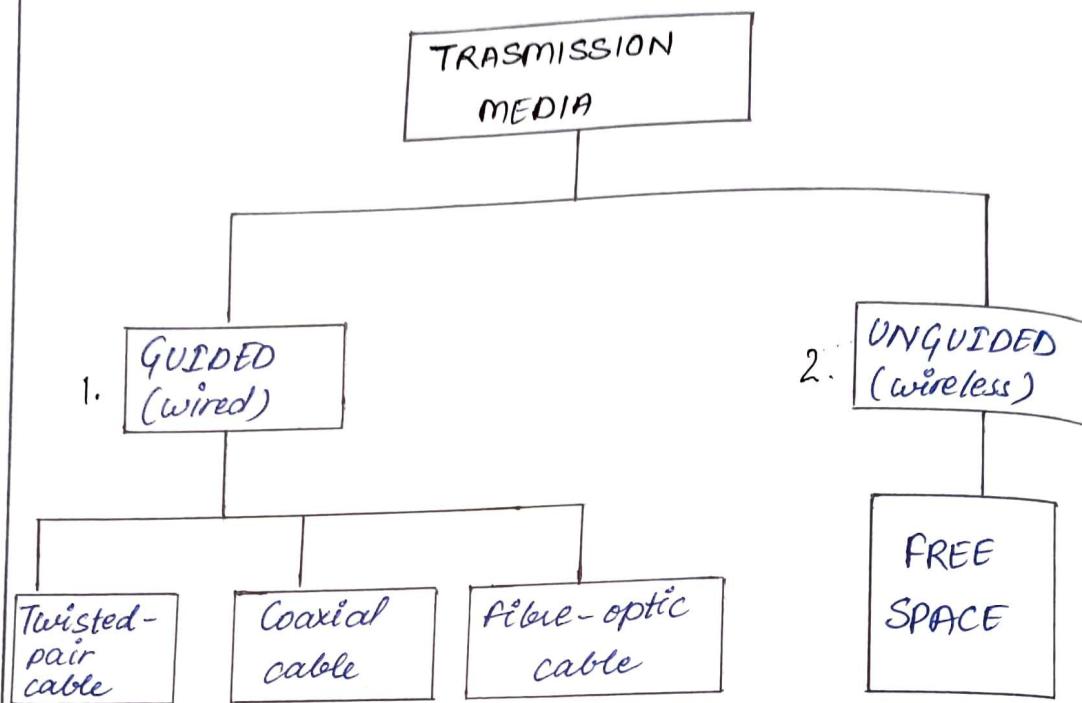


* TRANSMISSION MEDIA

- Transmission media / medium is the way to translate or transmit data from source to destination or one place to another.
- It provides a path way over which the message can be transmitted from sender to receiver.
- Each of the message can be send in the form of data by converting them into binary digits.
- These binary digits are then encoded into a signal that can be transmitted over the appropriated medium.
- In simply words, we can say that A transmission medium can be broadly defined as anything that can carry information from a source to a destination .
- for Example : The transmission medium for two people having a dinner conversation is the air. The air can also be used to convey the message in a smoke signal or semaphore.
- For a written message, the transmission medium might be a mail carrier, a truck, or an airplane .
- The transmission medium is usually free space, metallic cable, or fibre-optic cable .
- Transmission media can be divided into two broad categories : guided and unguided. Guided media include twisted-pair cable, coaxialcable, and fibre-optic cable. Unguided medium is free space .

* CLASSES OF TRANSMISSION MEDIA

- Diagram shows this taxonomy.



1. GUIDED MEDIA

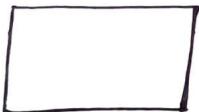
- Guided media, which are those that provide a conduit from one device to another, include twisted-pair cable, coaxial cable, and fibre-optic cable.
- A signal traveling along any of these media is directed and contained by the physical limits of the medium.
- Guided media are the cables that are tangible or physical existence.
- Twisted-pair and coaxial cable use metallic (copper) conductors that accept and transport signals in the form of electric current.
- Optical fibre is a cable that accepts and transports signals in the form of light.

