Transmission Media

A transmission media define as anything that can carry information from a source to a destination.

Figure 7.1 ***Transmission medium and physical layer***

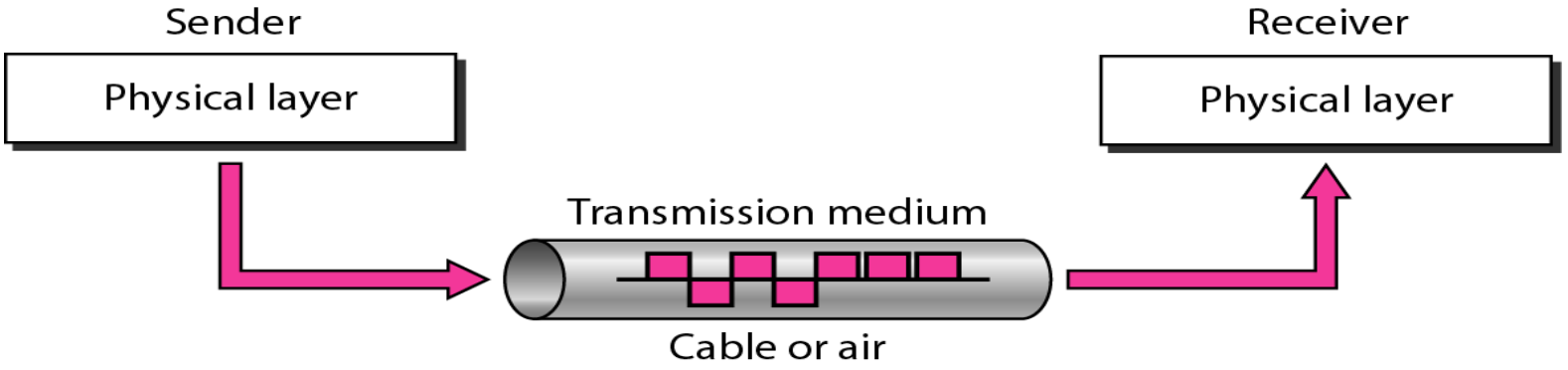
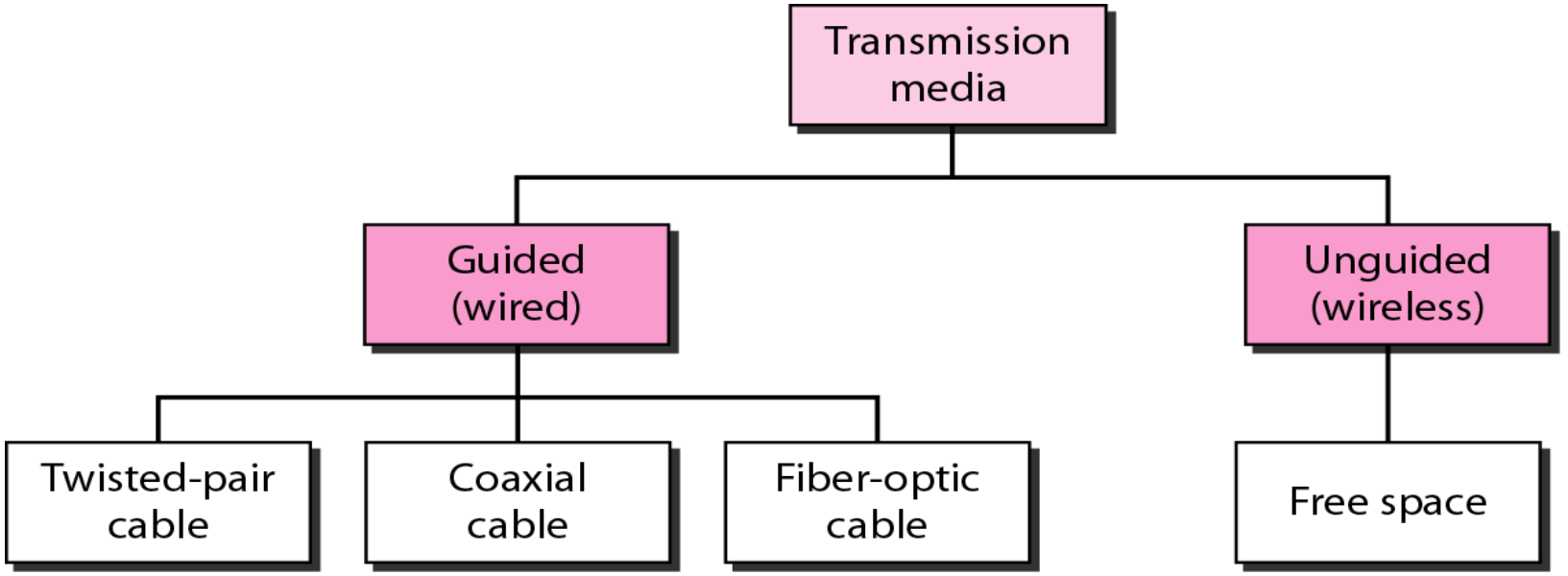


