# Data Communication & Networks

Chapter 3: Medium and its Types

# Physical Layer: Guided Medium (From Ferouzan, Chapter 7)

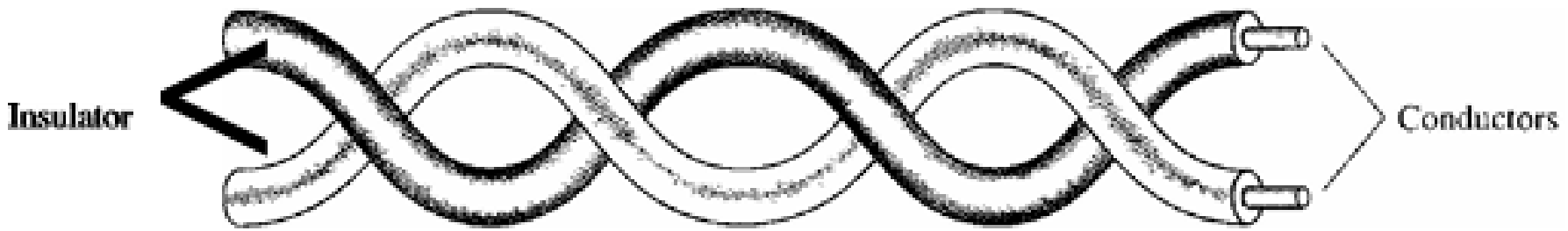
- Guided Transmission media: Transmission media that rely on a physical cable or wire are often called guided transmission media because the signal transmissions are guided along a path with a physical cable or wire.

# Guided Medium: Twisted Pair Cable

## Twisted-Pair Cable

A twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together, as shown in Figure 7.3.

Figure 7.3 *Twisted-pair cable*



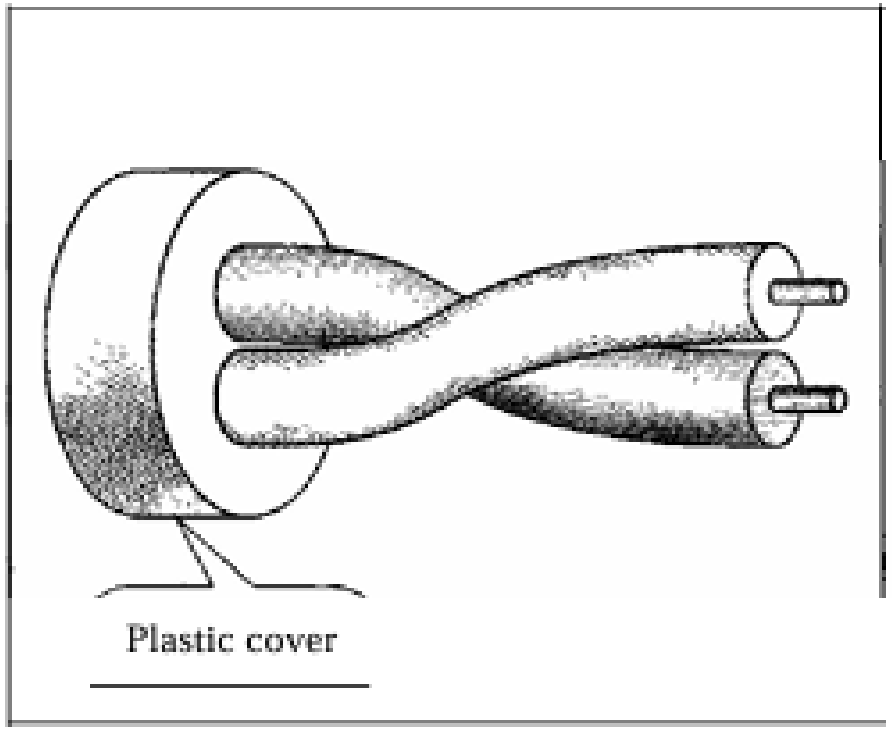

One of the wires is used to carry signals to the receiver, and the other is used only as a ground reference. The receiver uses the difference between the two.