3

i) Twisted Pair Cable

- A twisted pair cable is a pair of copper wire.
- Twisted pair is a physical media made up of a pair of cables twisted with each other.
- A twisted pair cable is cheap as compared to other transmission media.
- Installation of the twisted pair cable is easy, and it is a lightweight cable.
- The frequency range for twisted pair cable is from 0 to 3.5 kHz.
- A twisted pair consists of two insulated copper wires arranged in a regular spiral pattern.
- The degree of reduction in noise interference is determined by the number of turns per foot.
- Increasing the number of turns per foot decreases noise interference.

Jacket

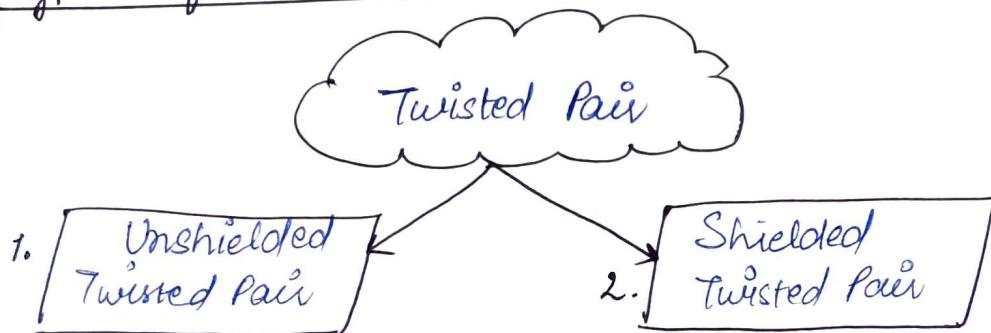


Twisted Pair

Bare Wire



Types of Twisted Pair



* Unshielded Twisted Pair

- An unshielded twisted pair is widely used in the telecommunication.
- following are the categories of the unshielded twisted pair cable:

Category 1: It is used for telephone lines that have low-speed data.

Category 2: It can support upto 4 Mbps.

Category 3: It can support upto 16 Mbps.

Category 4: It can support upto 20 Mbps. Therefore, it can be used for long-distance communication.

Category 5: It can support upto 200 Mbps.

→ Advantages of UTP

- It is cheap.
- Installation of UTP is easy.
- It can be used for high-speed LAN.

→ Disadvantages of UTP

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

⇒ Shielded Twisted Pair

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

⇒ It's Characteristics of STP

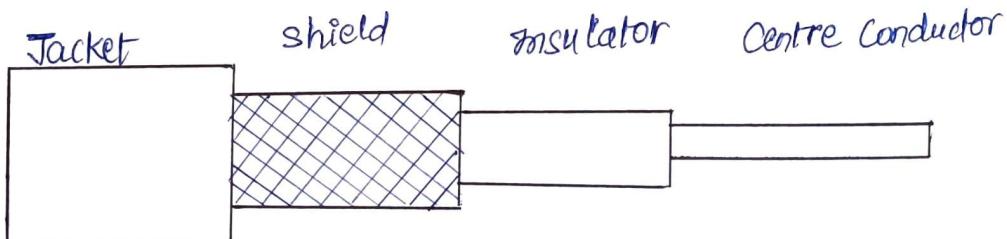
- The cost of STP cable is not very high and not very low.
- An installation of STP is easy.
- It has higher capacity as compared to unshielded twisted pair cable.
- It has a higher attenuation.
- It is shielded that provided the higher data transmission rate.

⇒ Disadvantages of STP

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

* Coaxial Cable

- Coaxial cable is very commonly used transmission media, for example, TV wire is usually a coaxial cable.
- The name of the cable is coaxial as it contains two conductors parallel to each other.
- It has a higher frequency as compared to Twisted pair cable.
- The inner conductor of the coaxial cable is made up of copper, and the outer conductor is made up of copper mesh. The middle core is made up of non-conductive cover that separates the inner conductor from the outer conductor.
- The middle core is responsible for the data transfering whereas the copper mesh pose prevents form the EMI (Electromagnetic interference).



→ Coaxial Cable is of two types

1. Baseband transmission: It is defined as the process of transmitting a single signal at high speed.
2. Broadband transmission: It is defined as the process of transmitting multiple signals simultaneously.