Figure 7.2 ***Classes of transmission media***

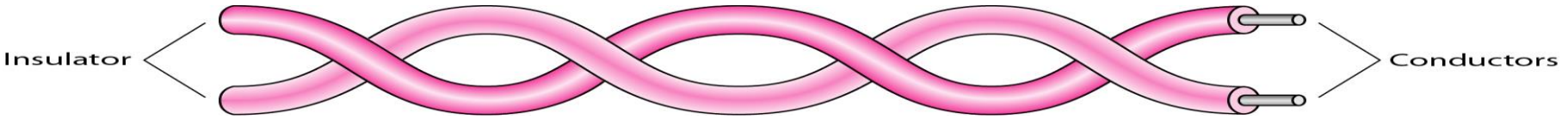


7-1 GUIDED MEDIA

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

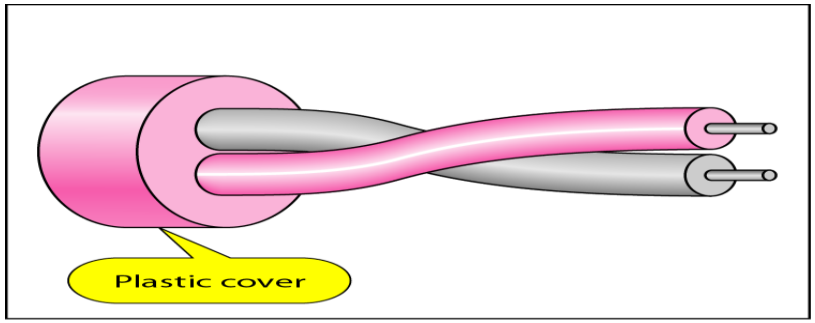
1. Twisted-Pair Cable

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

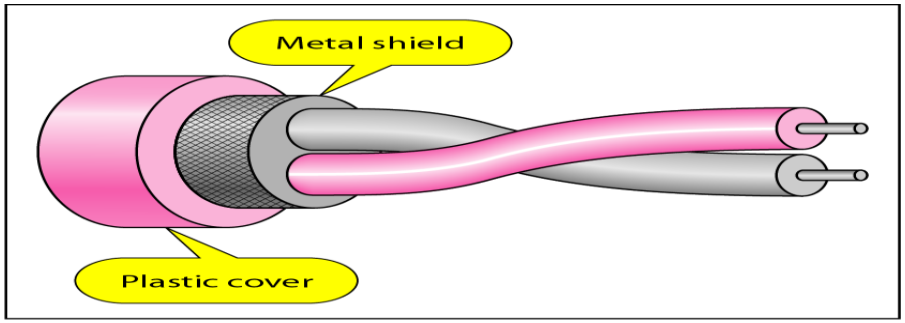


- One of the wires is used to carry signals to the receiver, and the other is used only as a ground reference. The receiver uses the difference between the two.
- In addition to the signal sent by the sender on one of the wires, interference (noise) and crosstalk may affect both wires and create unwanted 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 .
- This results in a difference at the receiver. By twisting 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.