# Guided Medium: Twisted Pair Cable

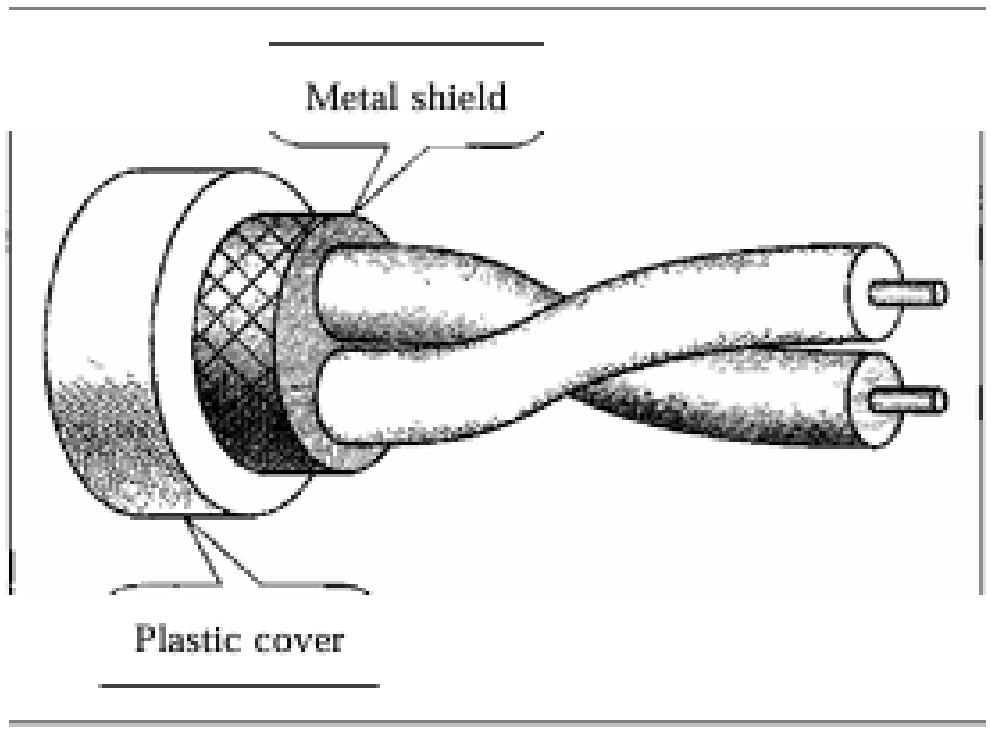
If the two wires are parallel, the effect of these unwanted signals is not the same in both wires because they are at different locations relative to the noise or crosstalk sources (e,g., one is closer and the other is farther). This results in a difference at the receiver. By twist,ing the pairs, a balance is maintained. For example, suppose in one twist, one wire is closer to the noise source and the other is farther; in the next twist, the reverse is true. 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 canceled 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.

# Guided Medium: Twisted Pair Cable

**Figure 7.4** *UTP and STP cables*




a.UTP




b.STP

- CAT2, CAT3, CAT5e

# Guided Medium: Twisted Pair Cable

*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.