7

→ Advantages of Coaxial Cable

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

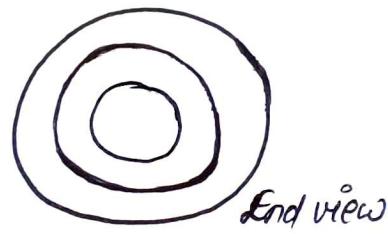
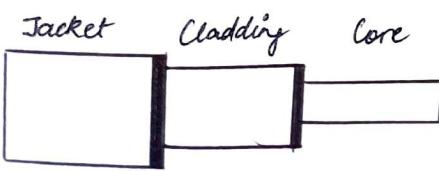
→ Disadvantages

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

★ FIBRE OPTIC

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

★ Diagrammatic Representation of Fibre optic cable



→ Basic Elements of Fibre Optic Cable

- CORE: The optical fibre consists of a narrow strand of glass or plastic known as a core.
- A core is a light transmission area of the fibre. The more the area of the core, the more light will be transmitted into the fibre.
- CLADDING: The concentric layer of glass is known as cladding. The main functionality of the cladding is to provide the lower refractive index at the core interface so to cause the reflection within the core so that the light waves are transmitted through the fibre.
- JACKET: The protective coating consisting of plastic is known as a jacket. The main purpose of a jacket is to preserve the fibre strength, absorb shock and extra fibre protection.

→ Following are the advantages of fibre optic cable over copper

- Greater Bandwidth: The fibre optic cable provides more bandwidth as compared copper. Therefore, the fibre optic carries more data as compared to copper cable.
- faster Speed: fibre optic cable carries the data in the form of light. This allows the fibre optic cable to carry the signals at a higher speed.
- Longer distances: The fibre optic cable carries the data at a longer distance as compared to copper cable.

- Better reliability: The fibre optic cable is more reliable than the copper cable as it is immune to any temperature changes while it can cause obstruct in the connectivity of copper cable.
- Thinner and Sturdier: fibre optic cable is thinner and lighter in weight so it can withstand more pull pressure than copper cable.

→ Disadvantages =

- Economic Evaluation is the major practical problem with fibre optics is that it usually costs more than ordinary wires.
- Sophisticated tools and methods for installation.
- Complex to layout and design.

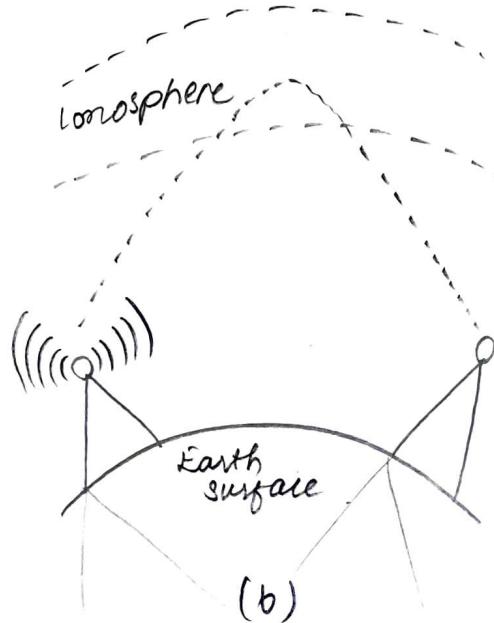
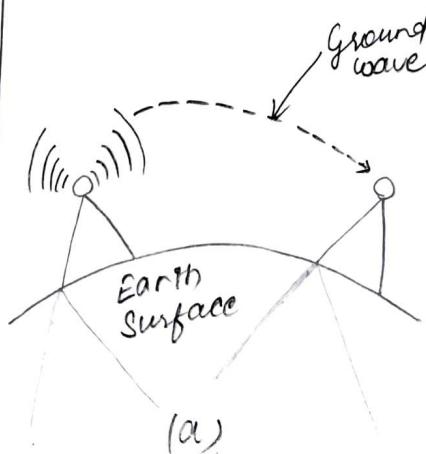
II. UNGUIDED TRANSMISSION

- An unguided transmission transmit the electromagnetic waves without using any physical medium.
- Therefore, it is also known as wireless transmission.
- In unguided media, air is the media through which the electromagnetic energy can flow easily.
- Signals are normally broadcast through free space and thus are available to anyone who has a device capable of receiving them.

