side

Transport layer receives the formatted data from the upper layer, performs segmentation and also implements flow & error control to ensure proper data transmission.

At receiver's side

Transport layer reads the port numbers from its header and forwards the data which it has received to the respective application.

- * It also performs sequencing and reassembling of the segmented data.

Functions of transport layer

1) Segmentation and reassembly

This layer accepts the message from the layer above and breaks the message into smaller units.

2) Service point addressing

In order to deliver the message to correct process, transport layer header includes a type of address called service point address or port address.

Services provided by the transport layer

1) connection oriented service

There are mainly three-phase process with includes

- connection establishment
- Data transfer
- Termination/disconnection.

The receiving device sends an acknowledgement back to the source after a package or group of packet is received. The type of transmission is reliable and secure.

2) connection less service

It is a one-phase process and includes data transfer. In this type of transmission the receiver does not acknowledge receipt of a packet.

* This will allow for much faster communication between devices.

* connection-oriented service is more reliable than connectionless service.

Segments

Transport layer is operated by the operating system.

* It is a part of the OS and communicates with the application layer making system calls.

* Transport layer is called as heart of OSI model.

5) Session layer (layer 5)

This layer is responsible for establishment of connection, maintenance of sessions, authentication and also ensures security.

Functions of the session layer

1) session establishment, maintenance and termination

The layer allows the two process to establish use and terminate a connection.

2) Synchronization:-

This layer allows a process to add check points which are considered as synchronization point into the data.

These synchronization point help to identify the errors so that the data is re-synchronized properly.

3) Dialog controller

The session layer allows two system to start communication with each other in half duplex or full duplex.

6) presentation layer (layer 6)

presentation layer is also called the translation layer.

* The data from the application layer is extracted here and manipulated as per the required format to transmit over the network.

1) Functions of the presentation layer

1) Translation.

- ASCII to EBCDIC
- American standard code for information interchange to extended binary coded decimal interchange code

2) Encryption / decryption

Data encryption translates the data into another form or code. The encrypted data is known as the cipher text and the decrypted data is known as plain-text.

A key value is used for encrypting as well as decrypting data.

3) Compression

Reduces the number of bits that need to be transmitted on the network.

7. Application layer (Layer 7)

The application layer produce the data, which has to be transferred over the network.

This layer also serves as a window for the application services to access the network and for displaying the received information to the user.

Ex: = Browsers, skype

-Application layer is also called as desktop layer

Functions of the application layer:

- 1) Network virtual-terminal
- 2) TTM-file-transfer access and management
- 3) mail services
- 4) Directory services

* Tcp/ip model (Transmission control protocol) internet protocol)

* It was designed to describe the functions of the communication system by dividing the communication procedure into smaller and simpler components.

* Tcp/ip model, it was designed and developed by department of defence (DOD) in 1960's and is based on standard protocols.

* It contains four layers, unlike seven layers in OSI model.

* The layers are

- 1) process / application layer
- 2) Host-to-Host / Transport layer
- 3) internet layer.
- 4) Network access / Link layer

Tcp/ip model
Application layer
Transport layer
internet layer
Network access layer

1) Network access layer

This layer corresponds to the combination of Data link layer and physical layer of OSI model.
* It looks out for hardware addressing and the protocol present in this layer allows for the physical transmission of data.

2) Internet layer

This layer parallels the function of OSI's network layer.

* It defines the protocols which are responsible for logical transmission of data over the entire network.

1) IP (Internet protocol)

The internet protocol and it is responsible for delivering packets from the source host to the destination host by 'looking at the IP address in the packet headers'.

* The IP has 2 versions IPv4 and IPv6.
* IPv4 is the one that most of the websites are using currently.

2) ICMP (Internet control message protocol)

It is encapsulated within the IP datagram and is responsible for providing hosts with information about network problems.

3) ARP (Address resolution protocol)

Its job is to find the hardware address of a host from a known IP address.

Types

ARP, Reverse ARP, proxy ARP, gratuitous ARP, inverse ARP.

* 3] Host-to-Host layer

This layer is analogous to the transport layer of the OSI model.

- * It is responsible for the end-to-end communication and error free delivery data.
- * It shields the upper-layer application from the complexities of data.
- * The two main protocols present in this layer are.

1) Transmission control protocol (TCP)

It is known to provide reliable and error free communication between end system.

- * It performs sequencing and segmentation data.
- * It also has acknowledgment feature and control in the flow of the data through flow control mechanism.
- * It is a very effective protocol but has a lot of overhead due to such features. Increased overhead leads to increased cost.

2) User Datagram protocol (UDP)

On the other hand does not provide any such features.

- * It is the go-to protocol if your application does not require reliable transport as it is very cost-effective.
- * TCP which is connection-oriented protocol / UDP is connectionless protocol.

4) Application layer

This layer performs the functions of top three layers of the OSI model.

Application, presentation and session layer.

