Unit-8

1) **What are the characteristics of different guided media used in the network?**
   Answer: -
   A) **Transmission characteristics of Twisted Pair Cable**
      a) Requires amplifiers for analog signals.
      b) Requires repeaters for digital signals.
      c) Attenuation is a strong function of frequency.
      d) Higher frequency implies higher attenuation.
      e) Susceptible to interference and noise.
      f) Improvement possibilities.
      g) Shielding with metallic braids or sheathing reduces interference.
      h) Twisting reduces low frequency interference.
      i) Different twist length in adjacent pairs reduces crosstalk.

   B) **Transmission characteristics Co-axial Cable**
      a) Used to transmit both analog and digital signals.
      b) Superior frequency characteristics compared to twisted pair.
      c) Can support higher frequencies and data rates.
      d) Shielded concentric construction makes it less susceptible to interference and crosstalk than twisted pair.
      e) Constraints on performance are attenuation, thermal noise, and intermodulation noise.
      f) Requires amplifiers every few kilometers for long distance transmission.
      g) Usable spectrum for analog signaling up to 500 MHz.
      h) Requires repeaters every few kilometers for digital transmission.
      i) For both analog and digital transmission, closer spacing is necessary for higher frequencies/data rates.

2) **What are the guided and unguided media? Explain the twisted pair and optical fibers as guided medium?**
   Answer: -
   A) The computer and other communicating devices represent data in the form of signals. The signals transmit between communicating devices in the form of electromagnetic energy, and hence the signals are called **electromagnetic signals**. Electromagnetic signals are the combination of electric and magnetic fields that vibrates in relation to each other. The electromagnetic signals can travel through various transmission media. The transmission media is broadly classified into two categories that are **guided** and **unguided media**.
   B) The basic difference between guided and unguided media is that in the **guided media**, the signal travels through a physical medium whereas, in **unguided media,** the signal travels through the air.
   C) Definition of Guided Media
   D) Guided transmission media are more commonly known as the **wired communication** or **bounded transmission media.** The electromagnetic signals travel between the communicating devices through a physical medium/conductor. As the medium for transmission is a physical conductor, it also provides **direction**

to the signal. But there are physical limitations of the conductor in the guided media. Like the length of the conductor, its installation cost, its maintenance, etc.

E) The guided media is categorized further into three categories that are **twisted-pair cable, coaxial cable** and **fiber-optic cable**. The twisted pair cable has two conductors wires wounded around each other and each surrounded by an insulating material. The twisted pair cable is flexible and easy to install. But it has *low bandwidth* and provide *less protection* from *interference*. Twisted pair cable are also of two types **shielded and unshielded twisted pair cable**.

F) The **coaxial cable** has a central core conductor (usually copper) enclosed in an insulating sheath, which is further encased in an outer metallic braid, it serves as both protection against noise and as a second conductor which completes the circuit. Now, the outer metallic covering is also covered by an insulating sheath. The coaxial cable carries signals of *higher frequency* than the twisted pair cable.

G) The third category is the **optical fibre** which is made of glass or plastic, and it transmits signals in the form of light. The optical fibre is *noise resistance, has less signal attenuation and has a higher bandwidth* in comparison to twisted pair cable and coaxial cable. But it also has some drawbacks like; it is *very expensive, i*t requires a lot of *installation and maintenance charge* as any defect in the cable can diffuse light and alter the signals. As the optical fibre is made of glass, it is very *fragile*.

H) Definition of Unguided Media

I) The **unguided media** is also called **wireless communication**. It does not require any physical medium to transmit electromagnetic signals. In unguided media, the electromagnetic signals are broadcasted through air to everyone. These signals are available to one who has the device capable of receiving those signal.

J) The unguided media is also called unbounded media as it does not have any border limitation. The unguided media allows the user to connect all the time, as the communication is wireless the user can connect himself from anywhere to the network.

K) The unguided media is categorized into **radio waves, microwaves and infrared waves**. The **radio waves** are generated easily; they are *low-frequency signals* and can travel a *long distance*. The radio waves can penetrate through the buildings.

L) The **microwaves** are transmitted in a straight line and hence require the **line-of-sight transmission**. The distance covered by the microwave signal depend on the height of the two antenna. More the taller are antennas longer is the distance covered by the signal. The microwave has a *frequency higher* than the radio waves. Microwave are used for telephone communication mobile phones, television distribution, etc.