- Unguided transmission is broadly classified into 3 categories :
 - a) Radio Waves
 - b) Microwaves
 - c) Infrared

★ Radio Waves

- Radio waves are the electromagnetic waves that are transmitted in all the directions of free space.
- Radio waves are omnidirectional, i.e., the signals are propagated in all the directions.
- The range of frequencies of radio waves is from 3 kHz to 1 MHz.
- In the case of radio waves, the sending & receiving antenna are not aligned, i.e., the wave sent by the sending antenna can be received by any receiving antenna.
- An example of the radio wave is FM radio.



11) Applications Of Radio Waves

- A radio wave is useful for multicasting when there is one sender and many receivers.
- An FM radio, television, cordless phones are the examples of a radio wave.

→ Advantages

- Radio transmission is mainly used for wide area networks (WAN) and mobile cellular phones.
- Radio waves cover a large area, and they can penetrate the walls.
- Radio transmission provides a higher transmission rate.

★ Microwaves *

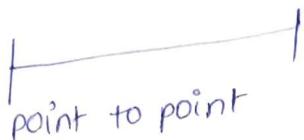
- Microwaves are used for unicast communication such as telephone and wireless lane.
- Microwaves used single directional antennas.
- In other hand, point-to-point communication is possible through microwaves.

→ Advantages

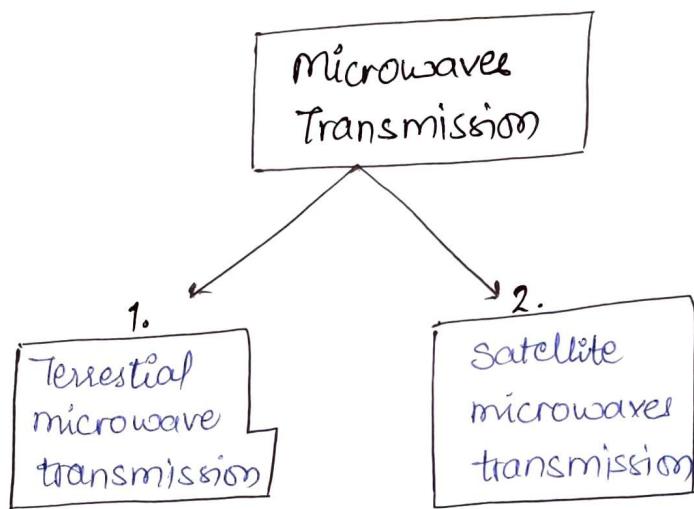
- i) Low-power requirement.
- ii) Minimum cross talk.
- iii) More secure.

⇒ Disadvantages

- i) Unidirectional
- ii) Difficult to analysis and design.



❖ Microwaves are of two types :



a) Terrestrial Microwave Transmission (TMT)

- TMT is a technology that transmits the focused beam of a radio signal from one ground-based microwave transmission antenna to another.
- Microwaves are the electromagnetic waves having the frequency in the range from 1GHz to 1000 GHz.
- Microwaves are unidirectional as the sending and receiving antenna is to be aligned, i.e., the waves sent by the sending antenna are narrowly focussed.

13

- In this case, antennas are mounted on the towers to send a beam to another antenna which is km away.
- It works on the line of sight transmission, i.e., the antennas mounted on the towers are direct sight of each other.

⇒ Characteristics of Microwave

- i) Frequency range: It is from 4 to 6 GHz to 21-23 GHz.
- ii) Bandwidth: It supports the bandwidth from 1 to 10 Mbps.
- iii) Short distance: It is inexpensive for short distance.
- iv) Long distance: It is expensive as it requires a higher tower for a longer distance.
- v) Attenuation: It means loss of signal. It is affected by environmental conditions and antenna size.

⇒ Advantages of Microwave

- It is cheaper than using cables.
- It is free from land acquisition as it does not require any land for the installation of cables.
- It provides an easy communication in terrains as the installation of cable in terrain is quite a difficult task.
- Communication over oceans can be achieved by using microwave transmission.

