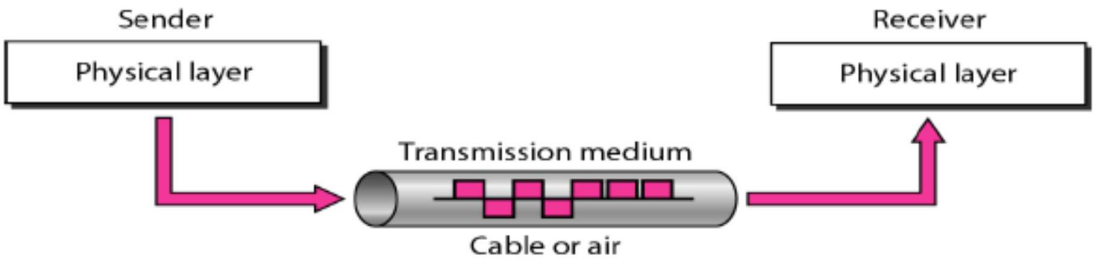
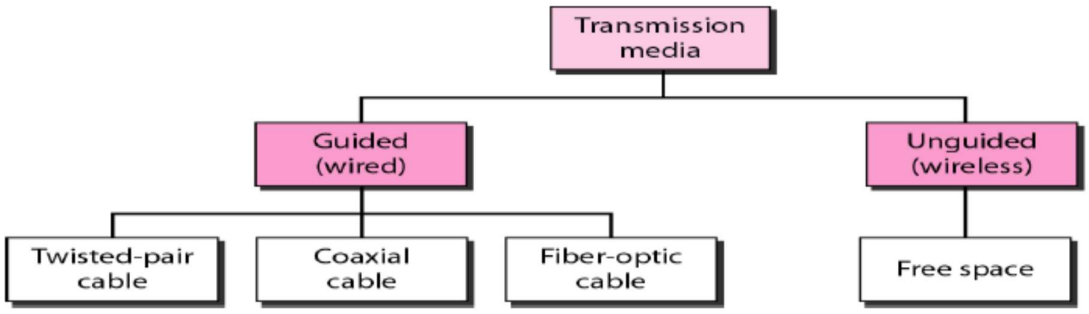
TRANSMISSION MEDIA

A **transmission medium** can be broadly defined as anything that can carry information from a source to a destination.

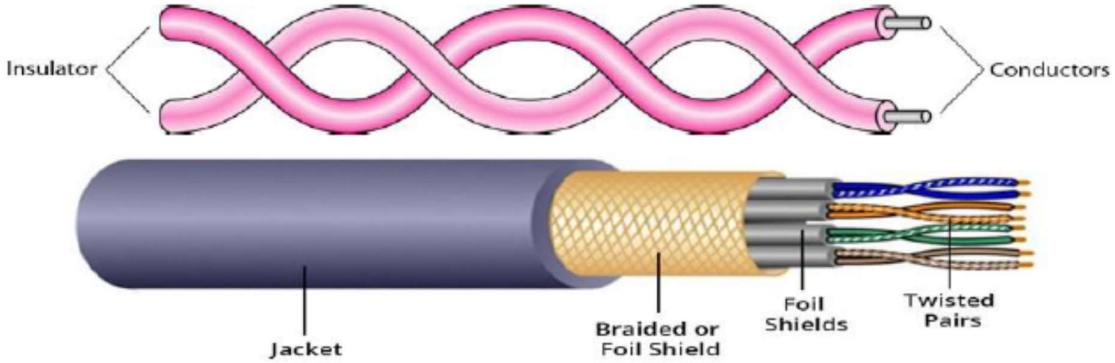


Classes of transmission media



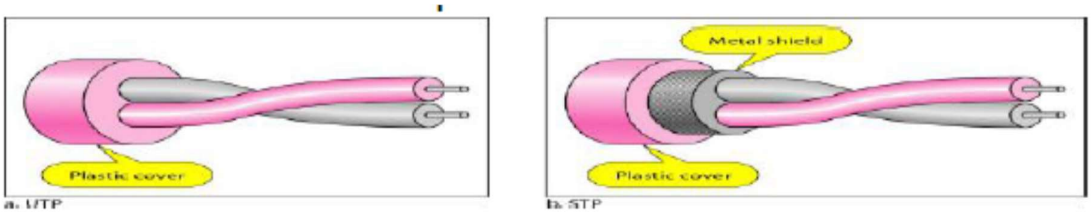
1) **Guided Media**: Guided media, which are those that provide a medium from one device to another, include twisted-pair cable, coaxial cable, and fiber-optic cable.

