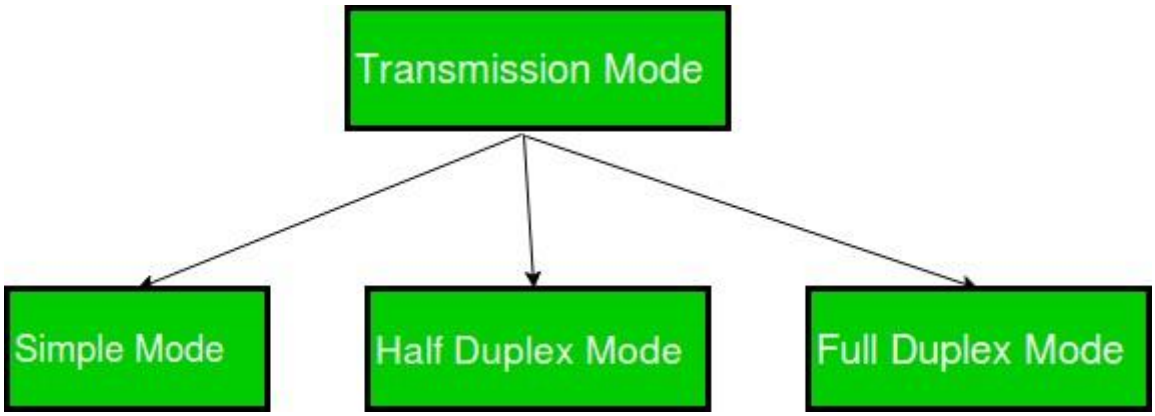
DATA COMMUNICATION & NET WORKING – 5MARKS

13. Write short notes on Transmission modes.

Transmission mode means transferring data between two devices. It is also known as a communication mode. Buses and networks are designed to allow communication to occur between individual devices that are interconnected.

There are three types of transmission mode:-

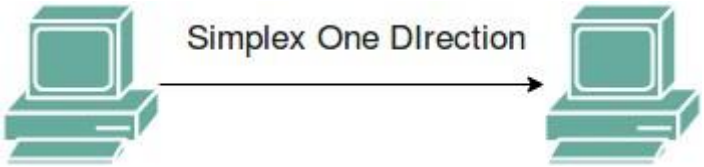


These are explained as following below.

1. Simplex Mode –

In Simplex mode, the communication is unidirectional, as on a one-way street. Only one of the two devices on a link can transmit, the other can only receive. The simplex mode can use the entire capacity of the channel to send data in one direction.

Example: Keyboard and traditional monitors. The keyboard can only introduce input, the monitor can only give the output.



Advantages:

- Simplex mode is the easiest and most reliable mode of communication.
- It is the most cost-effective mode, as it only requires one communication channel.
- There is no need for coordination between the transmitting and receiving devices, which simplifies the communication process.
- Simplex mode is particularly useful in situations where feedback or response is not required, such as broadcasting or surveillance.

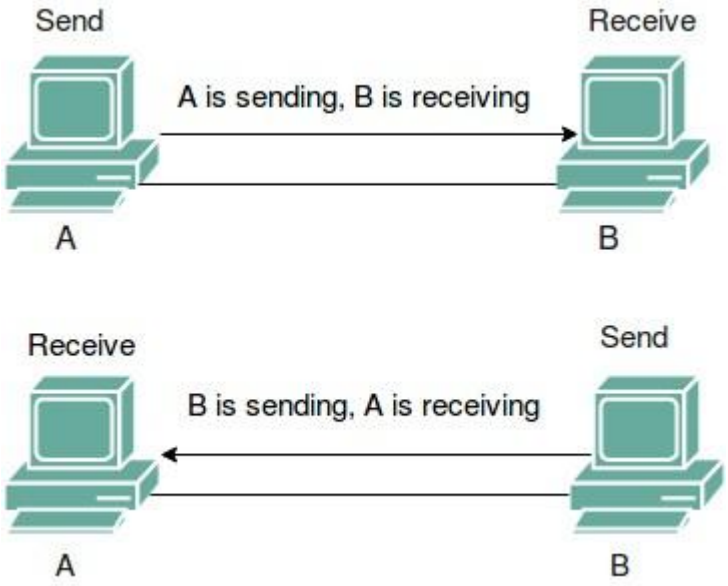
Disadvantages:

- Only one-way communication is possible.
- There is no way to verify if the transmitted data has been received correctly.
- Simplex mode is not suitable for applications that require bidirectional communication.

2. Half-Duplex Mode –

In half-duplex mode, each station can both transmit and receive, but not at the same time. When one device is sending, the other can only receive, and vice versa. The half-duplex mode is used in

cases where there is no need for communication in both directions at the same time. The entire capacity of the channel can be utilized for each direction.
Example: Walkie-talkie in which message is sent one at a time and messages are sent in both directions.
Channel capacity=Bandwidth * Propagation Delay



Advantages:

- Half-duplex mode allows for bidirectional communication, which is useful in situations where devices need to send and receive data.
- It is a more efficient mode of communication than simplex mode, as the channel can be used for both transmission and reception.
- Half-duplex mode is less expensive than full-duplex mode, as it only requires one communication channel.

Disadvantages:

- Half-duplex mode is less reliable than Full-Duplex mode, as both devices cannot transmit at the same time.
- There is a delay between transmission and reception, which can cause problems in some applications.
- There is a need for coordination between the transmitting and receiving devices, which can complicate the communication process.

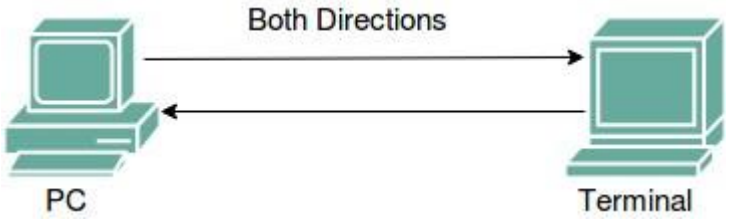
3. Full-Duplex Mode –

In full-duplex mode, both stations can transmit and receive simultaneously. In full_duplex mode, signals going in one direction share the capacity of the link with signals going in another direction, 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 is divided between signals traveling in both directions.

Full-duplex mode is used when communication in both directions is required all the time. The capacity of the channel, however, must be divided between the two directions. Example: Telephone Network in which there is communication between two persons by a telephone line, through which both can talk and listen at the same time.

Channel Capacity=2* Bandwidth*propagation Delay



Advantages:

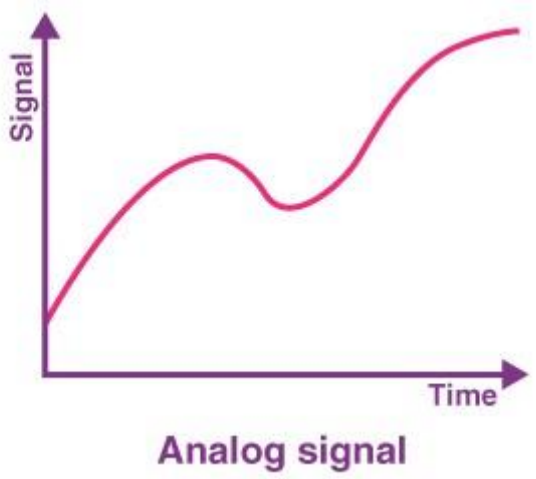
- Full-duplex mode allows for simultaneous bidirectional communication, which is ideal for realtime applications such as video conferencing or online gaming.
- It is the most efficient mode of communication, as both devices can transmit and receive data simultaneously.
- Full-duplex mode provides a high level of reliability and accuracy, as there is no need for error correction mechanisms.

Disadvantages:

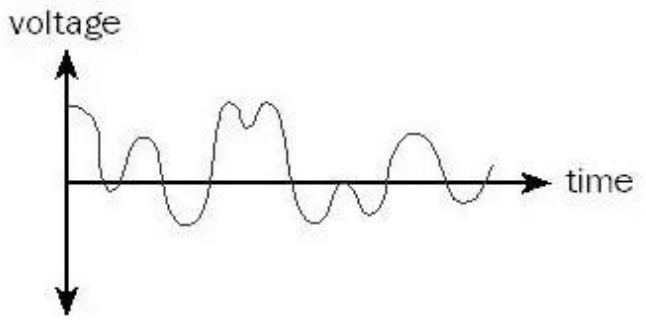
- Full-duplex mode is the most expensive mode, as it requires two communication channels.
- It is more complex than simplex and half-duplex modes, as it requires two physically separate transmission paths or a division of channel capacity.
- Full-duplex mode may not be suitable for all applications, as it requires a high level of bandwidth and may not be necessary for some types of communication.

14. Explain the Analog signals and Analog Transmission.

Analog signals were used in many systems to produce signals to carry information. These signals are continuous in both values and time. The use of analog signals has declined with the arrival of digital signals. In short, to understand analog signals – all signals that are natural or come naturally are analog signals.



Analog Transmission is the transmission of signals that vary smoothly with time, as shown in the diagram. An analog signal can take on any value in a specified range of values. A simple example is alternating current (AC), which continually varies between about +110 volts and -110 volts in a sine wave fashion 60 times per second.



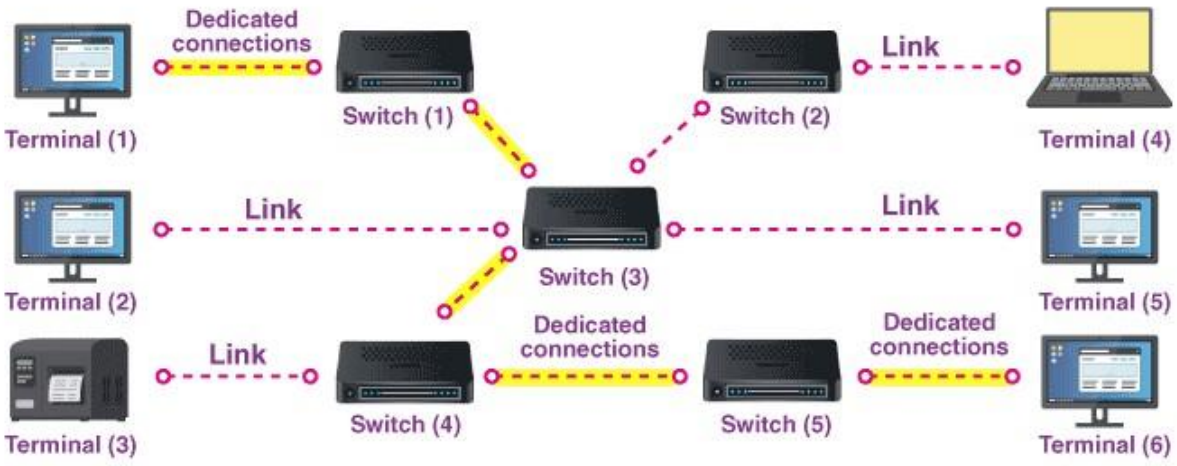
Analog Transmission

A more complex example of an analog signal is the time-varying electrical voltage generated when a person speaks into a dynamic microphone or telephone. Analog signals such as telephone speech contain a wealth of detail but are not readily accessible to computers unless they are converted to digital form using a device such as an analog-to-digital converter (ADC).

15. Discuss circuit switching.

The switching technique is a connection-oriented network that is divided into pieces and has a dedicated path established between the sender and receiver providing a guaranteed data rate.

Circuit Switching Diagram



Circuit Switching Examples

Examples of circuit switching are:

- Analog telephone network

- Optical mesh network
- Public Switched Telephone Network (PSTN)

Phases of Circuit Switching

Circuit Establishment

A dedicated circuit between the source and the destination is established with the help of numerous intermediate switching centres. The requesting and receiving of the communication signals are possible when the sender and receiver transmit signals across the circuit.

Data Transfer

The transfer of data and voice signals are possible between the source and the destination after the establishment of the circuit. The connection between both the end parties continues as long as they communicate.

Circuit Disconnection

The disconnection in the circuit happens when one of the users initiates to disconnect. When the disconnection takes place, all the intermediate links between the sender and receiver are removed.

Characteristics of Circuit Switched Network

- It is also known as the public network.
- Handling digital data and traffic is easy as the signals are voice signals.
- The transfer of electric current along with the voice signal is possible.
- The process is known as connection-oriented.
- In a circuit switching network, the establishment of the path takes place first and then the data transmission takes place.
- The amount of data transferred in the circuit switching is fixed.
- The termination of the path is possible only when there is a termination of the connection.

Advantages and Disadvantages of Circuit Switching

Advantages

- This type of switching technique is suitable for the continuous transmission of data as the data remains in conservation.
- The rate of communication is steady as a dedicated path for transmission.

- With the establishment of the circuit, there are no intermediate delays that make it suitable for voice and data transmission.

Disadvantages

- As there is an establishment of a dedicated connection between both ends, the transmission of any other data is challenging.
- Data with low volume demand high bandwidth.
- The usage of system resources becomes underutilized as the repetition of resources for other connections is not possible.
- The establishment time is high.

Types of Switches in Circuit Switching

There are two types of switches that are used in circuit switching, and they are:

- **Space Division Switches**

In space division switching, the paths in the circuit are separated from each other. The main purpose of the space division was for the analog network. However, it is used for both analog and digital switching. A switch known as a crosspoint is used in space division switches. It finds applications in digital communication and uses semiconductor gates.