⇒ Disadvantages of Microwave

- Eavesdropping: It creates insecure communication. Any malicious user can catch the signal in the air by using its own antenna.
- Out of phase signals: A signal can be moved out of phase by using microwave transmission.
- Susceptible to weather condition: It is susceptible to weather condition. This means that any environmental change such as rain, wind can distort the signal.
- Bandwidth Limited: Allocation of bandwidth is limited in the case of microwave transmission.

* Satellite Microwave Communication :

- A satellite is a physical object that revolves around the earth at a known height.
- It is more reliable nowadays as it offers more flexibility than cable and fibre optic systems.
- We can communicate with any point on the globe by using satellite communication.

* How Does Satellite work?

→ The satellite accepts the signals that is transmitted from the earth station, and it amplifies the signal. It is retransmitted to another earth station.

❖ Infrared Wave:

- An infrared transmission is a wireless technology used for communication over short ranges.
- The frequency of the infrared is in the range from 300 GHz to 400 GHz.
- It is used for short-range communication such as data transfer b/w two cell phones, TV remote operation, data transfer b/w a computer and cell phone resides in the same closed area.

⇒ Characteristics of Infrared

- It supports high bandwidth, and hence the data rate will be very high.
- It cannot penetrate the walls. Therefore, infrared communication in one room cannot be interrupted by the nearby rooms.
- An infrared communication provides better security with minimum interference.
- It is unreliable outside the building because the sun rays will interfere with the infrared waves.

⇒ Advantages of Satellite Microwave Communication

- The coverage area of a satellite microwave is more than the terrestrial microwave.
- The transmission cost of the satellite is independent of the distance from the centre of the coverage area.
- Satellite communication is used in mobile and wireless communication applications.
- It is easy to install.
- It is used in a wide variety of applications such as weather forecasting, radio / TV signal broadcasting, mobile communication etc.

⇒ Disadvantages

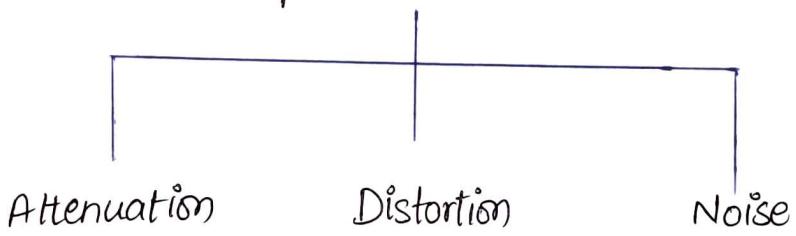
- Satellite designing and development requires more time and higher cost.
- The satellite needs to be monitored and controlled on regular periods so that it remains in orbit.
- The life of satellite is about 12-15 years. Due to this reason, another launch of the satellite has to be planned before it becomes non-functional.

* TRANSMISSION IMPAIRMENT IN DATA COMMUNICATION

- 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

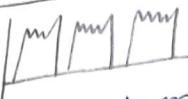
Impairment Causes



* 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 & 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 other wire.
 - Impulse noise is a signal with high energy that comes from lightning or power lines.

* 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 that's why it delay in arriving at the final destination.
- Each Every component arrive at different time which leads to distortion.
- Therefore , they have different phases at receiver end from what they had at sender end.

* THROUGHPUT

- Throughput can be defined as the actual measure of data transmitted in a specific period of time.
- Instead of providing the theoretical delivery of packets , throughput gives a practical measurement of the actual delivery.
- Throughput can be affected by the network traffic , transmission errors , change in interference , or the network devices .
- Throughput ~~is~~ is dependent on latency . The term latency is used to measure delay . After being transmitted , the time taken for a packet to reach its destiny is said to be delay .

⇒ ATTENUATION



- Attenuation is the loss of signal strength, caused by internal or external factor, in networking connections.
- In data communications, cables and connections are responsible for producing your WI-FI signal and keeping it strong.
- for Example - It occurs when you're at a coffee shop.
- for instance, dark glasses attenuate sunlight, water and air attenuates both light and sound at variable attenuation rates.

⇒ How Attenuation can be prevented?

