Transmission Media

- A transmission media can be defined as anything that can carry information from a source to a destination.
- On the basis of transmission of data, the transmission media can be classified into two categories:
    1. Guided (Physical) transmission media
    2. Unguided (Wireless) transmission media

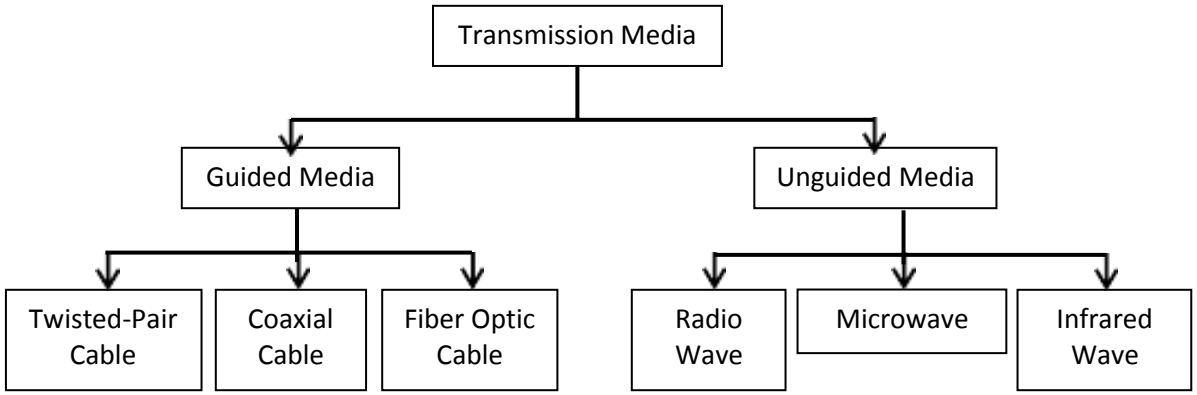

Figure 8: Classification Transmission Media

Guided Transmission Media

- Guided media are those that provide a channel from one device to another.
- The three Guided (Physical) media commonly used for data transmission are:
    1. Twisted-Pair
    2. Coaxial
    3. Fiber Optics

1. Twisted Pair

- A twisted pair consists of two insulated copper wires, typically about 1 mm thick.
- The wires are twisted together in a helical form, just like a DNA molecule.
- Twisting is done because two parallel wires constitute a fine antenna.
- When the wires are twisted, the waves from different twists cancel out, so the wire radiates less effectively.

Figure 9: Twisted Pair Cable

Why cable is twisted?

- 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 relatives to the noise or crosstalk sources.
- This results in a difference at the receiver.
- By twisting the pair, a balance is maintained.

Types of Twisted-Pair Cable

1) Unshielded twisted-pair (UTP)

- Twisted pair cabling comes in several varieties, two of which are important for computer networks.
- **Category 3** twisted pairs consist of two insulated wires gently twisted together.
- Most office buildings had one category 3 cable running from a central wiring closet on each floor into each office.
- **Category 5** is the more advanced twisted pairs were introduced.
- They are similar to category 3 pairs, but with more twists per centimeter, which results in less crosstalk and a better-quality signal over longer distances, making them more suitable for high-speed computer communication.
- Up-and-coming categories are 6 and 7, which are capable of handling signals with bandwidths of 250 MHz and 600 MHz, respectively (versus a mere 16 MHz and 100 MHz for categories 3 and 5 respectively).

Figure 10: Unshielded twisted-pair

2) Shielded twisted-pair (STP).

- STP cable has a metal foil or braided mesh covering that encases each pair of insulated conductors.
- Metal casing improves the quality of cable by preventing the penetration of noise or crosstalk.
- It is bulkier and more expensive.
- **Applications:**
  - Used in telephone lines to provide voice and data channels.
  - The DSL lines use by telephone companies use the high-bandwidth capability of UTPcables.
  - LANs, such as 10Base-T, 100Base-T also uses twisted-pair cables.