The advantage of a space-division switch is that it is instantaneous and the disadvantage is the number of crosspoints is dependent on the blocking.

- **Time-Division Switches**

In the time-division switching method, the number of connections travels along the same trunk line. The breaking of the streams into segments takes place with the help of time-division multiplexing, making sure that the segments are sent at specific intervals. The detection of the elements happens with the help of a de-multiplexer.

Difference Between Circuit and Packet Switching

The following is the list of differences between circuit and packet switching:

Circuit Switching	Packet Switching

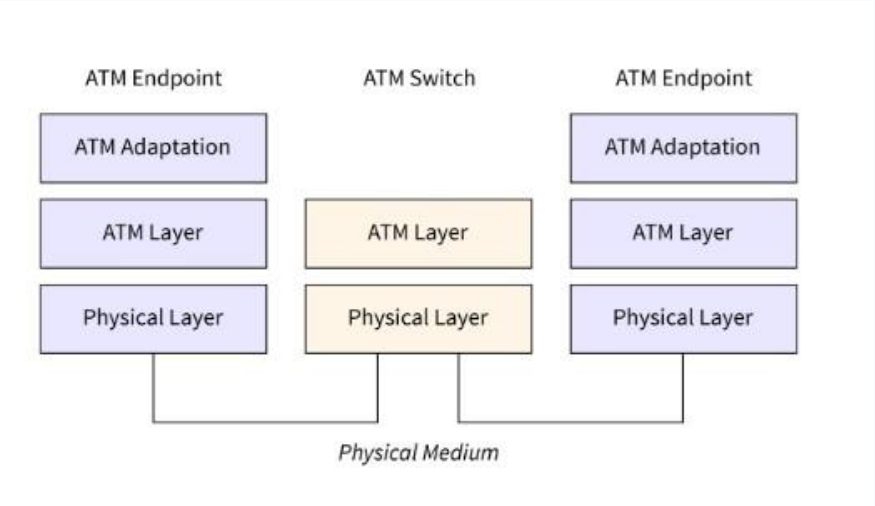
The transfer of data takes place after the establishment of the dedicated path.	The transfer of data takes place in the form of packets following dynamic routing.
It is mainly preferred for voice transmission.	It is mainly preferred for data transmission.
The implementation of this type of switching takes place at the physical layer.	The implementation of this type of switching takes place at the network layer.

16. Discuss about ATM protocol.

The full form of the ATM is Asynchronous Transfer Mode. Asynchronous Transfer Mode is a switching technique and time division multiplexing(TDM) is used by ATMs for data communication. **Time-division multiplexing (TDM)** is a method in which multiple data streams are put onto a single signal by separation of the signal into different segments and a short duration is assigned to each.

- ATM is considered the connection-oriented network for cell relay by which voice, data, and video communication are supported.
- Data is encoded in the form of small cells of a fixed size so that they become acceptable to TDM and can be transferred on a physical network.
- 53 bytes is the size of an ATM cell which consists of a 48-byte payload and 5 bytes for the header.
- Asynchronous Transfer Mode is also established for the networks that can carry conventional data traffic that has high throughput and real-time and low-latency data such as video, and voice.

Refer to the below image for the ATM's functional reference model.



ATM stands for Asynchronous Transfer Mode and this "asynchronous" means that ATM does not use a timer or any fixed speed for transmission of the information, but based on the hardware and flow reliability of the information ATM does the negotiation at the speed of the transmission. And in its name "transfer mode" means that the cells of fixed size are used by the ATM for information packaging.

The origin of the ATM technology is the B-ISDN(Broadband ISDN technology) and primarily it works on the Open Systems Interconnection (OSI) reference model layer 2. Virtual paths (VPS) and Virtual channels (VCs) are used by the Asynchronous Transfer Mode for the connection of the devices over the WAN. The **virtual channel(VC)** is the series connection of one or more than one physical ATM links for the data transmission among remote stations. VC exists only at the time of data transmission and to ensure the reliability of the data transmission same VC is followed by all the cells of the given ATM. And the collection of VCs is called the **virtual path(VP)**. And all the VCs of the virtual path have a similar source and destination point.

Wireless ATM

Wireless ATM (WATM) is a wireless network with an ATM core. High-speed mobile communication is provided by this ATM. This is the technology that came into the world after the wired ATM's success in responding to the increasing demands of wireless services in every field. Data, video, and voice are supported by WATM with the guaranteed QoS(Quality of Service). Like other available wireless technologies, Broadcasting is done by the ATM cells from the base station and transferred to the mobile terminals, and the mobility function is performed by the ATM switch here.

VoATM

VoATM stands for Voice over Asynchronous Transfer Mode and it is the protocol that allows the transmission of video, voice, and data packets via an ATM network. This technology is similar to VoIP(Voice over Internet Protocol) which is a technology that allows that enables making voice calls using a broadband Internet connection in place of a regular phone line) but the only difference is that the IP protocol is not used by this and it is somewhat costly in terms of implementation. But

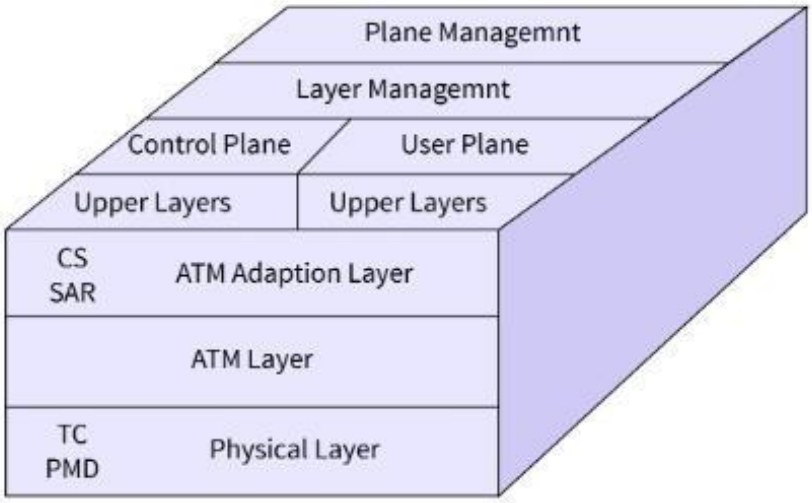
for the network, a high-speed transport facility is provided by it. And this technology is considered beneficial for companies that have in place ATM networks.

ATM vs DATA Networks (Internet)

ATM is based on the "virtual circuit": For the transmission, the path is reserved in the ATM, but IP(Internet Protocol) is the connectionless protocol and we cannot end-to-end resource reservations in the IP protocol data transmission. **ATM cells:** ATM has fixed size cells of small size and there is a tradeoff between data and voice. While packets used in IP protocol are of variable size. **Addressing:** Global NSAP addresses of 20 bytes are used by the ATM for the signaling and locally assigned labels of 32-bits in cells. And on the other hand, if we talk about IP the global address of 32-bits is by the IP is all the packets.

ATM Layers

Refer to the below image for the ATM Layers.



ATM Adaptation Layer (AAL)

It is a layer for isolation of Higher layer protocols and ATM processes details and user data prepared by it for converting it into cells and for converting segments into cell payload of 48 bytes. Transmission coming upper layer services are accepted by the AAL protocol and help in application mapping, e.g. voice, and data to the ATM cells.

Physical Layer

Medium-dependent transmission is managed by it. The transmission convergence sublayer and physical medium-dependent sublayer are two divisions of this layer. The main functions of this layer are given below:

- Cells are converted into a bit stream by it
- In the physical medium transmission and receipt of bits are controlled by it.

- ATM cell boundaries can also be tracked by it.
- It looks for cell packaging into proper frame types.

ATM Layer

Transmission, congestion, sequential delivery, switching, control, cell header processing, etc., is handled by it. And it is also responsible for simultaneously cell multiplexing and cell relay. Cell multiplexing is the sharing of the virtual circuit on the physical link. And the transmission of cells over an Asynchronous Transfer Mode network is known as cell relay and VPI and VCI information present in the cell Header is used.

The Application of Asynchronous Transfer Mode

- **ATM WAN:-** For transmitting cells over long distances it can be used as the WAN and the router that serves as an endpoint between the other networks and ATM networks having 2 stacks of the protocol.
- **Multimedia virtual private networks and managed services:–** LAN, voice, ATM, and video services can be managed by it and it enables full-service virtual private networking, and multimedia integrated access is involved in it
- **Frame relay backbone:-** Networking infrastructure is provided by the frame relay services for the range of data services and enables frame-relay ATM service to the internet working services.
- **Residential broadband networks:-** For finding highly scalable solutions, the networking infrastructure is provided by the ATM for the creation of residential broadband services.
- **Telephone and private line networks carrier infrastructure:-** Telephonic and private line traffic can be carried out by establishing ATM infrastructure which makes the SONET/SDH fiber infrastructure utilization effective.

Advantages and Disadvantages of Asynchronous Transfer Mode

Advantages

- ATM is beneficial as it provides the service of dynamic bandwidth that is especially suited for burst traffic.
- Data transmission can be done simply, predictably, and uniformly as all the data are encoded into identical cells.
- Mixed traffic is efficiently handled by the uniform packet size.
- Packet overload is decreased by small-sized headers and provides effective usage of bandwidth.
- ATM networks are speed and size-scalable.

Disadvantages

- There is an overhead of the cell header (5 bytes/cell) Achieving QoS has a complex mechanism.
- There may be a condition of cell loss due to congestion.
- Compared to LAN hardware, ATM switches are very expensive.

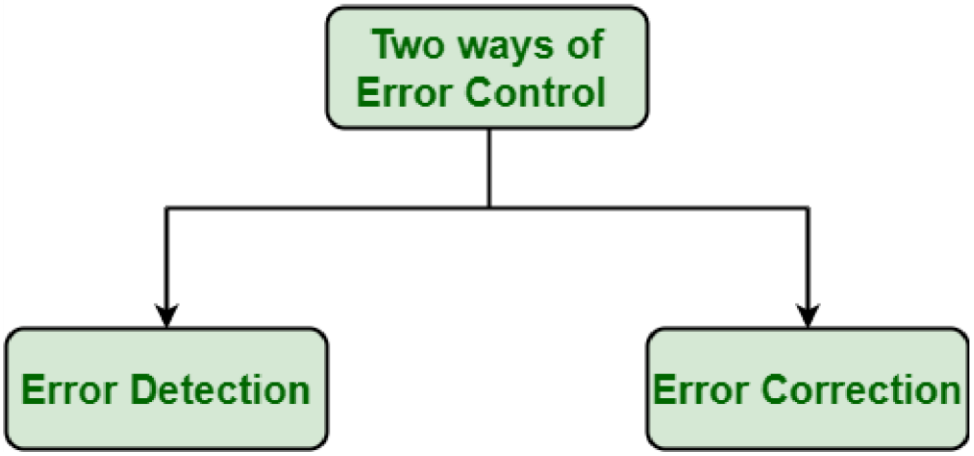
Conclusion

- ATM stands for Asynchronous Transfer Mode.
- Asynchronous Transfer Mode is a switching technique and time division multiplexing is used by ATMs for data communication.
- Wireless ATM (WATM) is a wireless network with an ATM core.
- VoATM stands for Voice over Asynchronous Transfer Mode and it is the protocol that allows the transmission of video, voice, and data packets via an ATM network.
- IP protocol is connectionless while ATM network is a connection-oriented technology.
- ATM Adaptation Layer, Physical Layer, and ATM layer are the layers of the ATM.
- Frame relay backbone, ATM WAN, etc. are some applications of the ATM network. Speed and size scalability are some advantages of the ATM network.

17. Discuss about Error control

Data-link layer uses the techniques of error control simply to ensure and confirm that all the data frames or packets, i.e. bit streams of data, are transmitted or transferred from sender to receiver with certain accuracy. Using or providing error control at this data link layer is an optimization, it was never a requirement. Error control is basically process in data link layer of detecting or identifying and re-transmitting data frames that might be lost or corrupted during transmission. In both of these cases, receiver or destination does not receive correct data frame and sender or source does not even know anything about any such loss regarding data frames.

Ways of doing Error Control : There are basically two ways of doing Error control as given below :



Ways of Error Control

1. **Error Detection :** Error detection, as the name suggests, simply means detection or identification of errors. These errors may occur due to noise or any other impairments during transmission from transmitter to the receiver, in communication system. It is a class of techniques for detecting garbled i.e. unclear and distorted data or messages.

2. **Error Correction :** Error correction, as the name suggests, simply means correction or solving or fixing of errors. It simply means reconstruction and rehabilitation of original data that is error-free. But error correction method is very costly and very hard.

Error Control Techniques

There are three main techniques for error control −

Various Techniques for Flow Control : There are various techniques of error control as given below :

1. Stop-and-Wait ARQ : Stop-and-Wait ARQ is also known as alternating bit protocol. It is one of the simplest flow and error control techniques or mechanisms. This mechanism is generally required in telecommunications to transmit data or information between two connected devices. Receiver simply indicates its readiness to receive data for each frame. In these, sender sends information or data packets to receiver. Sender then stops and waits for ACK (Acknowledgment) from receiver. Further, if ACK does not arrive within given time period i.e., time-out, sender then again resends frame and waits for ACK. But, if sender receives ACK, then it will transmit the next data packet to receiver and then again wait for ACK from receiver. This process to stop and wait continues until sender has no data frame or packet to send.