- 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.



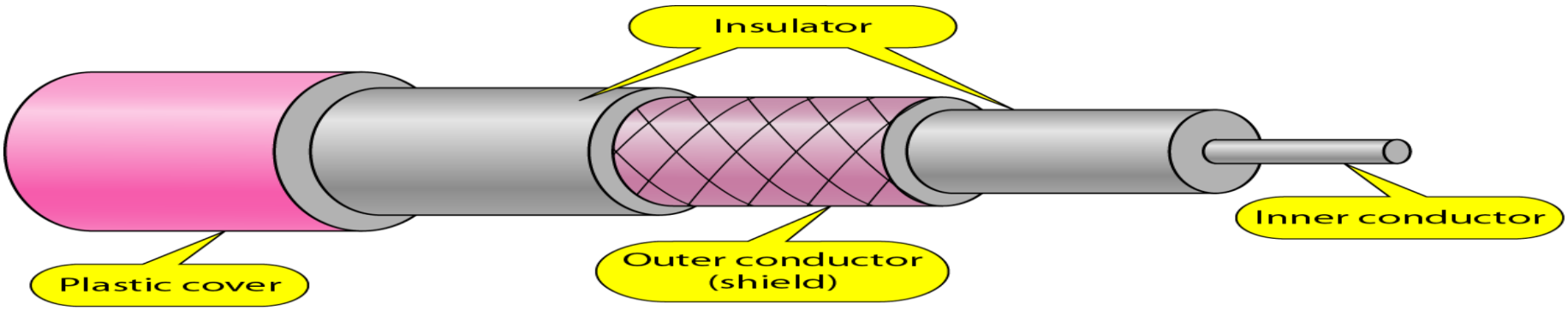
a. UTP



b. STP

- ***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.
- The DSL lines that are used by the telephone companies to provide high-data-rate connections also use the high-bandwidth capability of unshielded twisted-pair cables.

- ***Coaxial Cable***
- 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.



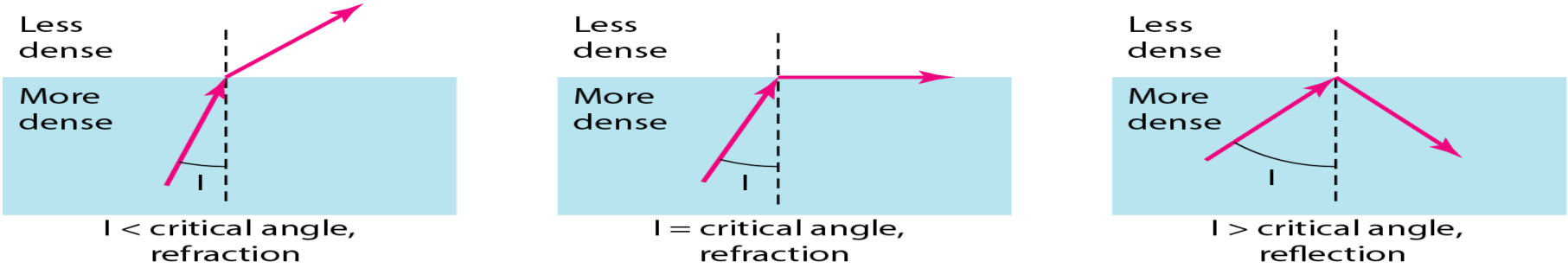
7-1 GUIDED MEDIA

- ***Coaxial Cable***
- The outer metallic wrapping serves both as a shield against noise and as the second conductor, which completes the circuit.
- This outer conductor is also enclosed in an insulating sheath, and the whole cable is protected by a plastic cover