   (i) **Twisted-Pair Cable**:
   - i. A twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together.
   - ii. One of the wires is used to carry signals to the receiver, and
   - iii. The other is used only as a ground reference.



   - iv. **Unshielded Versus Shielded Twisted-Pair Cable**:
     1. The most common twisted-pair cable used in communications is referred to as unshielded twisted-pair (UTP).

2. 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.



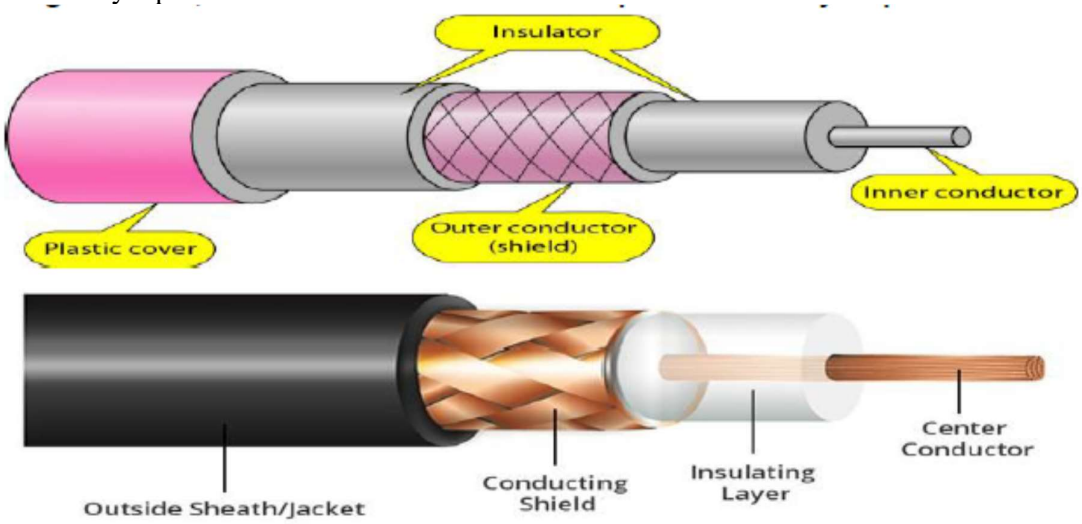
v. The most common UTP connector is RJ45 (RJ stands for registered jack)

Applications

1) Twisted-pair cables are used in telephone lines to provide voice and data channels.
2) Local-area networks, such as l0Base-T and l00Base-T, also use twisted-pair cables.

(ii) **Coaxial Cable**

i. Coaxial cable (or *coax)* carries signals of higher frequency ranges than those in twisted pair cable.
ii. 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.
iii. The outer metallic wrapping serves both as a shield against noise and as the second conductor, which completes the circuit.
iv. This outer conductor is also enclosed in an insulating sheath, and the whole cable is protected by a plastic cover.



The most common type of connector used today is the Bayone-Neill-Concelman (BNe), connector.

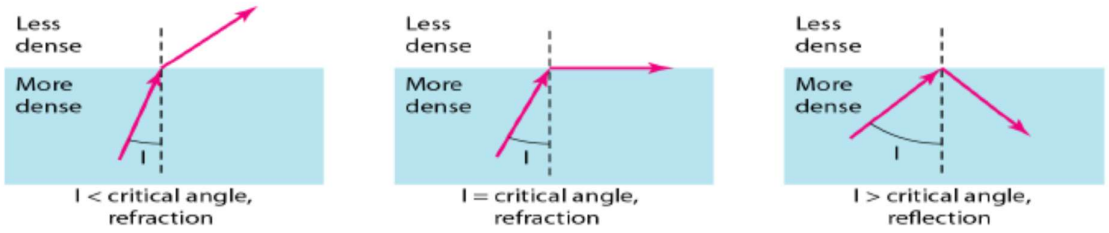
Applications

- Coaxial cable was widely used in analog telephone networks, digital telephone networks
- Cable TV networks also use coaxial cables.
- Another common application of coaxial cable is in traditional Ethernet LANs