M) **Infrared waves** are used for short range communication. Like, the remote control for televisions, VCRs, etc. uses infrared waves. It can not penetrate through obstacles. The government licence is not required, to operate an infrared system as it is more secure against eavesdropping.

N) Key Differences between Guided and Unguided Media

a) The key difference between guided and unguided media is that guided media uses a **physical path or conductor** to transmit the signals whereas, the unguided media **broadcast the signal** through the air.

b) The guided media is also called **wired communication** or **bounded transmission media**. However, the unguided media is also called **wireless communication** or **unbounded transmission media**.

c) The guided media provide **direction** to the signal whereas, the unguided media **does not direct** the signal.

d) Categories of guided media are **twisted pair cable, coaxial cable** and **optical fibre**. On the other hands, the categories of unguided media are **radio wave, microwave,** and **infrared signal**.

3) Difference between Guided media and Un-guided media?

Answer: -

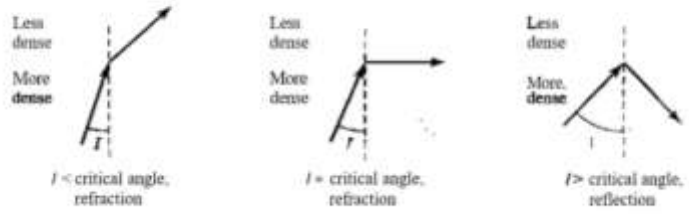
BASIS FOR COMPARISON	GUIDED MEDIA	UNGUIDED MEDIA
Basic	The signal requires a physical path for transmission.	The signal is broadcasted through air or sometimes water.
Alternative name	It is called wired communication or bounded transmission media.	It is called wireless communication or unbounded transmission media.
Direction	It provides direction to signal for travelling.	It does not provide any direction.
Types	Twisted pair cable, coaxial cable and fibre optic cable.	Radio wave, microwave and infrared.

4) Short Note on Fiber Optic Cable?

Answer: -

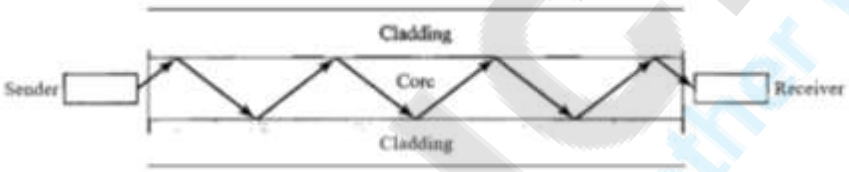
1) A fiber-optic cable is made of glass or plastic and transmits signals in the form of light. To understand optical fiber, we first need to explore several aspects of the nature of light. Light travels in a straight line as long as it is moving through a single uniform substance. If a ray of light traveling through one substance suddenly enters another substance (of a different density), the ray changes direction. Figure 7.10 shows how a ray of light changes direction when going from a denser to a less dense substance.

Figure 7.10 *Bending of light ray*



2) If the angle of incidence I (the angle the ray makes with the line perpendicular to the interface between the two substances) is less than the critical angle, the ray refracts and moves closer to the surface. If the angle of incidence is equal to the critical angle, the light bends along the interface. If the angle is greater than the critical angle, the ray reflects (makes a turn) and travels again in the denser substance. Note that the critical angle is a property of the substance, and its value differs from one substance to another. Optical fibers use reflection to guide light through a channel. A glass or plastic core is surrounded by a cladding of less dense glass or plastic. The difference in density of the two materials must be such that a beam of light moving through the core is reflected off the cladding instead of being refracted into it. See Figure 7.11.

Figure 7.11 *Optical fiber*



3) **Propagation Modes**

4) **Applications: -**

a) Fiber-optic cable is often found in backbone networks because its wide bandwidth is cost-effective. Today, with wavelength-division multiplexing (WDM), we can transfer data at a rate of 1600 Gbps.

b) Some cable TV companies use a combination of optical fiber and coaxial cable, thus creating a hybrid network. Optical fiber provides the backbone structure while coaxial cable provides the connection to the user premises. This is a cost-effective configuration since the narrow bandwidth requirement at the user end does not justify the use of optical fiber.

c) Local-area networks such as 100Base-FX network (Fast Ethernet) and 1000Base-X also use fiber-optic cable

5) **Advantages and Disadvantages of Optical Fiber**

A) **Advantages** Fiber-optic cable has several advantages over metallic cable (twisted-pair or coaxial).