- Lower Bandwidth

# Guided Medium: Co-axial Cable

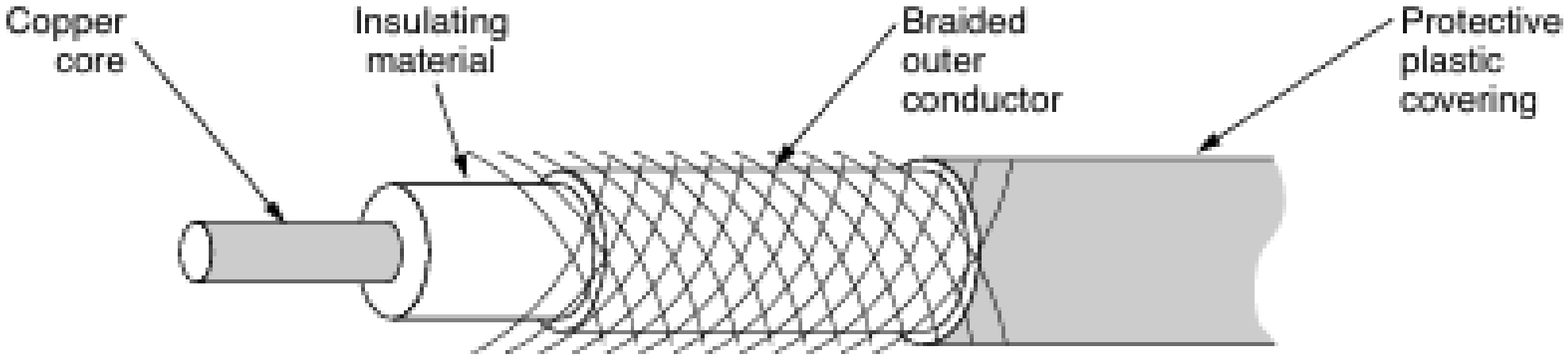


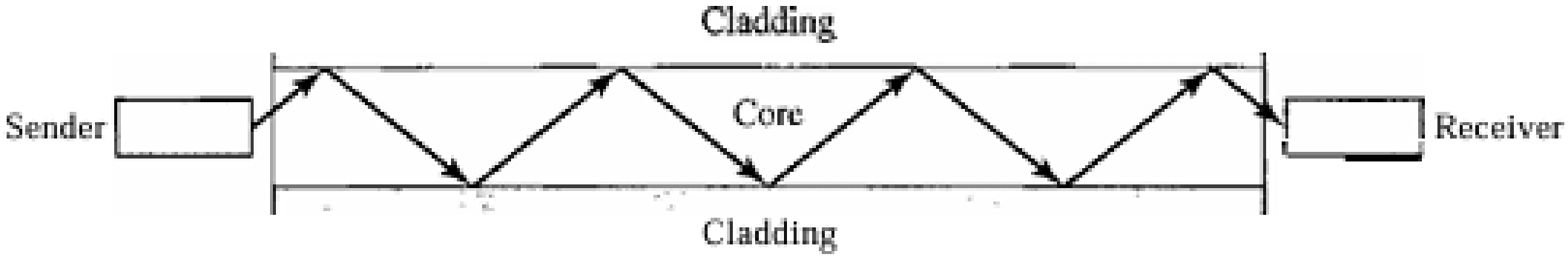

**Figure 2-2.** A coaxial cable.

- Higher Bandwidth but higher attenuation
- Cable TV, Thick or thin Ethernet

# Guided Medium: Optical Fiber

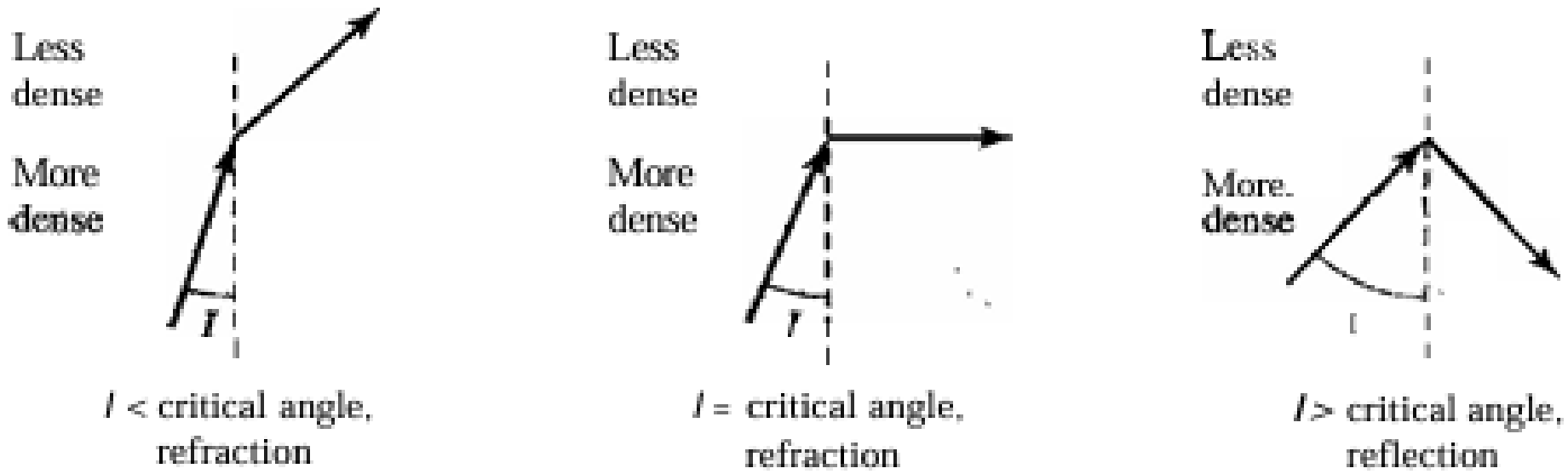
- A fiber-optic cable is made of glass or plastic and transmits signals in the form of light.