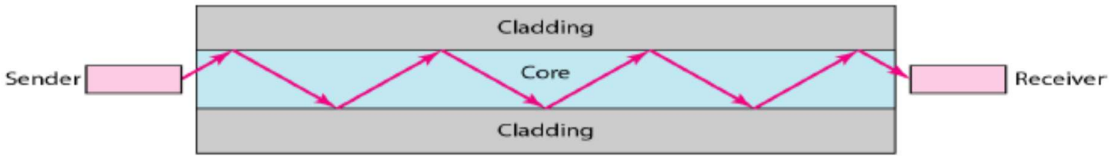
(iii) **Fiber-Optic Cable**

i. A fiber-optic cable is made of glass or plastic and transmits signals in the form of light.
ii. Light travels in a straight line as long as it is moving through a single uniform substance.
iii. If a ray of light traveling through one substance suddenly enters another substance (of a different density), the ray changes direction.

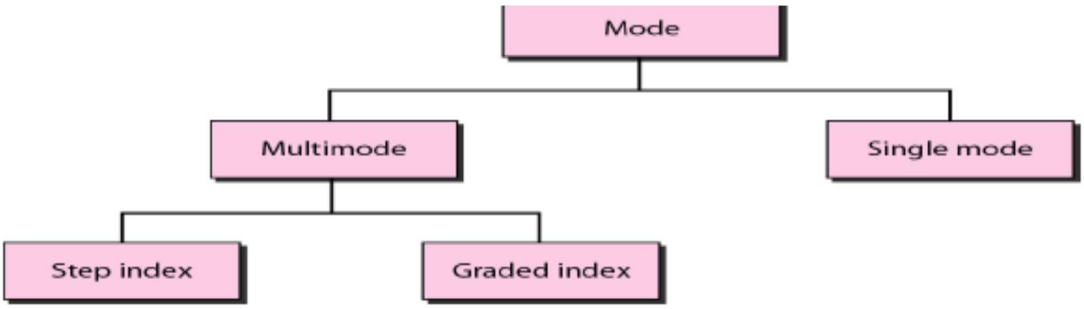
Bending of light ray



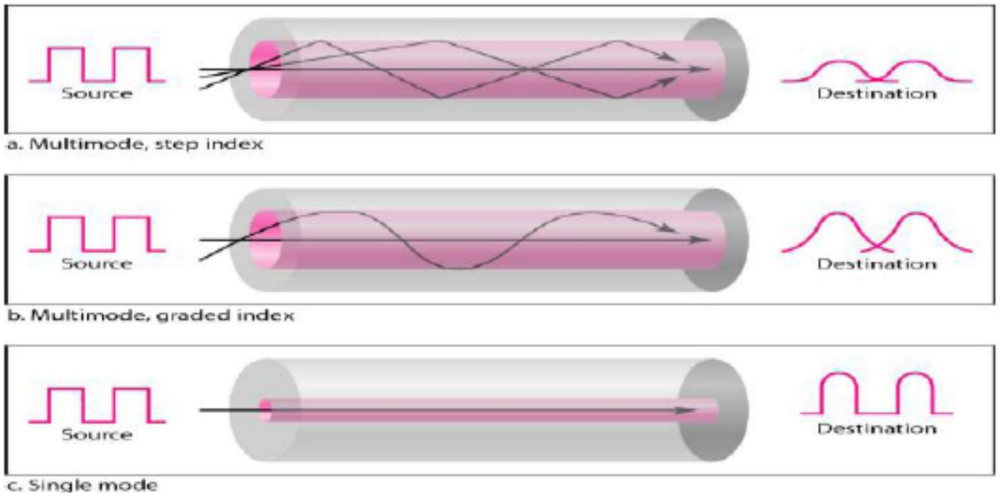
Optical fibers use reflection to guide light through a channel. A glass or plastic core is surrounded by a cladding of less dense glass or plastic.