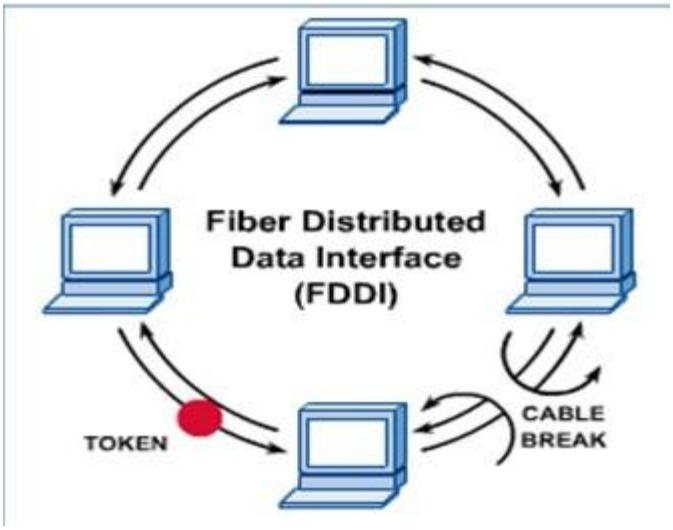
2. Sliding Window ARQ : This technique is generally used for continuous transmission error control. It is further categorized into two categories as given below :

- **Go-Back-N ARQ :** Go-Back-N ARQ is form of ARQ protocol in which transmission process continues to send or transmit total number of frames that are specified by window size even without receiving an ACK (Acknowledgement) packet from the receiver. It uses sliding window flow control protocol. If no errors occur, then operation is identical to sliding window.

- **Selective Repeat ARQ :** Selective Repeat ARQ is also form of ARQ protocol in which only suspected or damaged or lost data frames are only retransmitted. This technique is similar to Go-Back-N ARQ though much more efficient than the Go-Back-N ARQ technique due to reason that it reduces number of retransmission. In this, the sender only retransmits frames for which NAK is received. But this technique is used less because of more complexity between sender and receiver and each frame must be needed to be acknowledged individually.

18. Explain the concept of FDDI in detail.

FDDI stands for **Fiber Distributed Data Interface**. It is a set of ANSI and ISO guidelines for information transmission on fiber-optic lines in Local Area Network (LAN) that can expand in run upto 200 km (124 miles). The FDDI convention is based on the **token ring protocol.** In expansion to being expansive geographically, an FDDI neighborhood region arranges can support thousands of clients. FDDI is habitually utilized on the spine for a Wide Area Network(WAN).



An FDDI network contains **two token rings,** one for possible backup in case the essential ring falls flat.
The primary ring offers up to 100 Mbps capacity. In case the secondary ring isn't required for backup, it can also carry information, amplifying capacity to 200 Mbps. The single ring can amplify the most extreme remove; a double ring can expand 100 km (62 miles).

Characteristics of FDDI

- FDDI gives 100 Mbps of information throughput.
- FDDI incorporates two interfaces.
- It is utilized to associate the equipment to the ring over long distances.
- FDDI could be a LAN with Station Management.
- Allows all stations to have broken even with the sum of time to transmit information.
- FDDI defines two classes of traffic viz. synchronous and asynchronous.

Advantages of FDDI

- Fiber optic cables transmit signals over more noteworthy separations of approximately 200 km.
- It is conceivable to supply the need to the work stations associated within the chain. Consequently, based on the prerequisite a few stations are bypassed to supply speedier benefit to the rest.
- FDDI employments different tokens to make strides organize speed.
- It offers a higher transmission capacity (up to 250 Gbps). Thus, it can handle information rates up to 100 Mbps.

- It offers tall security because it is troublesome to spy on the fiber-optic link.
- Fiber optic cable does not break as effectively as other sorts of cables.

Disadvantages of FDDI

- FDDI is complex. Thus establishment and support require an incredible bargain of expertise.
- FDDI is expensive. Typically since fiber optic cable, connectors and concentrators are exceptionally costly.

19. Explain the following: (a) TCP/IP Network (b) Repeaters.

TCP (Transmission Control Protocol)

TCP enables applications to establish channels of communication via a network. It also allows a text to be split into various packets before they can be transmitted over the network and then arranged correctly at the destination network. So, it ensures the reliable transfer of information across the network. Besides, it also tests errors in the packets and demands for re-transmission if any errors are found.

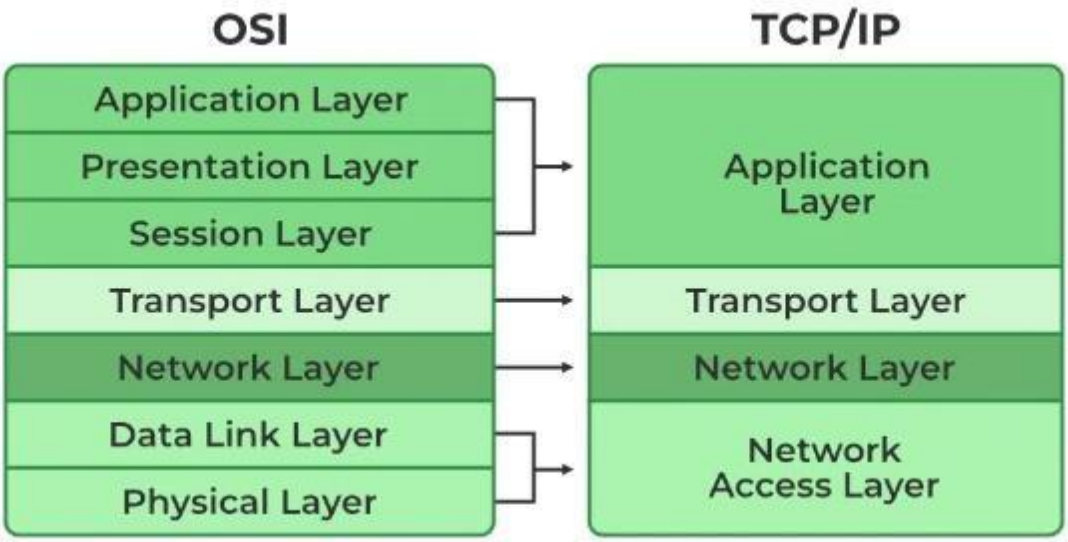
IP(Internet Protocol)

The IP address informs the packets of the path to reach the right endpoint. It has a technique that, after verifying the IPS address, allows gateway computers on the internet-connected network to forward the text. It's like accordance of workers passing coal to a mining cart from a mine.

Layers of TCP/IP Model

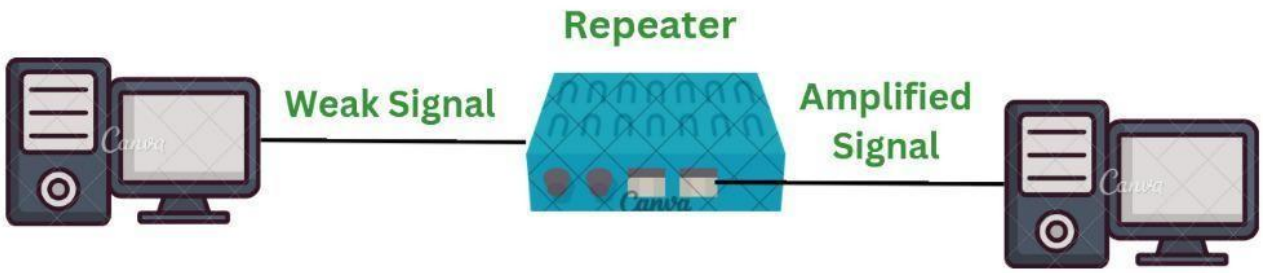
1. Application Layer
2. Transport Layer(TCP/UDP)
3. Network/Internet Layer(IP)
4. Data Link Layer (MAC)
5. Physical Layer

The diagrammatic comparison of the **TCP/IP and OSI** model is as follows:



(b) Repeaters:

Repeaters are defined as a networking device that is used to amplify and generate the incoming signal. Repeaters work at the physical layer of the OSI model. The main aim of using a repeater is to increase the networking distance by increasing the strength and quality of signals. The performance of Local Area Networks (LANs) and Wide Area Networks (WANs) repeaters are used. Using repeaters helps to reduce error, and loss of data and provides with delivery of data at specified locations only. The major advantage of using a repeater is that it provides with transfer of data with more security and over a long distance.



Repeater

Features of Repeaters

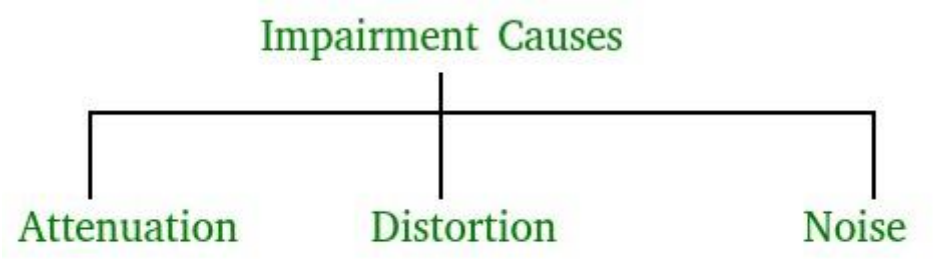
- Repeater can regenerate the signal without modifying it.
- Repeaters can be used in analog signals and digital signals.
- Repeaters can extend the range of networks.
- Dynamic networking is supported by repeater.
- Use of Repeaters reduces error and loss of data.

- Power is required for working of repeaters.
- Using repeater can add complexity in the network.

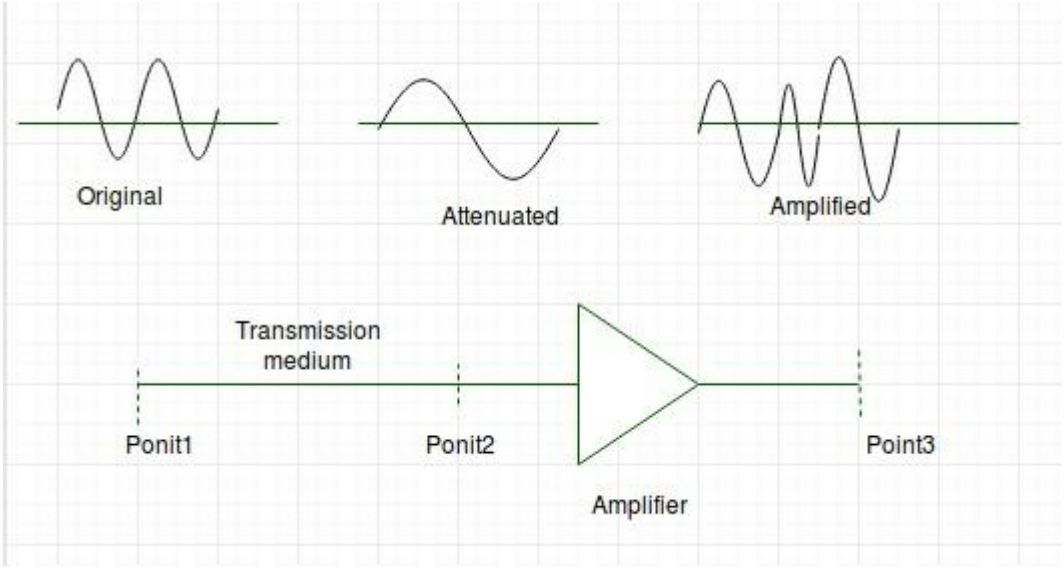
13. Write a short note on Transmission impairments.

In communication system, analog signals travel through transmission media, which tends to deteriorate the quality of analog signal, which means that the signal at the beginning of the medium is not the same as the signal at the end of the medium. The imperfection causes signal impairment. Below are the causes of the impairment.

Causes of impairment –



- **Attenuation –** It means loss of energy. The strength of signal decreases with increasing distance which causes loss of energy in overcoming resistance of medium. This is also known as attenuated signal. Amplifiers are used to amplify the attenuated signal which gives the original signal back and compensate for this loss.



- Image Source – aviationchief
  Attenuation is measured in **decibels(dB)**. It measures the relative strengths of two signals or one signal at two different point.

Attenuation(dB) = 10log10(P2/P1)

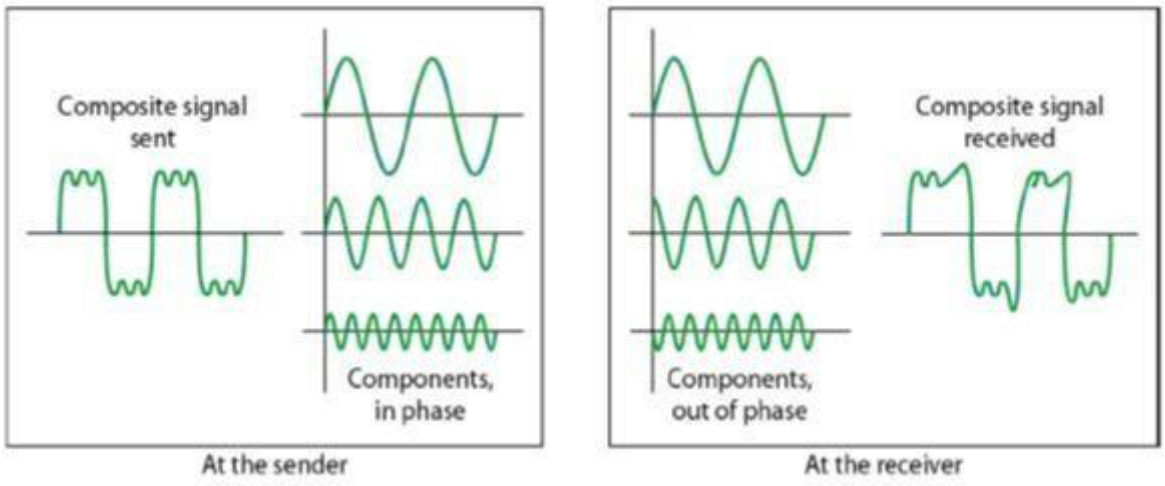
P1 is the power at sending end and P2 is the power at receiving end.