Figure 7.11 *Opticaljiber*



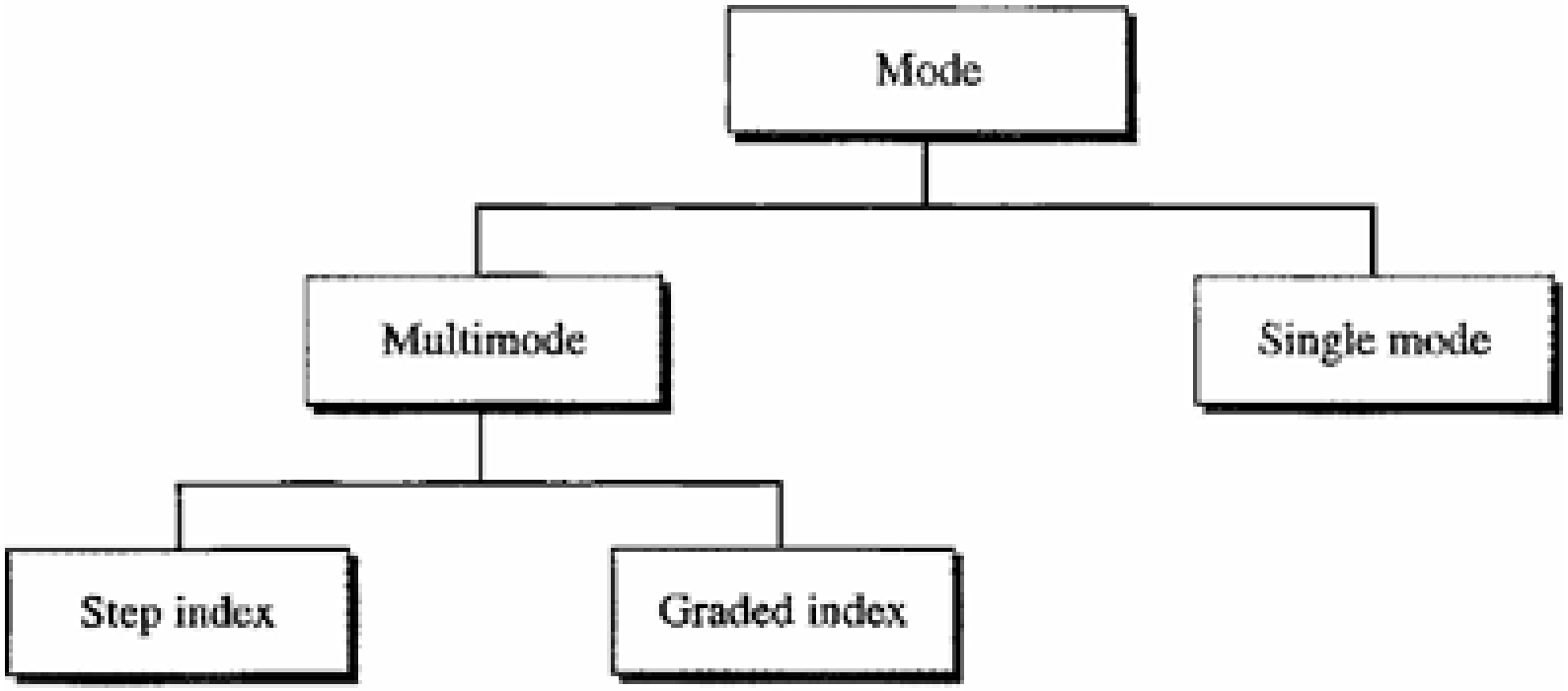
# Guided Medium: Optical Fiber

Figure 7.10 *Bending of light ray*



# Guided Medium: Optical Fiber

Figure 7.12 *Propagation modes*

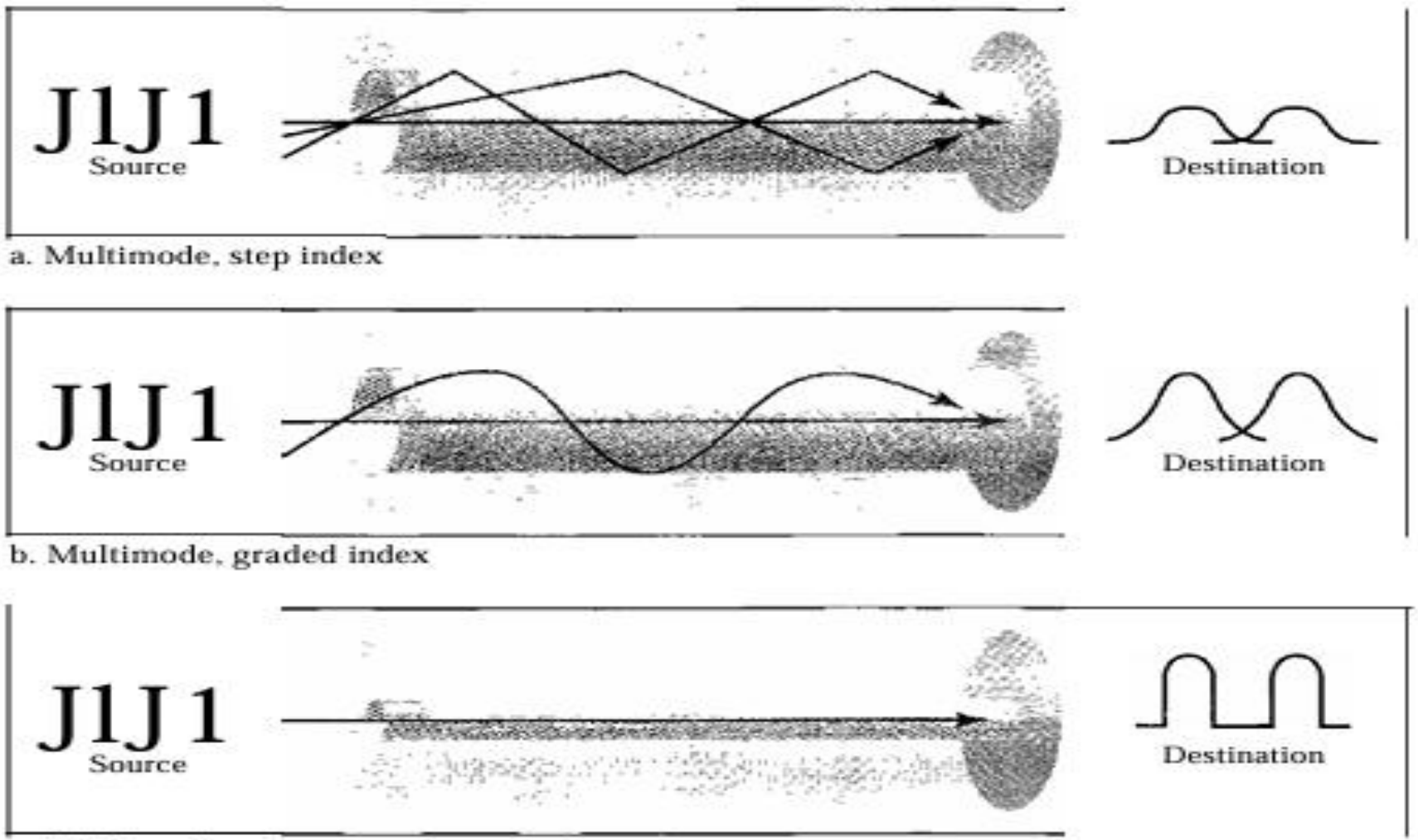


# Guided Medium: Optical Fiber

- 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.
- Multimode: Multimode is so named because multiple beams from a light source move through the core in different paths.
- Multimode step-index: The density of the core remains constant from the center to the edges.