1) **Higher bandwidth**. Fiber-optic cable can support dramatically higher bandwidths (and hence data rates) than either twisted-pair or coaxial cable. Currently, data rates and bandwidth utilization over fiber-optic cable are limited not by the medium but by the signal generation and reception technology available.

2) **Less signal attenuation**. Fiber-optic transmission distance is significantly greater than that of other guided media. A signal can run for 50 km without requiring regeneration. We need repeaters every 5 km for coaxial or twisted-pair cable.
3) **Immunity to electromagnetic interference.** Electromagnetic noise cannot affect fiber-optic cables.
4) **Resistance to corrosive materials**. Glass is more resistant to corrosive materials than copper.
5) **Light weight.** Fiber-optic cables are much lighter than copper cables.
6) **Greater immunity to tapping.** Fiber-optic cables are more immune to tapping than copper cables. Copper cables create antenna effects that can easily be tapped.

B) **Disadvantages** There are some disadvantages in the use of optical fiber.

1) Installation and maintenance. Fiber-optic cable is a relatively new technology. Its installation and maintenance require expertise that is not yet available everywhere.

2) Unidirectional light propagation. Propagation of light is unidirectional. If we need bidirectional communication, two fibers are needed.

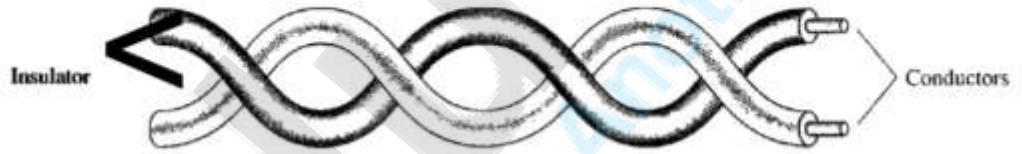
3) Cost. The cable and the interfaces are relatively more expensive than those of other guided media. If the demand for bandwidth is not high, often the use of optical fiber cannot be justified.

5) Short note on Twisted Pair Cable

Answer: -

1) A twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together, as shown in Figure

Figure 7.3 *Twisted-pair cable*



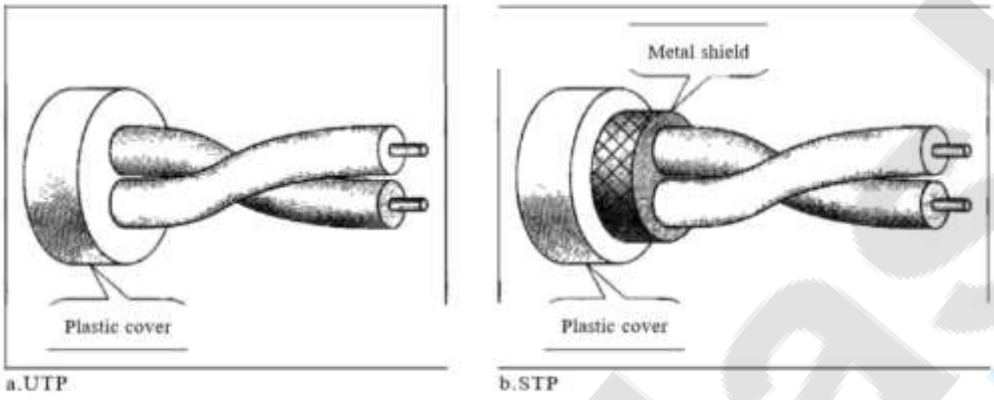
2) One of the wires is used to carry signals to the receiver, and the other is used only as a ground reference. The receiver uses the difference between the two. In addition to the signal sent by the sender on one of the wires, interference (noise) and crosstalk may affect both wires and create unwanted signals. If the two wires are parallel, the effect of these unwanted signals is not the same in both wires because they are at different locations relative to the noise or crosstalk sources (e,g., one is closer and the other is farther). This results in a difference at the receiver. By twisting the pairs, a balance is maintained.