- The most common way to prevent attenuation is use of repeaters which will regenerate the signal if the signal received is weak hence reduced attenuation.
- The cable should be checked during manufacturing and installations to prevent bending and imperfections so that losses can be minimized.
- Another way of reducing attenuation is amplification. Amplification is more effective than repeaters bcoz it only increases the amplitude (strength) of signal when the received signal is weak.
- Use of error correcting codes so as to maintain data reliability.

- Use of high quality fibre optics with better design to have low attenuation coefficient and reduce intrinsic losses.

- Communication should be done over a particular frequency so as to reduce electromagnetic interference.

∴

⇒ When we prevent attenuation we have certain advantages. The first advantage is that less power is consumed as power can be saved when signal is transmitted without any obstacle thus reducing operational costs. Also it will provide higher data integrity and reliability as chances of wrong data transmission will be reduced.

Advantages of Attenuation

- It can be used for control of signal strength, in the applications where strong signal need to be attenuated for proper operation.
- It can be used for noise reduction. Unwanted noise can be removed using attenuation for better quality signal transmission.

Disadvantages

- Loss of signal as this leads to poor signal quality and loss of data.
- It leads to reduction in distance over which signal can be transmitted. This poses as a challenge for long range communication.

21

- It can be measured at every layer of the OSI Model.
- It can also be measured in bits per second (bps).
- It is the actual delivery of the packet data over a communication channel.
- Throughput is the achieved value.
- In other words, we can define as throughput in computer networks is the rate at which data is transferred from one location to another in a given amount of time.

* PROPAGATION SPEED AND TIME

- The speed of propagation is the distance the wave travels in a given time, which is one wavelength in a time of one period.
- Propagation time refers to the duration it takes for an error to spread to the service interface in a processor component, with different components having varying manifestation times.
It is measured in nanosecond (ns).

★ WAVELENGTH

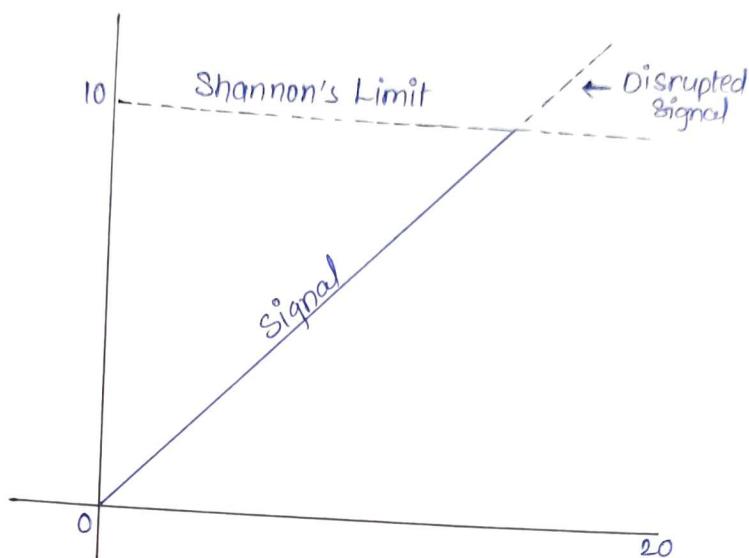
- Wavelength in computer network refers to the distance b/w identical points in a waveform signals that travels through space or along a wire.
- wavelength is usually measured in nanometers (nm) or billionths of a meter.
- wavelength technology uses light to transmit data through fibre optic cable, which provides secure, private and dedicated point-to-point connectivity.
- This type of data transfer is called wavelength-division multiplexing (WDM).
- Wavelength technology has several advantages, including high speed, security and reliability.

★ SHANNON CAPACITY

- Shannon Capacity or Shannon's Channel Capacity theorem, is a fundamental concept in information theory that defines the maximum rate at which information can be transmitted over a noisy channel without errors.
- The theorem was developed in the 1940s by Claude Shannon and Warren Weaver.

23

- Let us understand this theorem with the help of a diagram.



- In this diagram, the signal reaching from point 0-10, 0-20 has a theoretical limit beyond which it may encounter several error, data loss or packet loss.
- Shannon theorem has helped us derived this theoretical limit, also this signal can be produced with noise, bcz noiseless communication is expensive.
- Such communications will not disrupt the signal in anyway, this is also another advantages of shannon theorem.
- Some common terms related to Shannon Capacity
- Channel: A channel is a medium used to transmit signals, data or any information.
- Noise: A noise is any unwanted signal which can negatively impact the quality of any transmission.
- Shannon's Limit: It is a theoretical limit which tells us the maximum capacity for a signal to be transmitted through a channel.