Propagation Modes



Multimode is so named because multiple beams from a light source move through the core in different paths. How these beams move within the cable depends on the structure of the core, as shown in Figure.

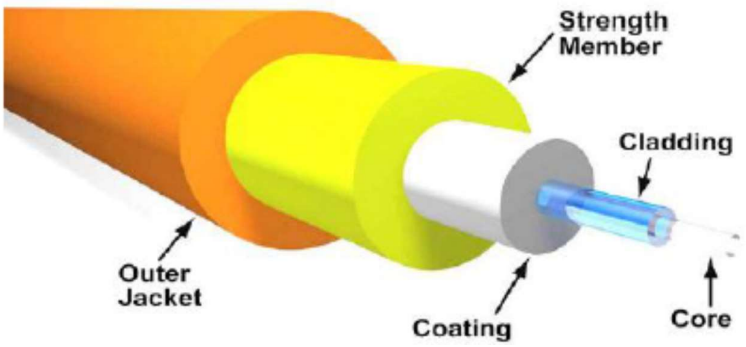


In **multimode step-index fiber** , the density of the core remains constant from the center to the edges. A beam of light moves through this constant density in a straight line until it reaches the interface of the core and the cladding. The term *step index* refers to the suddenness of this change, which contributes to the distortion of the signal as it passes through the fiber.

A second type of fiber, called **multimode graded-index fiber**, decreases this distortion of the signal through the cable. The word *index* here refers to the index of refraction.

Single-Mode: Single-mode uses step-index fiber and a highly focused source of light that limits beams to a small range of angles, all close to the horizontal.

Fiber Construction



The **subscriber channel** (SC) **connector,** The **straight-tip** (ST) **connector, MT-RJ (mechanical transfer registered jack)** is a connector

Applications

- Fiber-optic cable is often found in backbone networks because its wide bandwidth is cost-effective.
- Some cable TV companies use a combination of optical fiber and coaxial cable,thus creating a hybrid network.
- Local-area networks such as 100Base-FX network (Fast Ethernet) and 1000Base-X also use fiber-optic cable

Advantages and Disadvantages of Optical Fiber Advantages

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

1. Higher bandwidth.
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. 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.

Disadvantages

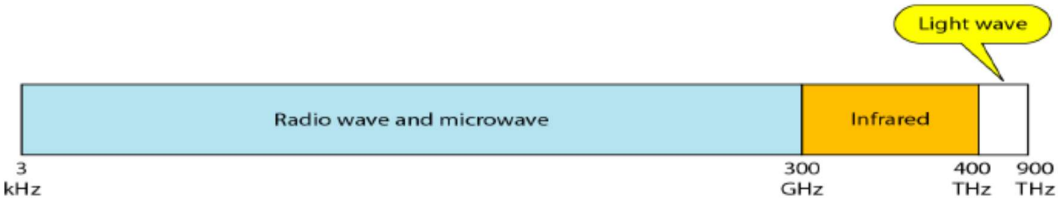
There are some disadvantages in the use of optical fiber.