3) Twisting makes it probable that both wires are equally affected by external influences (noise or crosstalk). This means that the receiver, which calculates the difference between the two, receives no unwanted signals. The unwanted signals are mostly cancelled out. From the above discussion, it is clear that the number of twists per unit of length (e.g., inch) has some effect on the quality of the cable.

4) the most common twisted-pair cable used in communications is referred to as unshielded twisted-pair (UTP). IBM has also produced a version of twisted-pair cable for its use called shielded twisted-pair (STP). STP cable has a metal foil or braided mesh covering that encases each pair of insulated conductors. Although metal casing improves

the quality of cable by preventing the penetration of noise or crosstalk, it is bulkier and more expensive. Figure 7.4 shows the difference between UTP and STP. Our discussion focuses primarily on UTP because STP is seldom used outside of IBM.

Figure 7.4 *UTP and STP cables*



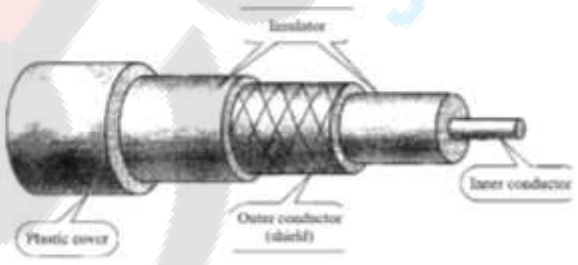
5) **Applications: -**Twisted-pair cables are used in telephone lines to provide voice and data channels. The local loop-the line that connects subscribers to the central telephone office commonly consists of unshielded twisted-pair cables

6) Short note on Coaxial Cable

Answer: -

1) Coaxial cable (or coax) carries signals of higher frequency ranges than those in twisted pair cable, in part because the two media are constructed quite differently. Instead of having two wires, coax has a central core conductor of solid or stranded wire (usually copper) enclosed in an insulating sheath, which is, in turn, encased in an outer conductor of metal foil, braid, or a combination of the two. The outer metallic wrapping serves both as a shield against noise and as the second conduct or, which completes the circuit. This outer conductor is also enclosed in an insulating sheath, and the whole cable is protected by a plastic cover.

Figure 7.7 *Coaxial cable*



2) **Coaxial Cable Standards**

Coaxial cables are categorized by their radio government (RG) ratings. Each RG number denotes a unique set of physical specifications, including the wire gauge of the inner conductor, the thickness and type of the inner insulator, the construction of the shield,

and the size and type of the outer casing. Each cable defined by an RG rating is adapted for a specialized function, as shown in Table.

Table 7.2 *Categories of coaxial cables*

Category	*Impedance*	*Use*
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet
RG-ll	50 Ω	Thick Ethernet

3) **Applications**

a) Coaxial cable was widely used in analogy telephone networks where a single coaxial network could carry 10,000 voice signals.

b) Later it was used in digital telephone networks where a single coaxial cable could carry digital data up to 600 Mbps. However, coaxial cable in telephone networks has largely been replaced today with fiber-optic cable.

7) Short note on Radio Wave

Answer: -

1) Although there is no clear-cut demarcation between radio waves and microwaves, electromagnetic waves ranging in frequencies between 3 kHz and 1 GHz are normally called radio waves; waves ranging in frequencies between 1 and 300 GHz are called microwaves. However, the behavior of the waves, rather than the frequencies, is a better criterion for classification.

2) Radio waves, for the most part, are omnidirectional. When an antenna transmits radio waves, they are propagated in all directions. This means that the sending and receiving antennas do not have to be aligned. A sending antenna sends waves that can be received by any receiving antenna. The omnidirectional property has a disadvantage, too. The radio waves transmitted by one antenna are susceptible to interference by another antenna that may send signals using the same frequency or band.

3) Radio waves, particularly those waves that propagate in the sky mode, can travel long distances. This makes radio waves a good candidate for long-distance broadcasting such as AM radio.

4) Radio waves, particularly those of low and medium frequencies, can penetrate walls. This characteristic can be both an advantage and a disadvantage. It is an advantage because, for example, an AM radio can receive signals inside a building. It is a disadvantage because we cannot isolate a communication to just inside or outside a building. The radio wave band is relatively narrow, just under 1 GHz, compared to the microwave band. When this band is divided into sub-bands, the sub-bands are also narrow, leading to a low data rate for digital communications.