2. Coaxial Cable

- It has better shielding than twisted pairs, so it can span longer distances at higher speeds.
- Two kinds of the coaxial cable are widely used. One kind is a 50-ohm cable which is commonlyused when it is intended for digital transmission from the start.
- The other kind is a 75-ohm cable which is commonly used for analog transmission and cable television but is becoming more important with the advent of the Internet over cable.
- A coaxial cable consists of stiff copper wire as the core surrounded by an insulating material.
- The insulator is encased by a cylindrical conductor, often as a closely-woven braided mesh.
- The outer conductor is covered in a protective plastic sheath.
- The construction and shielding of the coaxial cable give it a good combination of high bandwidth and excellent noise immunity.
- The bandwidth possible depends on the cable quality, length, and signal-to-noise ratio of the data signal. Modern cables have a bandwidth of close to 1 GHz.

- Coaxial cables used is widely used within the telephone system for long-distance lines but have now largely been replaced by fiber optics on long-haul routes.

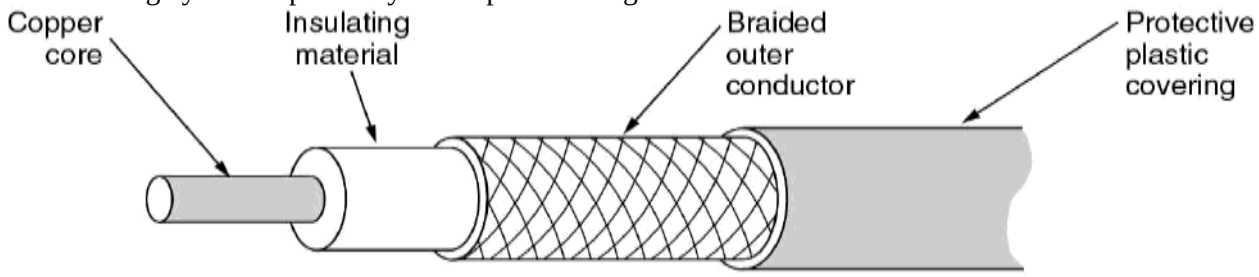

Figure 11: Coaxial Cable

3. Fiber Optics

- A fiber-optic cable is made of glass or plastic and transmits signals in the form of light.
- 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 througha core is reflected off the cladding instead of being refracted into it.

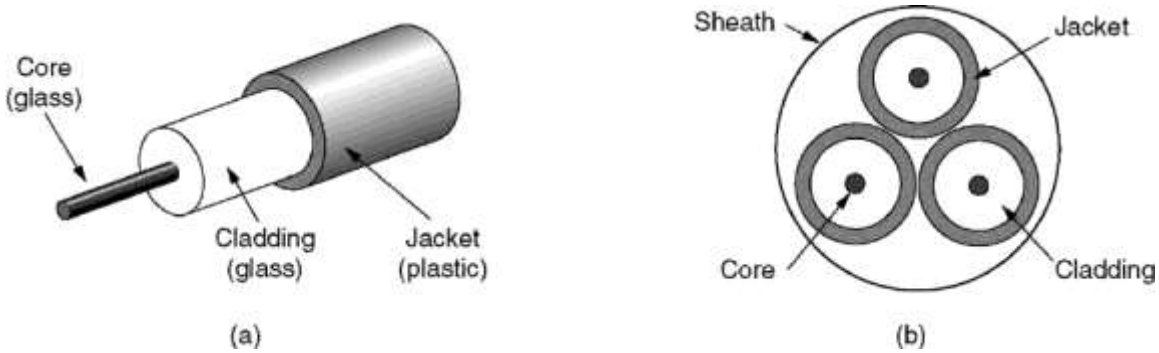

Figure 12: Fiber Optic Cable

- Fiber optic cables are similar to coax, except without the braid.
- The figure shows a single fiber viewed from the side. At the center is the glass core through which the light propagates.
- The core is surrounded by a glass cladding with a lower index of refraction than the core, to keep all the light in the core.
- Next comes a thin plastic jacket to protect the cladding. Fibers are typically grouped in bundles, protected by an outer sheath. The figure shows a sheath with three fibers.