Some where the decibel is also define in terms of voltage instead of power.In this case because power is proportional to the square of the voltage the formula is

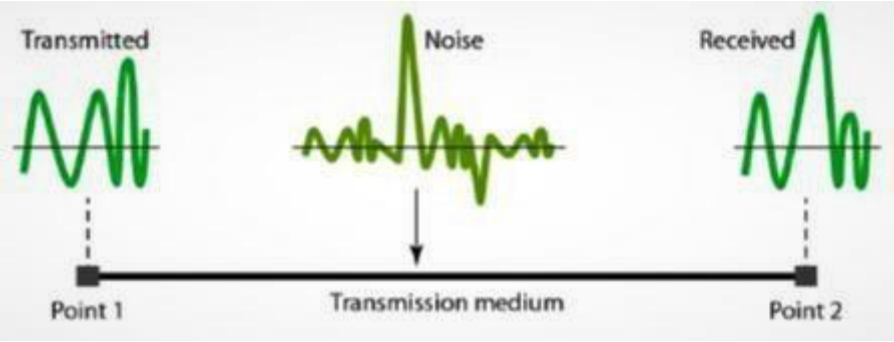
Attenuation(dB) = 20log10(V2/V1)

V1 is the voltage at sending end and V2 is the voltage at receiving end.

- **Distortion –** It means changes in the form or shape of the signal. This is generally seen in composite signals made up with different frequencies. Each frequency component has its own propagation speed travelling through a medium. And thats why it delay in arriving at the final destination Every component arrive at different time which leads to distortion. Therefore, they have different phases at receiver end from what they had at senders end.



- **Noise –** The random or unwanted signal that mixes up with the original signal is called noise. There are several types of noise such as induced noise, crosstalk noise, thermal noise and impulse noise which may corrupt the signal.
  Induced noise comes from sources such as motors and appliances. These devices act as sending antenna and transmission medium act as receiving antenna. **Thermal** noise is movement of electrons in wire which creates an extra signal. **Crosstalk** noise is when one wire affects the other wire. **Impulse** noise is a signal with high energy that comes from lightning or power lines



- To find the theoretical bit rate limit, we need to know the ration .The signal-to-noise ratio is defined as

SNR = AVG SIGNAL POWER / AVG NOISE POWER

SNR_{dB} = 10Log10SNR

EXAMPLE

The values of SNR and SNR_{dB} for a noiseless channel are

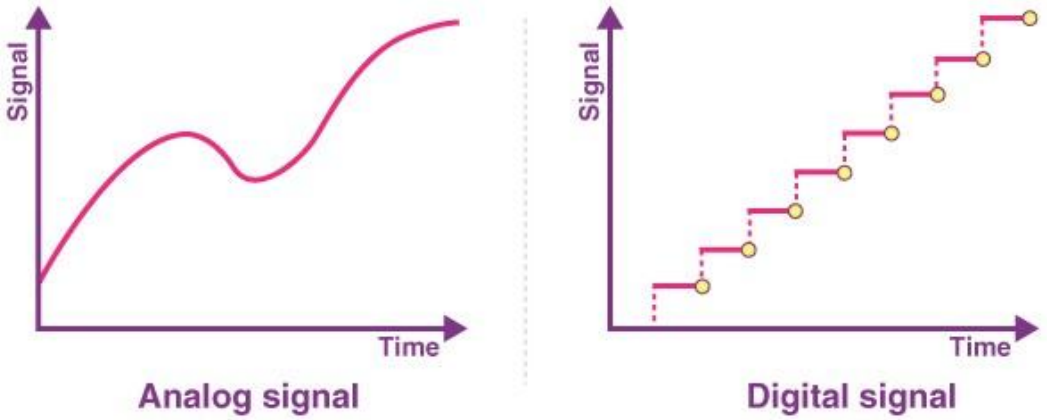
SNR = Signal Power/0 = ∞

$SNR_{dB} = 10Log_{10} ∞ = ∞$

We can never achieve this ratio in real life ; it is an ideal.

15. Explain the signals of Analog and Digital.

Analog and digital signals are the types of signals carrying information. The major difference between both signals is that the analog signals have continuous electrical signals, while digital signals have non-continuous electrical signals. The difference between analog and digital signal can be observed with the examples of different types of waves.



What Are Analog Signals:

Analog signals were used in many systems to produce signals to carry information. These signals are continuous in both values and time. The use of analog signals has declined with the arrival of digital signals. In short, to understand analog signals – all signals that are natural or come naturally are analog signals.

What Are Digital Signals:

Unlike analog signals, digital signals are not continuous, but signals are discrete in value and time. These signals are represented by binary numbers and consist of different voltage values.

Difference between Analog and Digital Signals

To summarise, we have given the various differences between analog signal and digital signal in a tabular form below. Both these signals are used in electronic communication system to transfer information from one place to another.

Difference between Analog and Digital Signal	
Analog Signals	**Digital Signals**
Continuous signals	Discrete signals
Represented by sine waves	Represented by square waves
Human voice, natural sound, analog electronic devices are a few examples	Computers, optical drives, and other electronic devices
Continuous range of values	

	Discontinuous values
Records sound waves as they are	
	Converts into a binary waveform
Only used in analog devices	Suited for digital electronics like computers, mobiles and more

16. Explain about: Message switching.

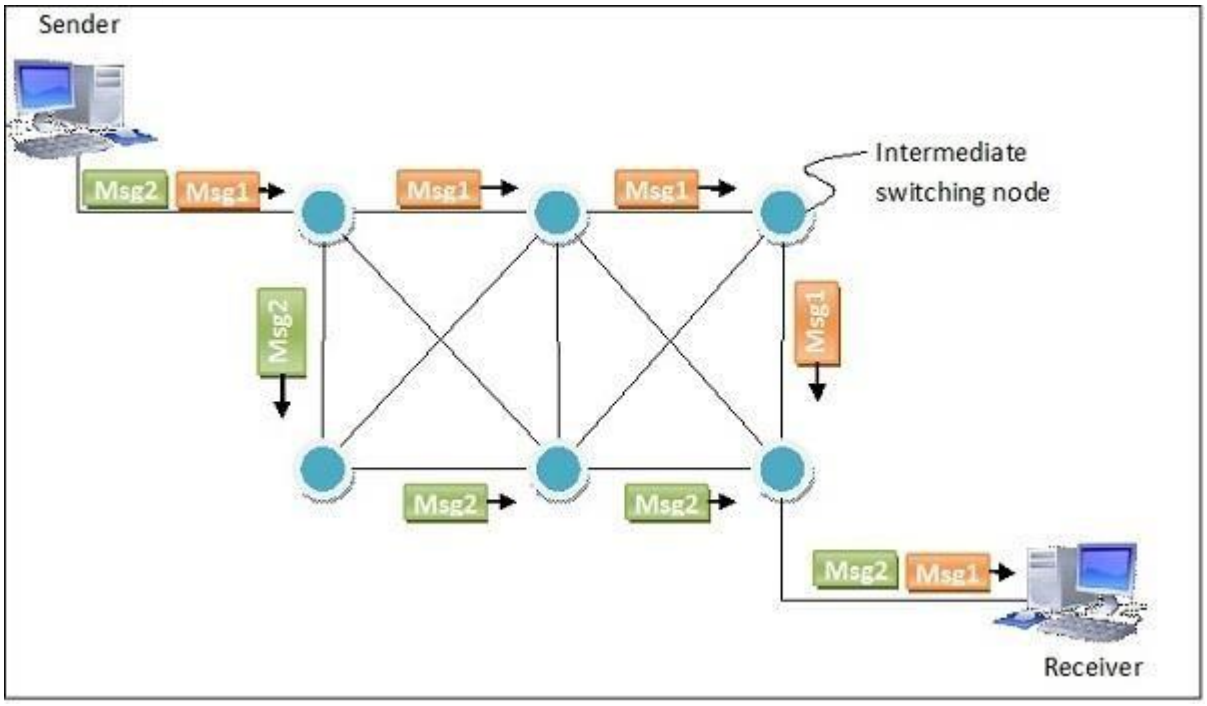
Switched communication networks are those in which data transferred from source to destination is routed between various intermediate nodes. Switching is the technique by which nodes control or switch data to transmit it between specific points on a network. There are 3 common switching techniques:

1. Circuit Switching
2. Packet Switching
3. Message Switching

Packet switching treats each message as an individual unit. Before sending the message, the sender node adds the destination address to the message. It is then delivered entirely to the next intermediate switching node. The intermediate node stores the message in its entirety, checks for transmission errors, inspects the destination address and then delivers it to the next node. The process continues till the message reaches the destination.

In the switching node, the incoming message is not discarded if the required outgoing circuit is busy. Instead, it is stored in a queue for that route and retransmitted when the required route is available.This is called store and forward network.

The following diagram represents routing of two separate messages from the same source to same destination via different routes, using message switching –



Advantages and Disadvantages of Message Switching

Advantages

- Sharing of communication channels ensures better bandwidth usage.
- It reduces network congestion due to store and forward method. Any switching node can store the messages till the network is available.
- Broadcasting messages requires much less bandwidth than circuit switching.
- Messages of unlimited sizes can be sent.
- It does not have to deal with out of order packets or lost packets as in packet switching.

Disadvantages

- In order to store many messages of unlimited sizes, each intermediate switching node requires large storage capacity.
- Store and forward method introduces delay at each switching node. This renders it unsuitable for real time applications.

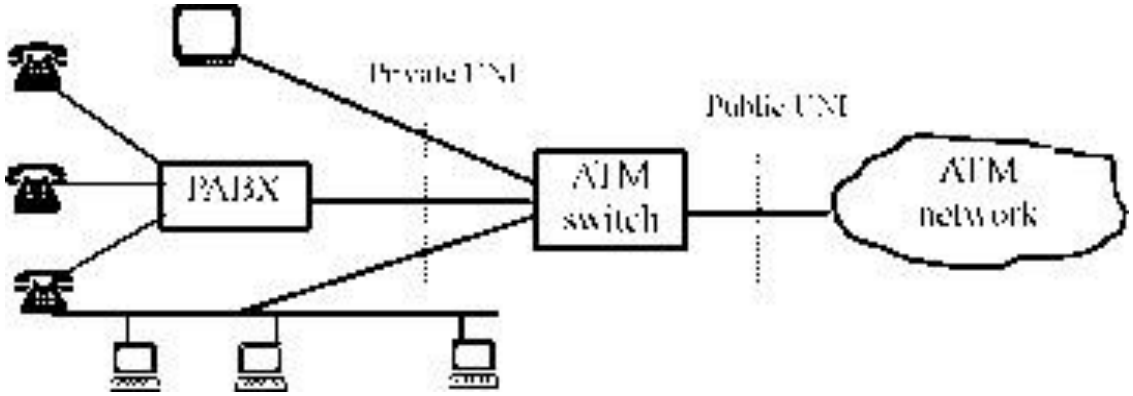
18. Explain: ATM Topology

Although much of ATM is still under study, the basic topology has been mapped out. At this point, ATM is intended to be a hierarchy of networks connected by associated interfaces. The two most important of these interfaces are the user network interface (UNI) and the network-to-network interface (NNI). A UNI is the interface between a user and the wide area ATM network. An NNI

UNI NNI UNI

UNI NNI UNI

In addition, we can have ATM switches that are used outside of the public ATM network, such as ATM LANs or an ATM backbone connecting the networks of a campus. To connect these private switches to the public network, we need a second type of UNI. A UNI that connects a user or service to an ATM switch is called a private UNI. A UNI that connects a user or service to a public ATM network is called a public UNI (see Figure 12.4-2). Note that the terms private and public in this context do not describe ownership. They merely indicate whether the interface is located inside or outside the user's premises.