- Statement of the Theorem:

It states that the maximum rate at which information can be transmitted over a communication channel of a specified bandwidth in the presence of noise.

$$C = B \log_2 (1 + S/N)$$

- C is the channel capacity in bits per second.
- B is bandwidth of the channel.
- S is average received signal.
- N is average power of noise.
- S/N is signal to noise ratio.

It's Applications

- Telecommunications: The theorem helps maintain the capacity of any telecommunication channel which can help in error-less communication and aid engineers or system architects to build a better model.
- In Wireless Communications: This theorem helps us calculate the maximum data that can be transferred in a wireless channel without error or data loss.
- Digital Signals: Shannon Theorem is also used in signals to calculate the amount of information that can be recovered from a signal with a particular noise.
- Audio and Video compression.
- Storage and Maintenance method of data.

- Errorless Channel: Due to noise an errorless channel may not be possible considering this theorem only provides conceptual proof.
- Increased Complexity: This Theorem may increase complexity since deriving a channel capacity requires complex and expensive methods which can largely impact the complexity of data communications.
- Limited Scope: This theorem only considers noise while modern communication faces a lots of other challenges such as interference, fading, packet loss and security concerns.

Comparison of Transmission Media:

- The comparison is held in between two type of transmission media that are
 - 1° Guided media and
 - 2° Unguided media.
- ⇒ Guided media - In this type of media, signal energy is enclosed and guided within a solid medium.
- The guided media is used either for point to point links or a shared link with various connections.
- In this, interference is generated by emissions in the adjacent cables.
- Proper shielding of guided media is required to reduce the interference issue.

* Advantages of Shannon Capacity :

- Structured framework: It breaks down communication processes into components such as sender, message, channel, noise, receiver and feedback.
- Enables enhanced communication: It helps boost the communication by outlining the major aspects that may cause an error in communication and make the functioning easier.
- Clarity and Simplicity: It provides a straightforward way of communication and can be understood by any new scholar or practitioner.
- Flexible: This capacity provides a wide range of applications ranging from high speed data transfer to simple voice communication.
- Cost effective: This capacity allows us to use noisy channels which are most cost effective as compared to noiseless channel.

* It's Disadvantages

- longer Delays: This capacity may cause delays considerably as it requires theoretical proof to proceed with the communication inside a channel.
- Error Rate Increases with Information Rate: This theorem may be error prone if the amount of information increases.

⇒ Unguided Media: The signal energy propagates through a wireless medium.

- It is used for radio broadcasting in all directions.
- Microwave links are chosen for long distance broadcasting transmission unguided media.
- Interference is also a problem in unguided media, overlapping frequency bands from competing signals can alter or eliminate a signal.
- Let's see the comparison b/w the guided and unguided media.

S. No.	GUIDED MEDIA	UNGUIDED MEDIA
1.	It is also called wired communication or bounded transmission media.	It is also called wireless communication or unbounded transmission media.
2.	The signal energy propagates through wires in guided media.	The signal energy propagates through the air in unguided media.
3.	It is cost-effective.	It is expensive.
4.	Discrete network topologies are formed by the guided media.	Continuous network topologies are formed by unguided media.
5.	It is used for point-to-point communication.	It is generally suited for radio broadcasting in all directions.
6.	Signals are in form of voltage, current or photons in the guided media.	Signals are in form of electromagnetic waves in the unguided media.

S. No.	GUIDED MEDIA	UNGUIDED MEDIA
7.	Example - twisted-pair wires, coaxial cables, optical fibre cables.	Example - microwave or radio links and infrared light.
8.	By adding more wires, transmission capacity can be increased in this media.	It is not possible to obtain additional capacity in unguided media.
9.	It sends out a signal that indicates which way to go.	It does not indicate which way to travel.
10.	For a shorter distance, this is the best option.	For longer distances, this method is used.
11.	It is unable to pass through walls.	It can pass through walls.