Unguided (Wireless) transmission media

- Unguided media transport electromagnetic waves without using a physical conductor. This type of communication is often referred to as wireless communication.
  1. Radio Transmission
  2. Microwave Transmission
  3. Infrared
  4. Lightwave Transmission

1. **Radio Transmission**
   - Radio waves are easy to generate, can travel long distances, and can penetrate buildings easily, so they are widely used for communication, both indoors and outdoors.
   - Radio waves also are omnidirectional, meaning that they travel in all directions from the source, so the transmitter and receiver do not have to be carefully aligned physically.
   - The properties of radio waves are frequency dependent.
   - At low frequencies, radio waves pass through obstacles well, but the power falls off sharply with distance from the source, roughly as $1/r^2$ in the air.
   - At high frequencies, radio waves tend to travel in straight lines and bounce off obstacles. They are also absorbed by rain.
   - At all frequencies, radio waves are subject to interference from motors and other electrical equipment.

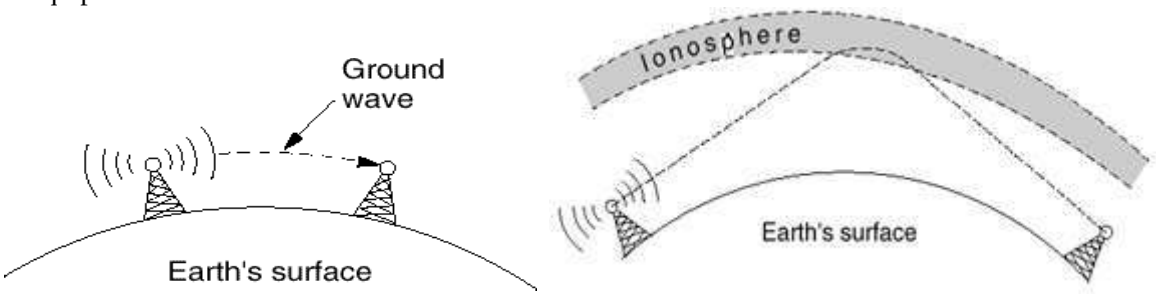

Figure 13: Ground wave

   - In the VLF, LF, and MF bands, radio waves follow the curvature of the earth.
   - In the HF they bounce off the ionosphere.

2. **Microwave Transmission**
   - Since the microwaves travel in a straight line, if the towers are too far apart, the earth will get in the way. Consequently, repeaters are needed periodically.
   - Unlike radio waves at lower frequencies, microwaves do not pass through buildings well. In addition, even though the beam may be well focused at the transmitter, there is still some divergence in space.
   - Above 100 MHz, the waves **travel in straight lines** and can, therefore, be narrowly focused. Concentrating all the energy into a small beam using a **parabolic antenna** gives a much higher signal to noise ratio.
   - **Advantages:**
     - No right way is needed (compared to wired media).
     - Relatively inexpensive.
     - Simple to install.
   - **Disadvantages:**
     - Do not pass through buildings well.
     - Multipath fading problem (the delayed waves cancel the signal).
     - Absorption by rain above 8 GHz.
     - A severe shortage of spectrum.

3. **Infrared**
   - Unguided infrared and millimetre waves are widely used for short-range communication.
   - The remote controls used on televisions, VCRs, and stereos all use infrared communication.

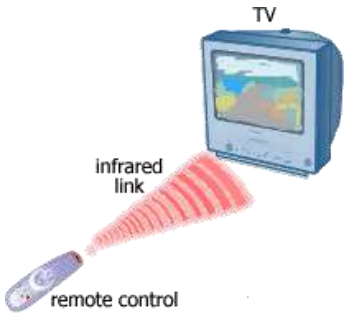

Figure 14: Infrared wave connection

- They are relatively directional, cheap, and easy to build but have a major drawback: they do not pass through solid objects (try standing between your remote control and your television andsee if it still works).
- In general, as we go from long-wave radio toward visible light, the waves behave more and morelike light and less and less like a radio.
- On the other hand, the fact that infrared waves do not pass through solid walls well is also aplus.
- It means that an infrared system in one room of a building will not interfere with a similarsystem in adjacent rooms or buildings.
- Furthermore, security of infrared systems against eavesdropping is better than that of radiosystems precisely for this reason.
- Therefore, no government license is needed to operate an infrared system, in contrast to radiosystems, which must be licensed outside the ISM bands.