1. Installation and maintenance
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.

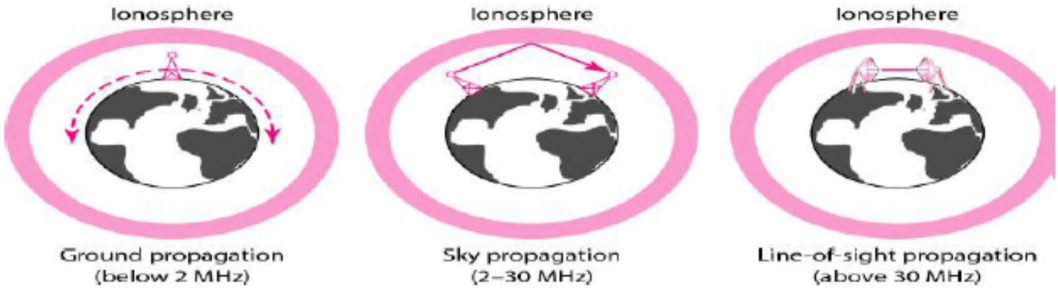
UNGUIDED MEDIA: WIRELESS

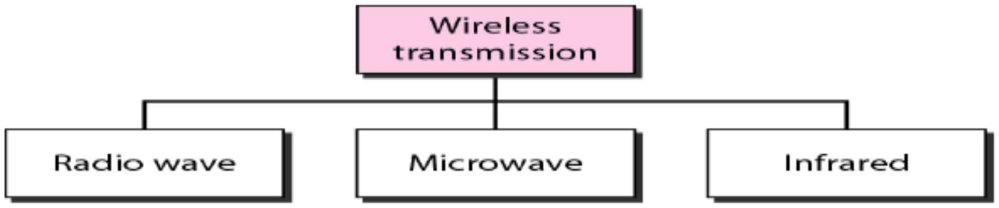
Unguided media transport electromagnetic waves without using a physical conductor. This type of communication is often referred to as wireless communication.

1. Radio Waves
2. Microwaves
3. Infrared



Unguided signals can travel from the source to destination in several ways: ground propagation, sky propagation, and line-of-sight propagation, as shown in Figure





Radio Waves

(i) Electromagnetic waves ranging in frequencies between 3 kHz and 1 GHz are normally called radio waves.
(ii) Radio waves are Omni directional.
(iii) 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.
(iv) A sending antenna sends waves that can be received by any receiving antenna.
(v) The Omni directional property has a disadvantage, too.
(vi) The radio waves transmitted by one antenna are susceptible to interference by another antenna that may send signals using the same frequency or band.

Omni directional Antenna

(i) Radio waves use omnidirectional antennas that send out signals in all directions.
(ii) Based on the wavelength, strength, and the purpose of transmission, we can have several types of antennas.
(iii) Figure shows an omnidirectional antenna.

Applications

(i) The Omni directional characteristics of radio waves make them useful for multicasting, in which there is one sender but many receivers.

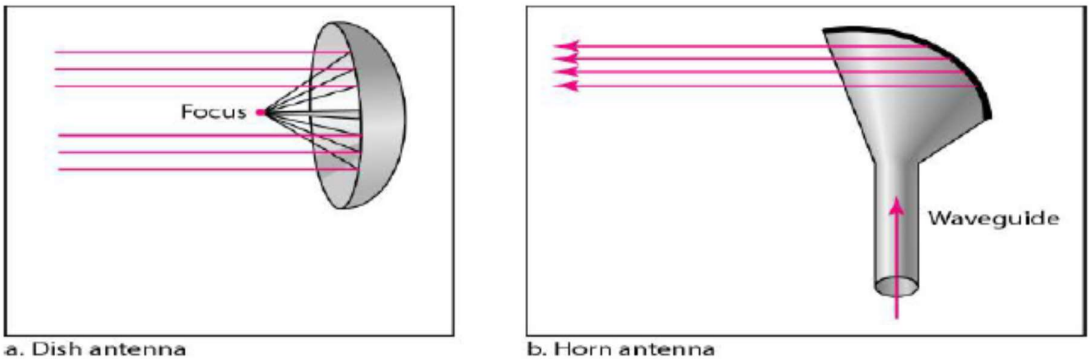
(ii) AM and FM radio, television, maritime radio, cordless phones, and paging are examples of multicasting.

Microwaves

- Electromagnetic waves having frequencies between 1 and 300 GHz are called microwaves.
- Microwaves are unidirectional.
- The sending and receiving antennas need to be aligned.
- A pair of antennas can be aligned without interfering with another pair of aligned antennas

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 horn



a. Dish antenna b. Horn antenna

Applications:

- Microwaves are used for unicast communication such as cellular telephones, satellite networks, and wireless LANs

Infrared

- 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.
- 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.
- When we use our infrared remote control, we do not interfere with the use of the remote by our neighbors.
- Infrared signals useless for long-range communication.
- In addition, we cannot use infrared waves outside a building because the sun's rays contain infrared waves that can interfere with the communication.

Applications:

Infrared signals can be used for short-range communication in a closed area using line-of-sight propagation.