- Multimode graded index: Density is highest at the center of the core and decreases gradually to its lowest at the edge.

# Guided Medium: Optical Fiber

Figure 7.13 *Modes*




a. Multimode, step index

b. Multimode, graded index

c. Single mode

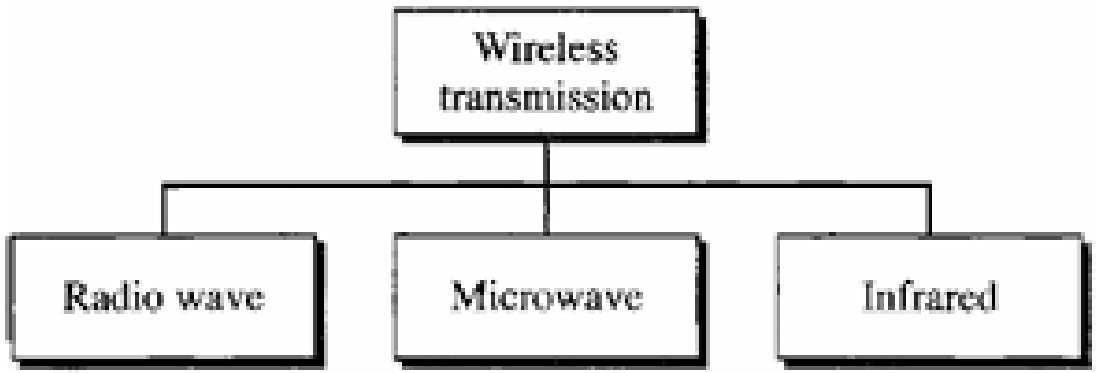
# Guided Medium: Optical Fiber

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

- 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.
- 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.
- Immunity to electromagnetic interference. Electromagnetic noise cannot affect fiber-optic cables.