5) **Applications: -**The omnidirectional characteristics of radio waves make them useful for multicasting, in which there is one sender but many receivers. AM and FM radio, television, maritime radio, cordless phones, and paging are examples of multicasting.

Figure 7.20 *Omnidirectional antenna*

Radio waves are used for multicast communications, such as radio and television, and paging systems.

8) Short note on Microwave

Answer: -

A) Electromagnetic waves having frequencies between I and 300 GHz are called microwaves.

B) Microwaves are unidirectional. When an antenna transmits microwave waves, they can be narrowly focused. This means that the sending and receiving antennas need to be aligned. The unidirectional property has an obvious advantage. A pair of antennas can be aligned without interfering with another pair of aligned antennas. The following describes some characteristics of microwave propagation:

a) Microwave propagation is line-of-sight. Since the towers with the mounted antennas need to be in direct sight of each other, towers that are far apart need to be very tall. The curvature of the earth as well as other blocking obstacles does not allow two short towers to communicate by using microwaves. Repeaters are often needed for long distance communication.

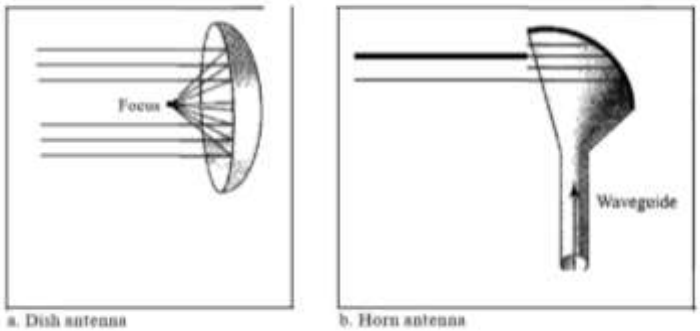
b) Very high-frequency microwaves cannot penetrate walls. This characteristic can be a disadvantage if receivers are inside buildings.

c) The microwave band is relatively wide, almost 299 GHz. Therefore wider sub bands can be assigned, and a high data rate is possible

d) Use of certain portions of the band requires permission from authorities.

C) **Unidirectional Antenna:** -Microwaves need unidirectional antennas that send out signals in one direction. Two types of antennas are used for microwave communications: the parabolic dish and the hom (see Figure 7.21). A parabolic dish antenna is based on the geometry of a parabola: Every line parallel to the line of symmetry (line of sight) reflects off the curve at angles such that all the lines intersect in a common point called the focus. The parabolic dish works as a funnel, catching a wide range of waves and directing them to a common point. In this way, more of the signal is recovered than would be possible with a single-point receiver.

Figure 7.21 *Unidirectional antennas*



D) **Applications**: -Microwaves, due to their unidirectional properties, are very useful when unicast (one-to-one) communication is needed between the sender and the receiver. They are used in cellular phones, satellite networks, and wireless LANs.

9) Short note on Infrared Signal.

Answer: **-**

1) Infrared waves, with frequencies from 300 GHz to 400 THz (wavelengths from 1 mm to 770 nm), can be used for short-range communication. Infrared waves, having high frequencies, cannot penetrate walls.
2) This advantageous characteristic prevents interference between one system and another; a short-range communication system in one room cannot be affected by another system in the next room.
3) When we use our infrared remote control, we do not interfere with the use of the remote by our neighbours. However, this same characteristic makes infrared signals useless for long-range communication.
4) In addition, we cannot use infrared waves outside a building because the sun's rays contain infrared waves that can interfere with the communication.
5) **Applications: -** The infrared band, almost 400 THz, has an excellent potential for data transmission. Such a wide bandwidth can be used to transmit digital data with a very high data rate. The Infrared Data Association (IrDA), an association for sponsoring the use of infrared waves, has established standards for using these signals for communication between devices such as keyboards, mice, PCs, and printers. For example, some manufacturers provide a special port called the IrDA port that allows a wireless keyboard to communicate with a PC. The standard originally defined a data rate of 75 kbps for a distance up to 8 m. The recent standard defines a data rate of4 Mbps. Infrared signals defined by IrDA transmit through line of sight; the IrDA port on the keyboard needs to point to the PC for transmission to occur.

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