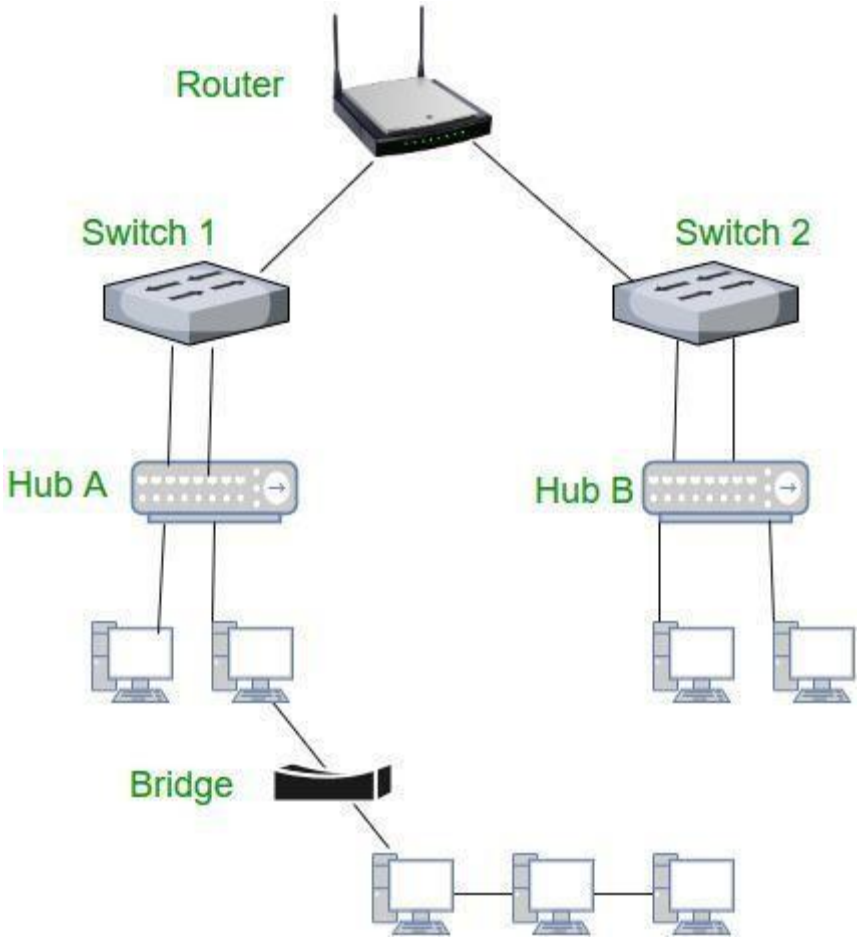


19. Discuss about: (a) Routers (b) Gateway

A Router is a networking device that forwards data packets between computer networks. One or more packet-switched networks or subnetworks can be connected using a router. By sending data packets to their intended IP addresses, it manages traffic between different networks and permits several devices to share an Internet connection.

A router determines a packet's future path by examining the destination IP address of the header and comparing it to the routing database. The list of routing tables outlines how to send the data to a specific network location. They use a set of rules to determine the most effective way to transmit the data to the specified IP address.

Static and dynamic tables come in two varieties in the router. The dynamic routing tables are automatically updated by dynamic routers based on network activity, whereas the static routing tables are configured manually.



Router Network

Types of Router

There are several types of routers available in the market. Some of them are mentioned below:

1. **Broadband Routers:** These are one of the important kinds of routers. It is used to do different types of things. it is used to connect computers or it is also used to connect to the internet.

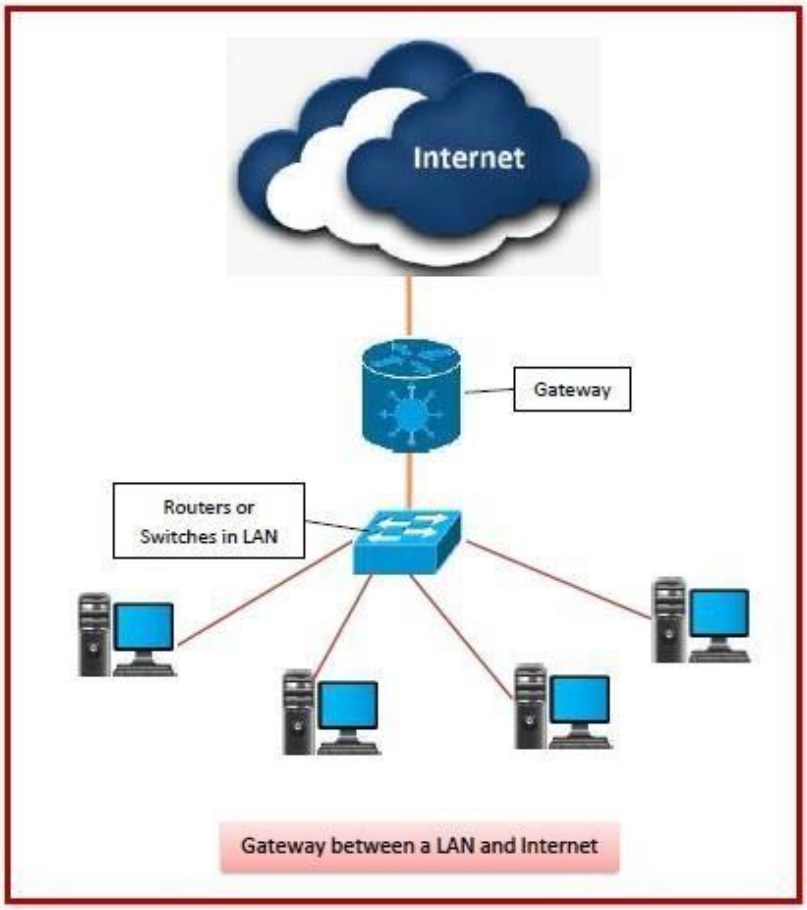
2. **Wireless routers:** These routers are used to create a wireless signal in your office or home. Wireless routers receive data packets over wired broadband, convert the packets written in binary code into radio signals that are picked up by electronic devices, and then convert them back into previous packets.

3. **Edge Routers**: As the name indicates, these are located at the edges usually connected to an Internet Service Provider, and distribute packets across multiple packets.

4. **Core Routers:** Core routers distribute packets within the same network. The main task is to carry heavy data transfers.

(b) Gateway

A gateway is a network node that forms a passage between two networks operating with different transmission protocols. The most common type of gateways, the network gateway operates at layer 3, i.e. **network layer** of the OSI (open systems interconnection) model. However, depending upon the functionality, a gateway can operate at any of the seven layers of **OSI model**. It acts as the entry – exit point for a network since all traffic that flows across the networks should pass through the gateway. Only the internal traffic between the nodes of a **LAN** does not pass through the gateway.



Features of Gateways

- Gateway is located at the boundary of a network and manages all data that inflows or outflows from that network.
- It forms a passage between two different networks operating with different transmission protocols.
- A gateway operates as a protocol converter, providing compatibility between the different protocols used in the two different networks.
- The feature that differentiates a gateway from other network devices is that it can operate at any layer of the OSI model.
- It also stores information about the routing paths of the communicating networks.

- When used in enterprise scenario, a gateway node may be supplemented as proxy server or firewall.
- A gateway is generally implemented as a node with multiple NICs (network interface cards) connected to different networks. However, it can also be configured using software.
- It uses packet switching technique to transmit data across the networks.

Types of Gateways

On basis of direction of data flow, gateways are broadly divided into two categories −

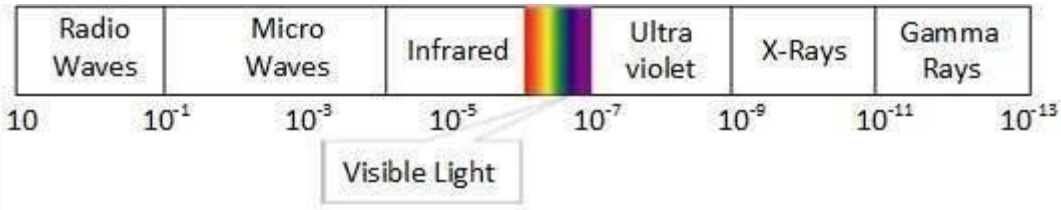
- **Unidirectional Gateways** − They allow data to flow in only one direction. Changes made in the source node are replicated in the destination node, but not vice versa. They can be used as archiving tools.
- **Bidirectional Gateways** − They allow data to flow in both directions. They can be used as synchronization tools.

13. Explain briefly the 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 are 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 signals and spread all over within its frequency range. The receptor on the other end receives these signals and converts them back to digital data.

A little part of electromagnetic spectrum can be used for wireless transmission.



Comparison of Infrared, Radio waves, Microwaves

S.no	Infrared	Radio Waves	Microwaves
1	Infrared is used for shortrange communication like TV remotes, mobile phones, personal computers, etc. In science, the Infrared is part of a spectrum that is not visible to the human eye	Radio waves are the type of wireless communication that can travel large distances as well as can penetrate any wall	Microwaves are a line of sight transmission, meaning both the antennas sending and receiving should be properly aligned.
2	The frequency range of infrared rays 300GHz – 400THz	The frequency range of radio waves:3KHz – 1GHz.	Microwaves have a frequency Range between 1GHz – 300GHz.
3	The limitation of infrared rays is that they cannot penetrate any obstacles and can only use for short-range. Also, Infrared is used in night vision cameras as it has thermal properties. The frequency range of infrared rays 300GHz – 400THz	It can travel large distances as well as can penetrate any wall (Omni-directional,	They are unidirectional, as they can move in only one direction, and therefore it is used in point-to-point communication or unicast communication such as radar and satellite.
4	Infrared is one of the secure wireless communication mediums as it is used for short-range. Also, unlike other wireless mediums, infrared is quite inexpensive, and this is some reason it is used in many electronic devices.	Radio waves can travel to long distances so it is used for long distance communication and there is no need of digging and spreading wires.	Advantages of microwaves then we say that it is a very fast way of communication, that can carry 25000 voice channels at the same time. Also, it is a wireless communication medium so there is no need of digging and spreading wires.

5	Infrared waves are used in TV remotes, mobile phones,	Radio waves are used in AM and FM radios, and	Microwaves are used in mobile phones
S.no	**Infrared**	**Radio Waves**	**Microwaves**
	personal computers	cordless phones.	communication and television distribution.

14. Compare and contrast Analog and Digital signals.

Analog signals use a continuous range of values to represent the data and information. Digital signals use discrete values (or discontinuous values), i.e. discrete 0 and 1, to represent the data and information. The bandwidth of an analog signal is low. The bandwidth of a digital signal is relatively high.

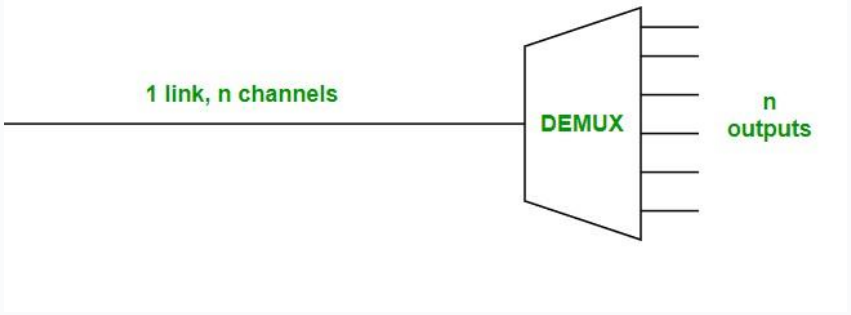
Comparison between Digital System and Analog System:

	Analog System	**Digital System**
Signal	Analog signal represents physical measurements.	Digital signals are discrete and generated by digital modulation.
Waves	Sine Waves	Square Waves
Representation	Continuous range of values to represent information	Uses discrete values to represent information
Technology	Records waveforms as they are.	Samples analog waveforms into a limited set of numbers and then records them.
Data transmissions	Affected by noise during transmission and write/read cycle.	Noise-immune during transmission and write/read cycle.
Response to Noise	More likely to get affected	Less likely to get affected
Flexibility	Hardware is not flexible.	Hardware is flexible.

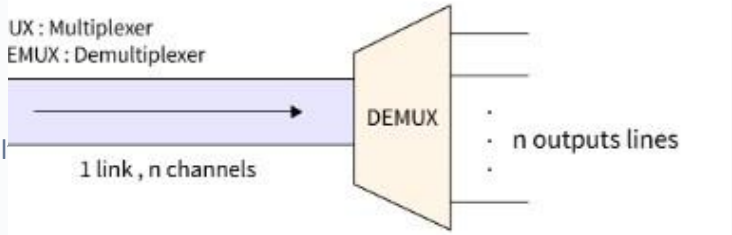
Bandwidth	Less bandwidth.	More bandwidth to carry out the same information
Memory	Stored data in the form of wave signal	Stored data in the form of binary bit
	Analog System	**Digital System**
Power	Consumes large power	Consumes negligible power
Uses	Best suited for audio and video transmission.	Best suited for Computing and digital electronics.
Cost	Cost is low	Cost is high
Example	Human voice in air, analog electronic devices.	Computers, CDs, DVDs,

16. Discuss about : Multiplexing.

Multiplexing is the process of combining multiple signals into one signal, over a shared medium. If analog signals are multiplexed, it is Analog Multiplexing and if digital signals are multiplexed, that process is Digital Multiplexing.



ne signal for transmission across a single media, such as
gnals can be analog or digital, depending on the sender. Multiplexing
rred more efficiently over a given communication channel, lowering



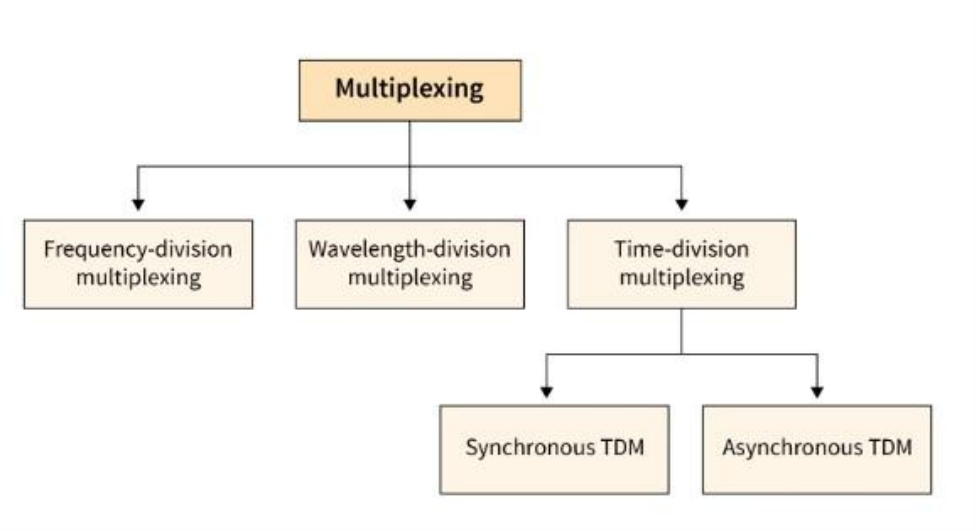
Multiplexing combines mul
into o

transmission costs.

