Unit-2

Physical Layer and Networking Media

Network Devices:

Hardware devices that are used to connect computers, printers, fax machines and other electronic devices to a network are called network devices. These devices transfer data in a fast, secure and correct way over same or different networks. Network devices may be inter-network or intra-network. Following are some of the key networking devices:

i) Repeater → A repeater is a networking device which operates at the physical layer. It's job is to regenerate the signal over the same network, before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network. Repeaters do not amplify the signals. When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength. It is a two port device.

ii) Hub → A hub is basically a multipoint repeater. A hub connects multiple wires comming from different branches. Hubs cannot filter data, so data packets are sent to all connected devices. There are two types of hub: active hub and passive hub.

Active hub have their own power supply and can clean, boost and ~~relu~~ relay the signal along with the network. Active hubs are used to extend maximum distance between nodes. Passive hubs have power supply from active hub and these hub can't clean, boost and relay the signals onto the network. Passive hubs can't be used to extend the distance between nodes.

iii) Switch → A switch is a multiport bridge with a buffer and a design that can boost its efficiency and performance. A switch is a data link layer device. The switch can perform error checking before foreworading data that makes it very efficient as it does not forward packets that have errors and forward good packets selectively to correct port only.

iv) Bridge → A bridge operates at data link layer. A bridge is a repeater, with add on the functionality of filtering content by reading the MAC addresses of source and destination. It is also used for interconnecting two LANs working on the same protocal. It has a single input and single output port, thus making it a 2 port device.

There are two types of bridges: transparent bridges and source routing bridges. In transparent bridge the stations are completely ~~turn~~ unaware whether a bridge is added or deleted from the network or not. In source routing bridge, routing operation is performed by source station and frame specifies which route to follow.

v) Routers → A router is a device like a switch that routes data packets based on their IP addresses. Router is mainly a network layer device. Routers normally connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets. Router divide broadcast domains of hosts connected through it.

⑧ Different Types of Transmission Medias:

Transmission media are the means by which a communication signal is carried from one system to another. Mainly there are two types of transmission medias: Wired and wireless.

ⓐ Wired transmission medias: - It is also referred as guided media or bounded media. Signal being transmitted are directed and confined in a narrow pathway by using physical links. It has features like high speed and secure and used for comparatively shorter distances.

Types

1) Twisted pair cable: - It consists of 2 seperately insulted 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. Twisted pair cable is futher of following two types:

Unshielded Twisted Pair (UTP):- This type of cable has the ability to block interference and does not depend on a physical shield for this purpose. It is used for telephonic applications. Following are the advantages of UTP:

- → least expensive
- → Easy to install
- → High speed capacity

Limitations:

- → lower capacity and performance in comparision to STP.
- → Short distance transmission due to attenuation.

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 and data channels of telephone lines.

Advantages

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

Disadvantages

- → Bulky
- → Expensive
- → Comparatively difficult to install and manufacture.

iii) Coaxial Cable:

It has an outer plastic covering containing 2 parallel conductors each having a seperate insulted protection cover. Coaxial cable transmits information in two modes: Baseband mode and Broadband ~~cable~~ mode. Cable TVs and analog television networks widely use Coaxial cables.

Advantages

- → High Bandwidth.
- → Better noise immunity.
- → Easy to install and expand.

Disadvantage

- → Single cable failure can disrupt the entire network.

iii) 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 cable can be unidirectional or bidirectional.

Advantages

→ Increased capacity and bandwidth.
→ Light weight.
→ less signal attenuation.
→ Immunity to electromagnetic interference
→ Resistance to corrosive materials.

Disadvantages

→ Difficult to install and maintain
→ High cost
→ Fragile.

(b). Wireless / Unguided Media:

It is also referred to as wireless or unbounded transmission media. No physical medium is required for the transmission of electromagnetic signals.

Features:

→ Signal is broadcasted through air.
→ less Secure.
→ Used for larger distances.

There are three major types of unguided media:

i) Radiowaves → These are easy to generate and can penetrate through buildings. The sending and receiving antennas need not to be aligned. Frequency range: 3KHz – 1GHz. AM and FM radios and cordless phones use Radiowaves for transmission.

ii) Microwaves → It is a line of sight transmission i.e, the sending and receiving antennas need to be properly aligned to each other. The distance covered by the signal is directly proportional to the height of the antena. Frequency Range: 1GHz – 300GHz. These are majorly used for mobile phone communication and television distribution.

⊛. Circuit, Message & Packet Switching:-

Whenever we are dealing with a large network or say a very long-distance data transmission has to take place, this can't be done directly without any external hardware support. Hence, we must have a dedicated path for our data packets to traverse. Since there are so many choices for which path to take, so we have to select a particular path. This selecting of the path on which our data packets will be transmitted is known as Switching. We can categorize and sub-categorize the switching techniques as below:-

1). Circuit Switching:- The circuit switching technique establishes a dedicated path or channel between the sender and receiver for data transmission, and once a dedicated path is established then it does not terminate it until and unless the connection between the two data transmission point terminates.

We can say that it operates in a similar manner in which a telephonic network operates when we call someone, then a dedicated communication channel or path is established between we two, which remains open till we disconnect the phone call.

There are two methods through which we can perform multiplexing multiple signals into a single ~~channel~~ channel or path.

- Frequency Division Multiplexing (FDM) → We use FDM when multiple data signals are combined for simultaneous data transmission through a shared communication channel. It divides total bandwidth into a series of non-overlapping frequency sub-bands, where each sub-band carries a different signal for data transmission. Radio transmission and optical fiber transmission to share multiple independent signals is its example.