* It is responsible for node-to-node communication and controls user-interface specification.

* Some protocols are present in this layer

* HTTP, HTTPS, FTP, TFTP, Telnet, SSH, SMTP, SNMP, NTP, DNS, DHCP, NFS, X Window, LDAP

HTTP & HTTPS

Hypertext transfer protocol. It is used by the worldwide web to manage communication between the web browsers and servers.

* Hypertext transfer protocol secure. It is a combination of HTTP with SSL (secure socket layer).

* It is efficient in cases where the browser need to fill out forms, sign in authenticate and carry out bank transactions.

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ARPANET / INTERNET

ARPANET stands for Advanced Research projects Agency NET.

ARPANET was first network which considered aspects of distributed control.

* It was first to implement TCP/IP protocols.

* It was basically beginning of internet with use of these technologies.

* ARPANET was introduced in the year 1969 by Advanced Research projects Agency (ARPA) of US department of defense.

Characteristics of ARPANET

- 1) It is basically a type of WAN
- 2) It used concept of packet switching network
- 3) It used interface message processor for sub-netting
- 4) ARPANET software was split into two parts - a host and a subnet

Advantages of ARPANET

- * ARPANET was designed to service even in a nuclear attack.
- * It was used for collaborations through E-mail
- * It created an advancement in transfer of important files and data of reference.

Limitations of ARPANET

- * Increased number of LAN connections resulted in difficulty handling.
- * It was unable to cope-up with advancement in technology.

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Example networks

There are mainly 11 types of networks

- 1) personal area network (PAN)
- 2) Local area network (LAN)
- 3) wide area network (WAN)
- 4) wireless local area network (WLAN)
- 5) campus area network (CAN)
- 6) Metropolitan area network (MAN)
- 7) Storage area network (SAN)
- 8) passive optical local area network (POLAN)
- 9) system-area network (SAN)
- 10) Enterprise private network (EPN)
- 11) virtual private network (VPN)

1) personal area network (PAN)

PAN is the most basic type of computer network. The network is restricted to single person, that is communication between the computer device is centred only to an individual's work space.

* PAN offers a network range of 10 meters from person to the device providing communication.

EXB = USB, computer, phone, tablets, printer, PDA

2) Local area network (LAN)

LAN is the most frequently used network.

* A LAN is a computer network that connects computers together through a common communication path, contained within a limited area.

* A LAN encompasses two or more computers connected over a server

The two important technologies involved in the network are Ethernet and WiFi.

Exs= LAN are networking in a home, school, library, laboratory, college, office, etc.

3) Wide Area Network (WAN)

WAN is a type of computer network that connects computers over a large geographical distance through a shared communication path. It is not restrained to a single location but extends over many locations.

WAN can also be defined as a group of local area networks that communicate with each other.

Exs= Internet

4) Wireless Local Area Network (WLAN)

WLAN is a type of computer network that acts as a local area network but makes use of wireless network technology like WiFi.

The network doesn't allow devices for communicating over physical cable like LAN. But it allows devices to communicate wirelessly.

Exs= Wi-Fi

5) campus Area Network (CAN)

CAN is bigger than a LAN but smaller than a MAN.

- * This type of computer network which is usually used in places like a school or college.
- * This network covers a limited geographical area that is, it spreads across several buildings within the campus.

Ex- CAN are networks that covers schools, colleges, buildings etc.

6) metropolitan Area Network (MAN)

A MAN is larger than a LAN but smaller than WAN.

- * This is the type of computer networks that connects computer over a geographical distance through a shared communication path over a city, town or metropolitan city.

Ex- MAN are networking in towns, cities, a single large city, large area with multiple buildings etc...

7) storage area Network (SAN)

SAN is a type of computer network that is high speed and connects group of storage devices to several servers.

- * This network does not depends on LAN or WAN.
- * Instead a SAN moves the storage resources from the network. A SAN provides access to block level data storage.

EXB=

SAN are network of disk accessed by a network of servers.

8) system area network (SAN)

A SAN is a type of computer network that connects a cluster of high performance computers.

* It is a connection-oriented and high bandwidth network.

* A SAN is a type of LAN that handles high amount of information in large requests.

* This network is useful for processing application that require high network performance.

9) passive optical Local Area Network (POLAN)

A POLAN is a type of computer network which is an alternative to a LAN.

* POLAN uses optical splitters to split an optical signal from a single strand of single mode optical fibre to multiple signal to distribute users and devices.

* The POLAN is a point to multipoint LAN architecture.

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10) Enterprise private Network (EPN)

EPN is a type of computer network mostly used by business that want a secure connection over various location to share computer resources.

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1) Virtual private Network (VPN)

A VPN is a type of computer network that extends a private network across the internet and lets the user send and receive data as if they were connected to a private network even though they are not.

- * Through a virtual point-to-point connection, users can access a private network remotely.
- * VPN protects you from malicious source by operating as a medium that gives you protected network connection.