1. On the sender end, a device Multiplexer (MUX) is used to combine n input lines to produce a single output line. Multiplexing is done in a many-to-one approach, with n input and one output line.
2. On the receiver side, a device known as a Demultiplexer (DEMUX) divides a signal into its constituent signals (one input and n outputs). As a result, demultiplexing follows the one-tomany approach.

Types of Multiplexing Techniques

There are primarily four types of Multiplexing techniques, and they are as follows:



There are mainly two types of **multiplexers**, namely **analog** and digital. They are further divided into **FDM**, **WDM**, and **TDM**.

Analog Multiplexing

The analog multiplexing techniques involve signals which are analog in nature. The analog signals are multiplexed according to their frequency (FDM) or wavelength (WDM).

Frequency Division Multiplexing (FDM)

In analog multiplexing, the most used technique is Frequency Division Multiplexing FDM. This technique uses various frequencies to combine streams of data, for sending them on a communication medium, as a single signal.

Example: A traditional television transmitter, which sends a number of channels through a single cable, uses FDM.

Wavelength Division Multiplexing (WDM)

Wavelength Division Multiplexing is an analog technique, in which many data streams of different wavelengths are transmitted in the light spectrum. If the wavelength increases, the frequency of the signal decreases.

Example: Optical fibre Communications use the WDM technique, to merge different wavelengths into a single light for the communication.

Digital Multiplexing

The term digital represents the discrete bits of information. Hence the available data is in the form of frames or packets, which are discrete.

Time Division Multiplexing (TDM)

In TDM, the time frame is divided into slots. This technique is used to transmit a signal over a single communication channel, with allotting one slot for each message. Of all the types of TDM, the main ones are Synchronous and Asynchronous TDM.

Synchronous TDM

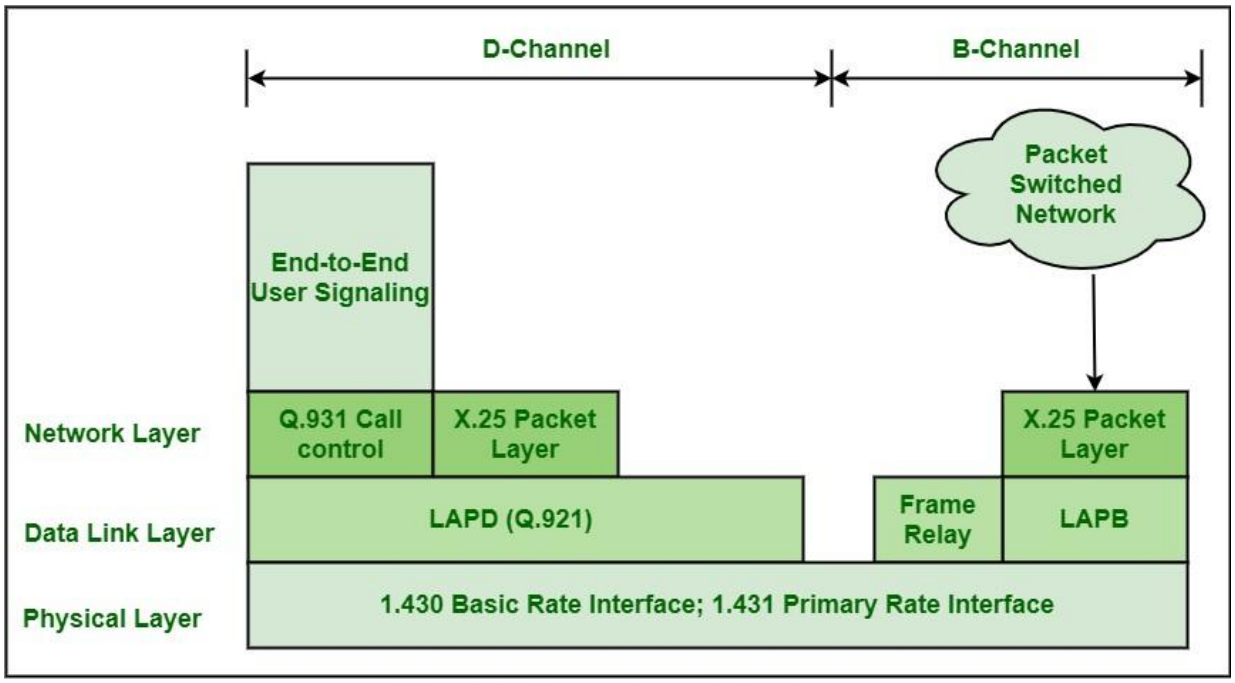
In Synchronous TDM, the input is connected to a frame. If there are 'n' number of connections, then the frame is divided into 'n' time slots. One slot is allocated for each input line. In this technique, the sampling rate is common to all signals and hence same clock input is given. The mux allocates the same slot to each device at all times.

Asynchronous TDM

In Asynchronous TDM, the sampling rate is different for each of the signals and the clock signal is also not in common. If the allotted device, for a time-slot, transmits nothing and sits idle, then that slot is allotted to another device, unlike synchronous. **17. Discuss about : ISDN Layers.**

Integrated Services Digital Network (ISDN) is simply considered as general-purpose digital network that is being capable of highly and fully supporting wide range of services like voice, data, text, and image with the help of very small set of standard multipurpose user-network interfaces. It is also useful in providing very useful framework for development and establishment of future telecommunications networks and services.

Previously, it is known as Integrated Digital Network (IDN) which is basically standardization digital technique for switching and transmission. ISDN also supports two types of switching operations i.e., circuit-switched operations and packet-switched operations. ISDN protocol architecture takes care of both of these switching operations. Circuit Switching is provided at the very nominal bit rate of 64 kbps whereas packet switching is provided for wide range of bit rates up to 64 kbps.



ISDN Protocol Architecture

Types of Channels :

ISDN generally contains three types of channels i.e., B-channel (Bearer channel), D-channel (Data Channel), and H-channel (Hybrid Channel).

1. **B-Channel :**
   B-channel usually has 64 kbps data rate. This channel is required for voice, data, or other low data rate information. For higher data rates, two B-channel will get combined to give total of 128 kbps data rates.
2. **D-Channel :**
   D-channel usually has 16 to 64 kbps data rate. This channel is required for signaling or packetswitched data. D-channel does not even carry data. It is simply required for carrying all of the controlling signals as establishing call, ringing, call interrupt, etc. It is common channel signaling that carries control signals for all of the using out-band signaling. Using this channel subscribes generally provide security to B connection. It is also required to carry data or information as videotext, tele-text, emergency services alarms, etc. in case of no signaling.
3. **H-Channel :**
   H-channel generally has kbps, 1536 kbps, or 1920 kbps data rate. This channel is required for video, video-conferencing, high-speed data/audio, etc.

Types of Layers :

ISDN usually contains two different layering mechanisms out of which one is for B/H Channels and other one for D Channel. For D-channel, ISDN contains three-layered protocol architecture. On the other hand, for B-channel, ISDN contains only one protocol layer i.e. physical layer and rest of upper layers are dependent on the application.

1. **Physical Layer :**
   At this layer, B and D channels are same and uses either BRI or PRI Interface. It defines various primary aspects such as mechanical and electrical specifications of interface R, S, T, and U, Encoding, or power supply, etc. It is also based in X.21 for interfacing with public circuit switching network through an 8-pin connector.
2. **Data Link Layer :**
   At this layer, B or D Channel generally uses LAPB or LAPD. B and D channels use different data link protocols i.e. LAPB For B channel and LAPD for D channel.
3. **Network Layer :**
   At this channel, B-channel has different options in connecting to circuit either circuit-switched, packet-switched, frame relay, or ATM networks.

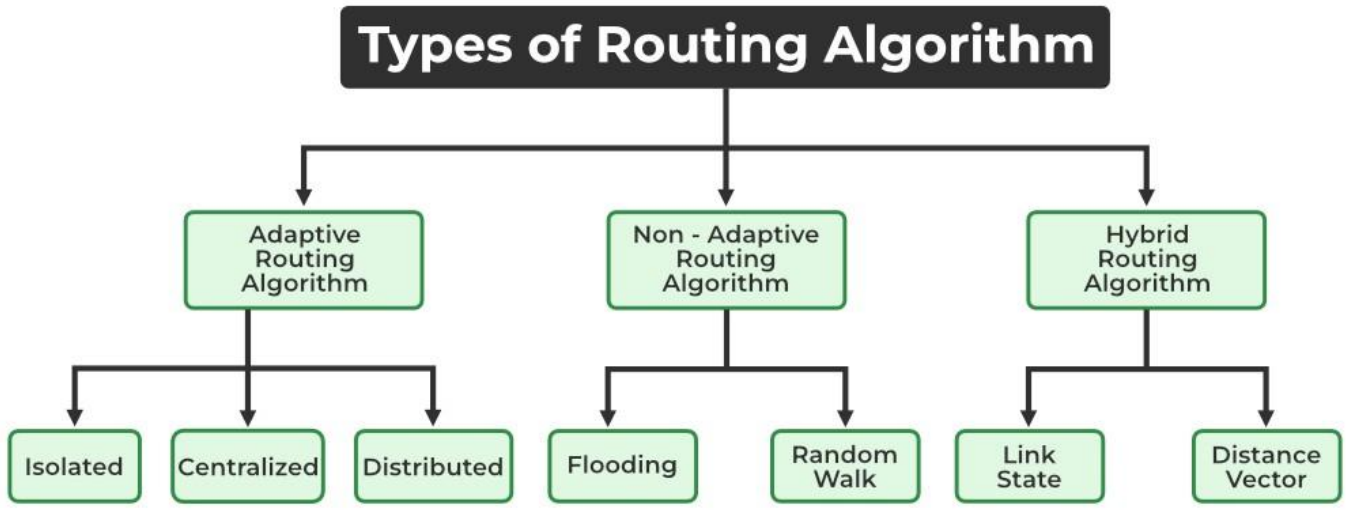
18. Explain about Routing Algorithm.

Routing is the process of establishing the routes that data packets must follow to reach the destination. In this process, a routing table is created which contains information regarding routes that data packets follow. Various routing algorithms are used for the purpose of deciding which route an incoming data packet needs to be transmitted on to reach the destination efficiently.

Classification of Routing Algorithms

The routing algorithms can be classified as follows:

1. Adaptive Algorithms
2. Non-Adaptive Algorithms
3. Hybrid Algorithms



Types of Routing Algorithm

1. Adaptive Algorithms

These are the algorithms that change their routing decisions whenever network topology or traffic load changes. The changes in routing decisions are reflected in the topology as well as the traffic of

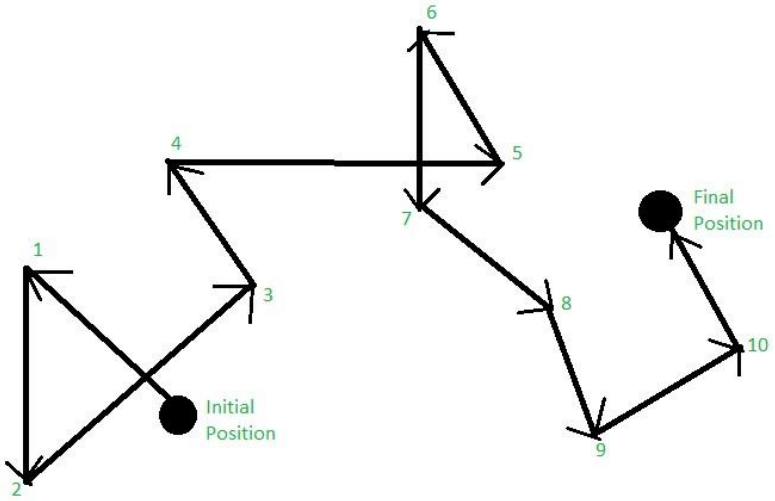
the network. Also known as dynamic routing, these make use of dynamic information such as current topology, load, delay, etc. to select routes. Optimization parameters are distance, number of hops, and estimated transit time. Further, these are classified as follows:

- **Isolated:** In this method each, node makes its routing decisions using the information it has without seeking information from other nodes. The sending nodes don't have information about the status of a particular link. The disadvantage is that packets may be sent through a congested network which may result in delay. Examples: Hot potato routing, and backward learning.
- **Centralized:** In this method, a centralized node has entire information about the network and makes all the routing decisions. The advantage of this is only one node is required to keep the information of the entire network and the disadvantage is that if the central node goes down the entire network is done. The link state algorithm is referred to as a centralized algorithm since it is aware of the cost of each link in the network.
- **Distributed:** In this method, the node receives information from its neighbors and then takes the decision about routing the packets. A disadvantage is that the packet may be delayed if there is a change in between intervals in which it receives information and sends packets. It is also known as a decentralized algorithm as it computes the least-cost path between source and destination.