- Time Division Multiplexing (TDM) → It divides the data transmission into time frames. It transmitts and receives independent signals over a common communication channel through synchronized switches at each end of the transmission line. This technique is widely used for long-distance communication links and also supports heavy data traffic loads from both the ends.

iii) Infrared → Infrared waves are used for very short distance communication. They cannot penetrate through obstacles. This prevents interference between systems. Frequency Range: 300 GHz – 400 THz. It is used in TV remotes, wireless mouse, keyboard, printer etc.

Less Imp ⊛ Ethernet Cable Standards: [Also called twisted pair cables]

ⓐ Ethernet copper twisted pair: cables are broadly classified into two: Unshielded Twisted Pair (UTP) cable and Shielded Twisted Pair (STP) cable. Thes cables are used for different shielding techniques to limit any signal from the cable or wire to escape and to reduce electromagnetic interface from outside environment.

i) UTP
ii) STP } These two are already discussed.

ⓑ. Fiber Cable Standards:-

Fiber cable standards are mainly of two types: multimode and singlemode, which are as follows:-

	Multimode	Singlemode
IEC/ISO 11801	OM1, OM2, OM3, OM4	OS1, OS2
IEC 60793-2	$^{-10}$ (A1b), $^{-10}$ (A1a), $^{-10}$ (A1a.2), $^{-10}$ (A1a.3)	$^{-50}$ (B1.1) $^{-50}$ (B1.2)
ITU-T	G.651, G.651, G.651, G1651	G.652 G.652.D
TIA-492	AAAA AAAB AAAC AAAD	CAAA CAAB.

Advantages:-
→ Establishment of a dedicated channel.
→ Improves data transmission rate.
→ Improves data loss.
→ Improves delay in the data flow.

Disadvantages:-
→ Establishing a dedicated channel sometimes takes a very long duration of time.
→ The amount of bandwidth required is more for establishing a dedicated channel.

2). Message Switching:- This technique was developed to act as an alternative to circuit switching. In this technique data is transmitted in form of messages which consist of entire data to be shared. Unlike circuit switching there's no dedicated path between the sender and the receiver, hence they are connected through several intermediate nodes which helps and ensures proper data transfer.
They have 2 important characteristics:-

i) Store & forward → Each node must have a storage capacity, because a message will only be delivered if the next node and the link between them are available to connect otherwise it will be stored indefinitely. A store and forward switch thus forwards a message only if sufficient resources are available and the next node is ready to accept the data. This was earlier used in telegraph message switching centres.

ii) Message delivery → The entire ~~message~~ information is compiled into a single message and then that message is transmitted from source to destination. To successfully reach its destination each message must contain the routing information in its header section.

Advantages:
→ Stores the message when the next node is not available.
→ Reduces traffic congestion.
→ Data channels are shared by network devices.
→ Manages traffic efficiently by assigning priorities.

Disadvantages:
→ Storing of message causes delays.
→ The whole network require a large storage capacity.

3). Packet Switching:

The packet switching technique transmits data through the network by breaking it down into several data packets for more efficient transfer and it also utilizes multiple vacant resources, these network devices direct or route the data packets to the destination where the receiving device then collects all of them and ressembles to get the proper orientation of message.

Types:

i) Connectionless Packet Switching:- This technique consists of multiple data packets, each data packet is individually routed, means every single data packet contains complete routing information in its header section. This kind of packet switching technique is also known as Datagram switching.

ii) Connection-Oriented Packet Switching:- In this type of packet switching the data-packets are first assembled and then sequentially numbered. Now they are ready to travel across a predefined route sequentially. The information about the address is not required here, because all the data packets are sent in sequence. This technique is also known as Virtual Circuit switching.

Advantages:
→ Highly efficient
→ Faster
→ Cost-effective.
→ Digital
→ Reliable

⊛. ISDN [Interface & Standards]:

ISDN stands for Integrated Services Digital Network. It is a circuit-switched telephone network system, but it also provides access to packet switch networks that allows digital transmission of voice and data. This results in potentially better voice and data quality than an analog phone can provide.

It provides a packet-switched connection for data increments of 64 kilobits. It provided a maximum of 128 kilobits bandwidth in both upstream and downstream directions. A greater data rate was achieved through channel bonding.

ISDN Interfaces:-

i). Basic Rate Interface (BRI) → There are two data-bearing channels ('B' channels) and one signaling channel ('D' channel) in BRI to initiate connections. The B channels operate at a maximum of 64 kbps while the D channel operates at maximum of 16 kbps. The two channels are independent of eachother.

ii). Primary Rate Interface (PRI) → Primary Rate Interface service consists of a D channel and either 23 or 30 B channels depending on the country you are in. PRI is not supported on the 7 Series. A digital pipe with 23 B channels and one 64 kbps D channel is present in PRI. PRI requires a digital pipe of 1.544 Mbps.

iii) Broadband-ISDN (B-ISDN) → Narrowband ISDN has been designed to operate over the current communications infrastructure, which is heavily dependent on the copper cable however B-ISDN relies mainly on the evolution of fiber optics. According to CCITT, B-ISDN is best described as "a service requiring transmission channels capable of supporting rates greater than the primary rate."

ISDN Standard:

The ISDN works based on the standards defined by ITU-T (formally CCITT). The Telecommunication Standardization Sector (ITU-T) coordinates standards for telecommunications on behalf of the International Telecommunication Union (ITU) and is based in Geneva, Switzerland. The various principles of ISDN as per ITU-T recommendation are:-

→ To support switched and non-switched applications.
→ To support voice and non-voice applications.
→ Reliance on 64-kbps connections.
→ Intelligence in the network.
→ Layered protocal architecture.
→ Variety of configurations.