# Unguided Medium (Wireless medium)

Figure 7.19 *Wireless transmission waves*



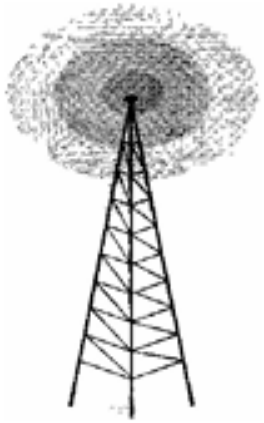
# Wireless medium: Radio Waves

- Transmission Frequency ranges from 3kHz and 1GHz

*Omnidirectional Antenna*

Radio waves use omnidirectional antennas that send out signals in all directions. Based on the wavelength, strength, and the purpose of transmission, we can have several types of antennas. Figure 7.20 shows an omnidirectional antenna.

Figure 7.20 *Omnidirectional antenna*



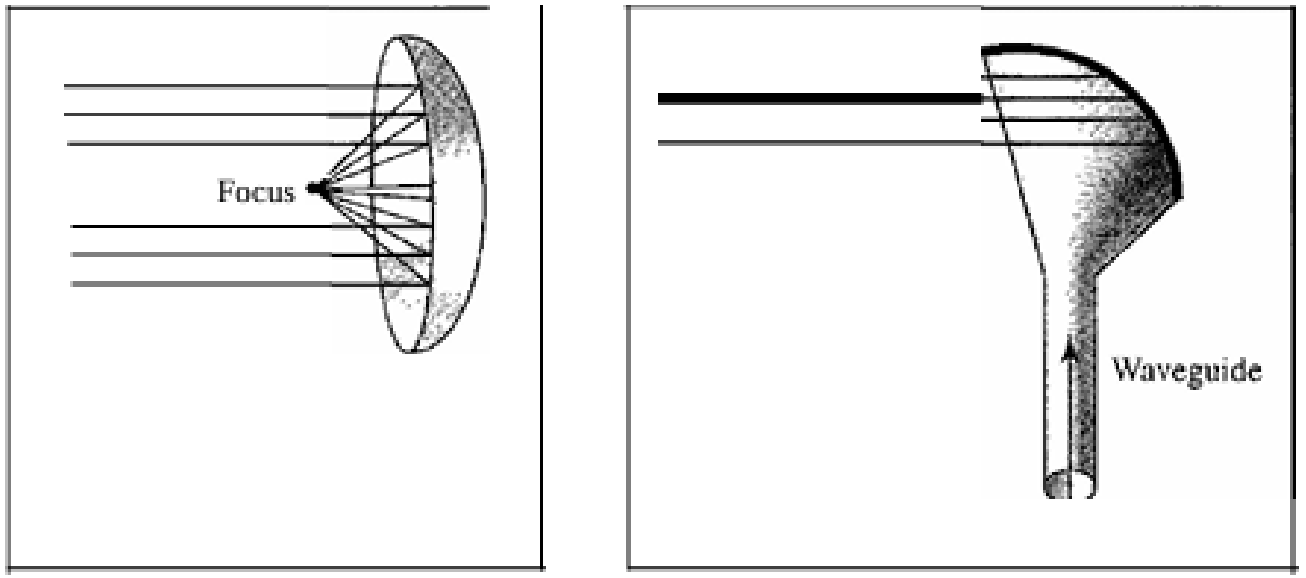
Radio waves are used for multicast communications, such as radio and television, and paging systems.

# Wireless medium: Microwaves

## Microwaves

Electromagnetic waves having frequencies between I and 300 GHz are called micro-waves.

Figure 7.21 *Unidirectional antennas*




a. Dish antenna

b. Horn antenna

# Wireless medium: Microwaves Characteristics

- 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 do not allow two short towers to communicate by using microwaves. Repeaters are often needed for long-distance communication.
- Very high-frequency microwaves cannot penetrate walls. This characteristic can be a disadvantage if receivers are inside buildings.
- The microwave band is relatively wide, almost 299 GHz. Therefore wider subbands can be assigned, and a high data rate is possible
- Use of certain portions of the band requires permission from authorities.

- Infrared : Read from book