2. Non-Adaptive Algorithms

These are the algorithms that do not change their routing decisions once they have been selected. This is also known as static routing as a route to be taken is computed in advance and downloaded to routers when a router is booted. Further, these are classified as follows:

- **Flooding:** This adapts the technique in which every incoming packet is sent on every outgoing line except from which it arrived. One problem with this is that packets may go in a loop and as a result of which a node may receive duplicate packets. These problems can be overcome with the help of sequence numbers, hop count, and spanning trees.
- **Random walk:** In this method, packets are sent host by host or node by node to one of its neighbors randomly. This is a highly robust method that is usually implemented by sending packets onto the link which is least queued.



Random Walk

3. Hybrid Algorithms

As the name suggests, these algorithms are a combination of both adaptive and non-adaptive algorithms. In this approach, the network is divided into several regions, and each region uses a different algorithm.

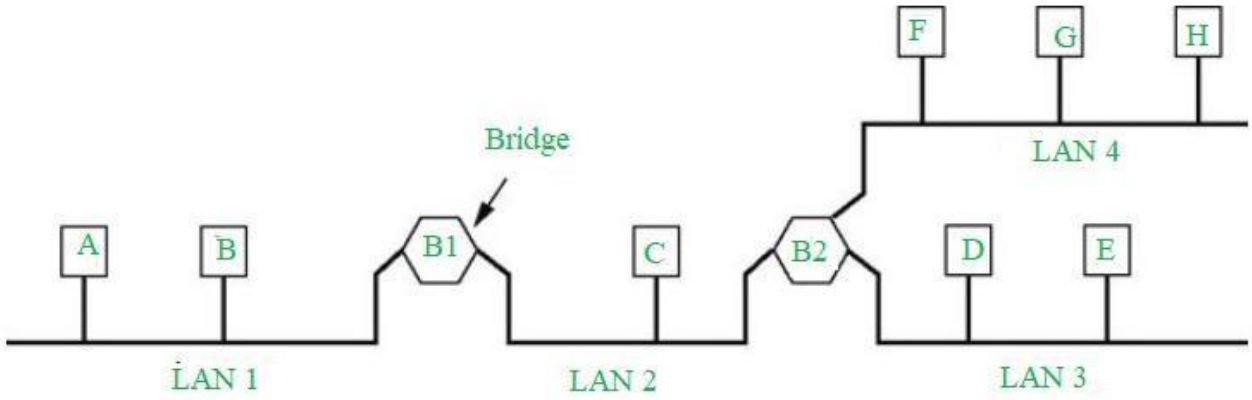
Further, these are classified as follows:

- Link-state: In this method, each router creates a detailed and complete map of the network which is then shared with all other routers. This allows for more accurate and efficient routing decisions to be made.
- Distance vector: In this method, each router maintains a table that contains information about the distance and direction to every other node in the network. This table is then shared with other routers in the network. The disadvantage of this method is that it may lead to routing loops.

19. Discuss about (a) Bridges

A bridge in a computer network is a device used to connect multiple LANs together with a larger Local Area Network (LAN). The mechanism of network aggregation is known as bridging. The bridge is a physical or hardware device but operates at the OSI model's data link layer and is also known as a layer of two switches.

The primary responsibility of a switch is to examine the incoming traffic and determine whether to filter or forward it. Basically, a bridge in computer networks is used to divide network connections into sections, now each section has separate bandwidth and a separate collision domain. Here bridge is used to improve network performance.



Types of Bridges:
There are three types of bridges in computer networks, which are as follows:

1. Transparent bridge
2. Source routing bridge
3. Translational bridge

Transparent Bridge:
Transparent bridges are invisible to other devices on the network. This bridge doesn't reconfigure the network on the addition or deletion of any station. The prime function of the transparent bridge is to block or forward the data according to the MAC address.

Source Routing Bridge:

Source routing bridges were developed and designed by IBM specifically for token ring networks. The frame's entire route is embedded with the data frames by the source station to perform the routing operation so that once the frame is forwarded it must follow a specific defined path/route.

Translational Bridge:

Translational bridges convert the received data from one networking system to another. Or it is used to communicate or transmit data between two different types of networking systems. Like if we are sending data from a token ring to an Ethernet cable, the translational cable will be used to connect both the networking system and transmit data.

Advantages:

- Bridges can be used as a network extension like they can connect two network topologies together.
- It has a separate collision domain, which results in increased bandwidth.
- It can create a buffer when different MAC protocols are there for different segments.
- Highly reliable and maintainable. The network can be divided into multiple LAN segments.
- Simple installation, no requirement of any extra hardware or software except the bridge itself.
- Protocol transparency is higher as compared to other protocols.

Disadvantages:

- Expensive as compared to hubs and repeaters.
- Slow in speed.
- Poor performance as additional processing is required to view the MAC address of the device on the network.
- As the traffic received is in bulk or is broadcasted traffic, individual filtering of data is not possible.
- During the broadcasting of data, the network has high broadcast traffic and broadcast storms can be formed.

Uses of Bridge in Computer Network:

- Bridges are used to increase the network capacity as they can integrate multiple LANs together.
- On receiving a data frame, databases use the bridge to decide whether to accept or reject the data.
- In the OSI model, it can be used to transmit the data to multiple nodes of the network.
- Used to broadcast the data even if the MAC address or destination address is unavailable.
- It forwards data packets despite faulty nodes.
- The data packet can be forwarded or discarded by the bridge when the MAC address is available.

Functions of Bridges in the Network

- The bridge is used to divide LANs into multiple segments.
- To control the traffic in the network.
- It can interconnect two LANs with a similar protocols.
- It can filter the data based on destination/MAC address.

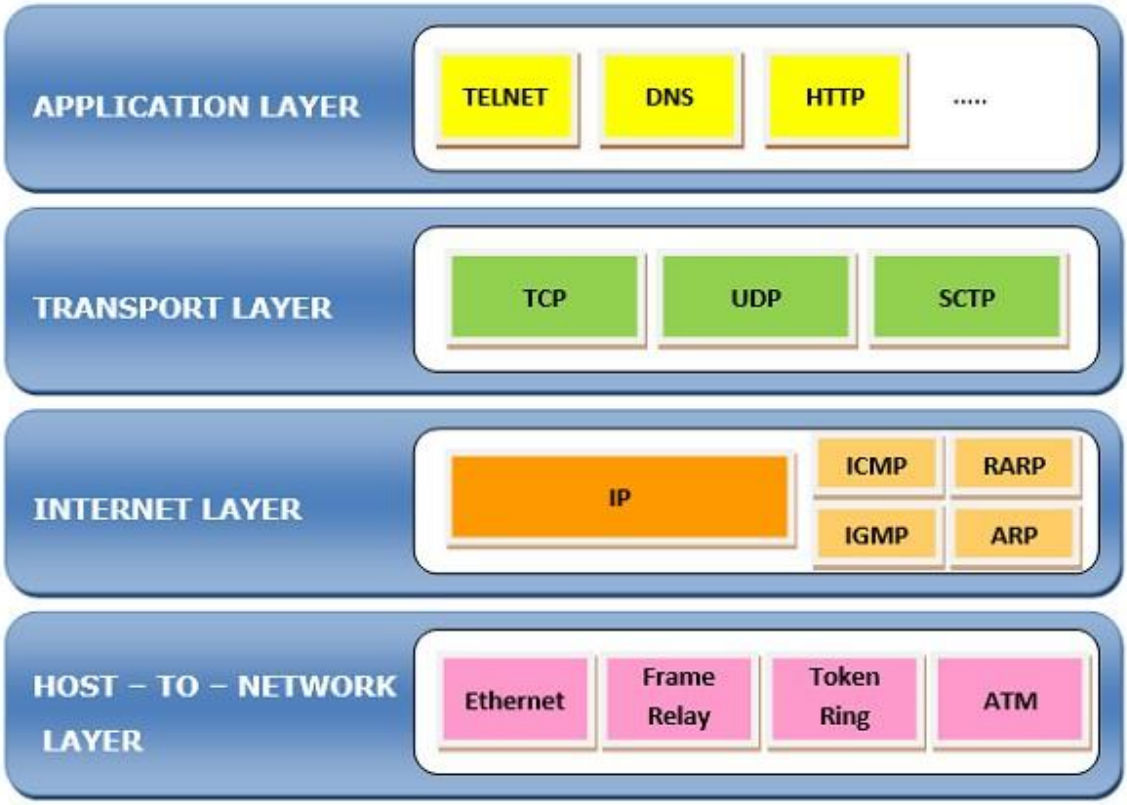
13. Explain the TCP / IP reference Model.

TCP/IP Reference Model is a four-layered suite of communication protocols. It was developed by the DoD (Department of Defence) in the 1960s. It is named after the two main protocols that are used in the model, namely, TCP and IP. **TCP** stands for "**Transmission Control Protocol**" and **IP** stands for "**Internet Protocol**".

The four layers in the TCP/IP protocol suite are −

1. **Host-to- Network Layer –**It is the lowest layer that is concerned with the physical transmission of data. TCP/IP does not specifically define any protocol here but supports all the standard protocols.
2. **Internet Layer –**It defines the protocols for logical transmission of data over the network. The main protocol in this layer is Internet Protocol (IP) and it is supported by the protocols ICMP, IGMP, RARP, and ARP.
3. **Transport Layer –** It is responsible for error-free end-to-end delivery of data. The protocols defined here are Transmission Control Protocol (TCP) and User Datagram Protocol (UDP).
4. **Application Layer –** This is the topmost layer and defines the interface of host programs with the transport layer services. This layer includes all high-level protocols like Telnet, DNS, HTTP, FTP, SMTP, etc.

   The following diagram shows the layers and the protocols in each of the layers −



15. Explain how guided Media differ from unguided Media.

Both guided and unguided media are used to transmit the signals or information. Their mediums are different, but their motive is to transfer the signals. Let’s discuss some more differences between guided and unguided media.

What is Guided Media:

Guided media is like a physical medium via which the signals are transmitted. The guided media is used to provide a conduit from one machine to another that can have twisted-pair, coaxial cable and fibre-optic cable. It is also known as Bounded media.

There are four types of Guided Media which are as follows:

- Open Wire
- Twisted Pair
- Coaxial Cable
- Optical Fibre

What is Unguided Media:

Unguided transmission media are techniques that allow transmission of electromagnetic waves through a wireless medium or we can say without using any physical medium. It provides a mechanism for transferring electromagnetic waves but does not direct them.

There are three types of Unguided Transmission Media which are as follows:

- Microwave Transmission
- Radio Transmission
- Infrared Transmission

Difference between Guided and Unguided Media

S.No.	Guided Media	Unguided Media
1.	In guided media, the signal energy communicates via wires.	In unguided media, the signal energy communicates through the air.

2.	Guided media is generally preferred when we want to execute direct communication.	Unguided media is generally preferred for radio broadcasting in all directions.
3.	The guided media formed the different network topologies.	The unguided media formed the continuous network topologies.
4.	Here, the signals are in the state of current and voltage.	Here, the signals are in the state of electromagnetic waves.
5.	In the case of guided media, the transmission capacity can be boosted by counting more wires.	In the case of unguided media, it is not feasible to acquire more capacity.
6.	Open Wire, Twisted Pair, Coaxial Cable, and Optical Fibre are the different kinds of guided media.	Microwave Transmission, Radio Transmission, and Infrared Transmission are the types of unguided media.

16. Explain about Connection Oriented Services.

Connection-Oriented Service is basically a technique that is typically used to transport and send data at session layer. The data streams or packets are transferred or delivered to receiver in a similar order in which they have seen transferred by sender. It is actually a data transfer method among two devices or computers in a different network, that is designed and developed after telephone system.

Whenever a network implements this service, it sends or transfers data or message from sender or source to receiver or destination in correct order and manner.
This connection service is generally provided by protocols of both network layer (signifies different path for various data packets that belongs to same message) as well as transport layer (use to exhibits independence among packets rather than different paths that various packets belong to same message will follow).

Operations :
There is a sequence of operations that are needed to b followed by users. These operations are given below :

1. **Establishing Connection –**
   It generally requires a session connection to be established just before any data is transported or sent with a direct physical connection among sessions.
2. **Transferring Data or Message –**
   When this session connection is established, then we transfer or send message or data.
3. **Releasing the Connection –**
   After sending or transferring data, we release connection.

Different Ways :
There are two ways in which connection-oriented services can be done. These ways are given below :

1. **Circuit-Switched Connection –**
   Circuit-switching networks or connections are generally known as connection-oriented networks. In this connection, a dedicated route is being established among sender and receiver, and whole data or message is sent through it. A dedicated physical route or a path or a circuit is established among all communication nodes, and after that, data stream or message is sent or transferred.

2. **Virtual Circuit-Switched Connection –**
   Virtual Circuit-Switched Connection or Virtual Circuit Switching is also known as ConnectionOriented Switching. In this connection, a preplanned route or path is established before data or messages are transferred or sent. The message Is transferred over this network is such a way that it seems to user that there is a dedicated route or path from source or sender to destination or receiver.

Types of Connection-Oriented Service :

Service	Example
Reliable Message Stream	Sequence of pages, etc.
Reliable Byte Stream	Song Download, etc.
Unreliable Connection	VoIP (Voice Over Internet Protocol)

Advantages :

- It kindly support for quality of service is an easy way.
- This connection is more reliable than connectionless service.
- Long and large messages can be divided into various smaller messages so that it can fit inside packets.
- Problems or issues that are related to duplicate data packets are made less severe.

Disadvantages :

- In this connection, cost is fixed no matter how traffic is.
- It is necessary to have resource allocation before communication.
- If any route or path failures or network congestions arise, there is no alternative way available to continue communication.

17. List the advantages of ATM Topology.

ATM (Asynchronous Transfer Mode) topology refers to the physical and logical arrangement of ATM networks. While ATM technology is less common today than it was in the past, it had some advantages that made it suitable for certain applications. Here are some advantages of ATM topology:

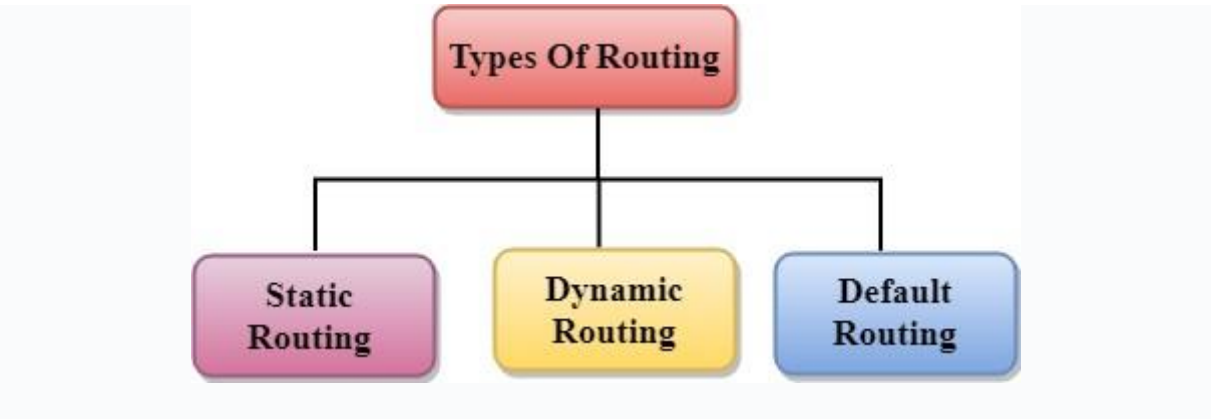
1. High Bandwidth: ATM networks could provide high bandwidth, making them suitable for data, voice, and video applications. This high bandwidth allowed for the transmission of large amounts of data at high speeds.
2. Quality of Service (QoS): ATM offered strict Quality of Service guarantees, ensuring predictable and consistent network performance. This made it suitable for real-time applications such as voice and video conferencing.
3. Scalability: ATM networks could be easily scaled to accommodate increased network traffic by adding more switches and connections.
4. Low Latency: ATM networks had low latency, which is important for real-time applications where delay can disrupt communication quality.
5. Error Correction: ATM incorporated error correction and fault tolerance mechanisms to ensure data integrity and reliability.
6. Multiservice Support: ATM supported various types of traffic, including data, voice, and video, on the same network, making it a versatile option for integrated services.
7. Virtual Circuits: ATM used virtual circuits, which allowed for efficient routing of data and traffic management. Permanent Virtual Circuits (PVCs) and Switched Virtual Circuits (SVCs) provided flexibility in network configuration.
8. Prioritization: ATM allowed for traffic prioritization, ensuring that critical applications received the necessary resources and bandwidth to operate smoothly.
9. Broadband Support: ATM was well-suited for broadband services due to its high data rates, making it suitable for applications such as DSL and fiber optics.
10. Low Overhead: ATM had relatively low overhead compared to some other networking technologies, making it an efficient choice for data transmission.
11. Reliability: ATM networks were designed to be highly reliable, with built-in redundancy and fault tolerance features.
12. Security: ATM networks provided a level of security through features like virtual circuits and encryption, making it harder for unauthorized access.

19. Write a brief note on Routing.

Routing is a fundamental concept in computer networking that involves the process of determining the path or route that data packets should follow to reach their destination in a network. It plays a crucial role in ensuring that data is efficiently and effectively transmitted from the source to the destination, whether it's within a local area network (LAN), a wide area network (WAN), or the global Internet. Here's a brief overview of routing:

- A Router is a process of selecting path along which the data can be transferred from source to the destination. Routing is performed by a special device known as a router.
- A Router works at the network layer in the OSI model and internet layer in TCP/IP model
- A router is a 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 algorithm to determine the optimal path to the destination. ○ The routing algorithm initializes and maintains the routing table for the process of path determination.

- Static Routing ○ Default Routing
- Dynamic Routing



Static Routing

- Static Routing is also known as Nonadaptive Routing.
- It is a technique in which the administrator manually adds the routes in a routing table.

- A Router can send the packets for the destination along the route defined by the administrator. ○ In this technique, routing decisions are not made based on the condition or topology of the networks

Default Routing

- Default Routing is a technique in which a router is configured to send all the packets to the same hop device, and it doesn't matter whether it belongs to a particular network or not. A Packet is transmitted to the device for which it is configured in default routing.
- Default Routing is used when networks deal with the single exit point.
- It is also useful when the bulk of transmission networks have to transmit the data to the same hp device.
- When a specific route is mentioned in the routing table, the router will choose the specific route rather than the default route. The default route is chosen only when a specific route is not mentioned in the routing table.

Dynamic Routing ○ It is also known as

Adaptive Routing.

- It is a technique in which a router adds a new route in the routing table for each packet in response to the changes in the condition or topology of the network.
- Dynamic protocols are used to discover the new routes to reach the destination.
- In Dynamic Routing, RIP and OSPF are the protocols used to discover the new routes.
- If any route goes down, then the automatic adjustment will be made to reach the destination.

14.Describe parallel and serial Transmission Techniques:

What is data transmission:

Data transmission refers to the process of transferring data between two or more digital devices. Data is transmitted from one device to another in analog or digital format. Basically, data transmission enables devices or components within devices to speak to each other.

How does data transmission work between digital devices:

Data is transferred in the form of bits between two or more digital devices. There are two methods used to transmit data between digital devices: serial transmission and parallel transmission. Serial data transmission sends data bits one after another over a single channel. Parallel data transmission sends multiple data bits at the same time over multiple channels.

What is serial transmission:

When data is sent or received using serial data transmission, the data bits are organized in a specific order, since they can only be sent one after another. The order of the data bits is important as it dictates how the transmission is organized when it is received. It is viewed as a reliable data transmission method because a data bit is only sent if the previous data bit has already been received.

Example of Serial Data Transmission

Serial transmission has two classifications: asynchronous and synchronous.

Asynchronous Serial Transmission

Data bits can be sent at any point in time. Stop bits and start bits are used between data bytes to synchronize the transmitter and receiver and to ensure that the data is transmitted correctly. The time between sending and receiving data bits is not constant, so gaps are used to provide time between transmissions.

The advantage of using the asynchronous method is that no synchronization is required between the transmitter and receiver devices. It is also a more cost effective method. A disadvantage is that data transmission can be slower, but this is not always the case.

Synchronous Serial Transmission

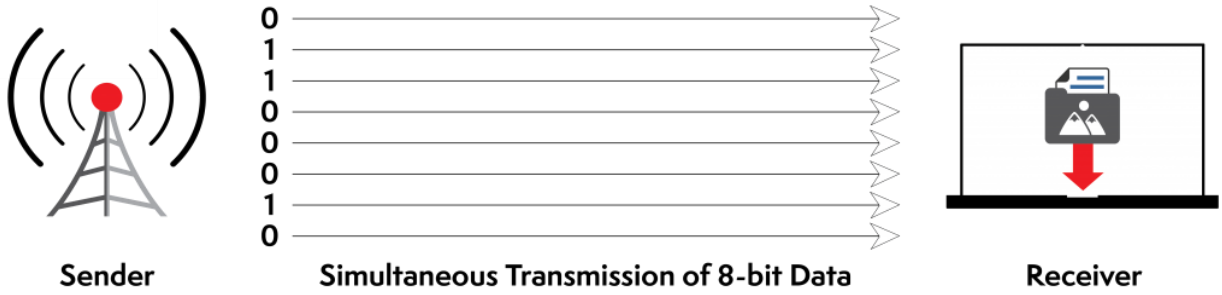
Data bits are transmitted as a continuous stream in time with a master clock. The data transmitter and receiver both operate using a synchronized clock frequency; therefore, start bits, stop bits, and gaps are not used. This means that data moves faster and timing errors are less frequent because the transmitter and receiver time is synced. However, data accuracy is highly dependent on timing being synced correctly between devices. In comparison with asynchronous serial transmission, this method is usually more expensive.

When is serial transmission used to send data:

Serial transmission is normally used for long-distance data transfer. It is also used in cases where the amount of data being sent is relatively small. It ensures that data integrity is maintained as it transmits the data bits in a specific order, one after another. In this way, data bits are received insync with one another.

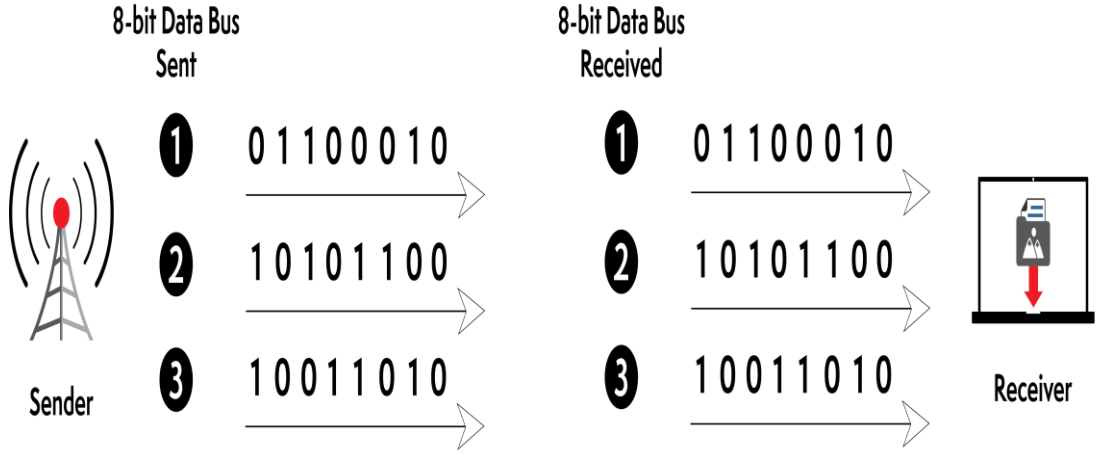
What is parallel transmission:

When data is sent using parallel data transmission, multiple data bits are transmitted over multiple channels at the same time. This means that data can be sent much faster than using serial transmission methods.

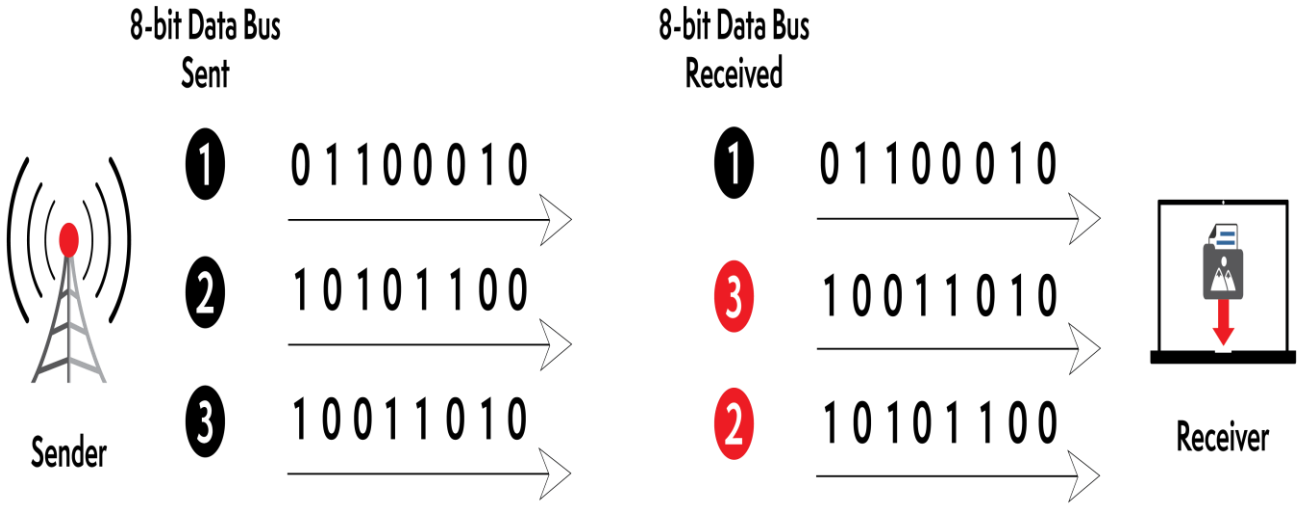


Example of Parallel Data Transmission

Given that multiple bits are sent over multiple channels at the same time, the order in which a bit string is received can depend on various conditions, such as proximity to the data source, user location, and bandwidth availability. Two examples of parallel interfaces can be seen below. In the first parallel interface, the data is sent and received in the correct order. In the second parallel interface, the data is sent in the correct order, but some bits were received faster than others.



Example of Parallel Transmission – Data Received Correctly



Example of Parallel Transmission – Data Received Incorrectly