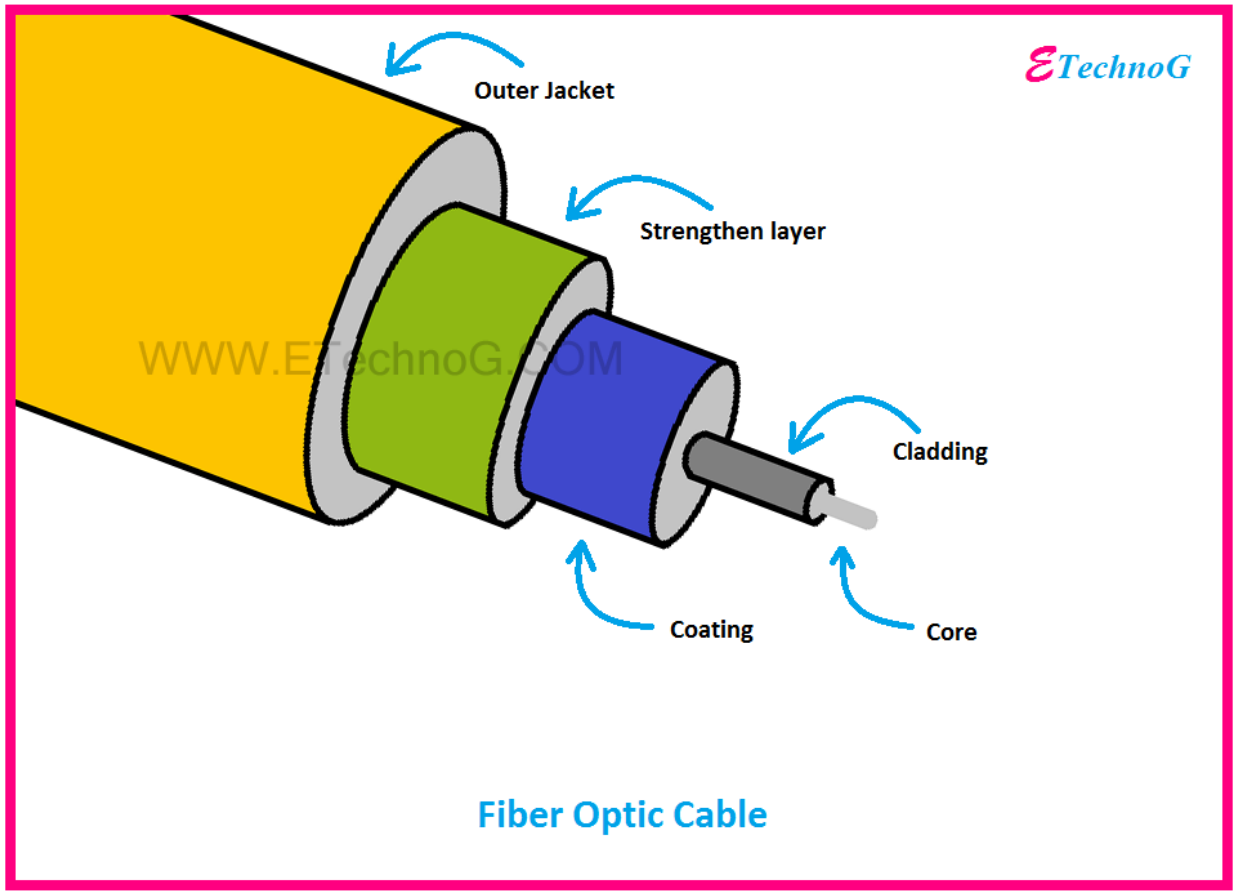
3. Fiber-Optic Cable

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

Figure 7.10 ***Bending of light ray***



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


ETechnoG
Outer Jacket
Strengthen layer
WWW.ETechnoG.COM
Cladding
Coating
Core
Fiber Optic Cable

3. Fiber-Optic Cable

- 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.

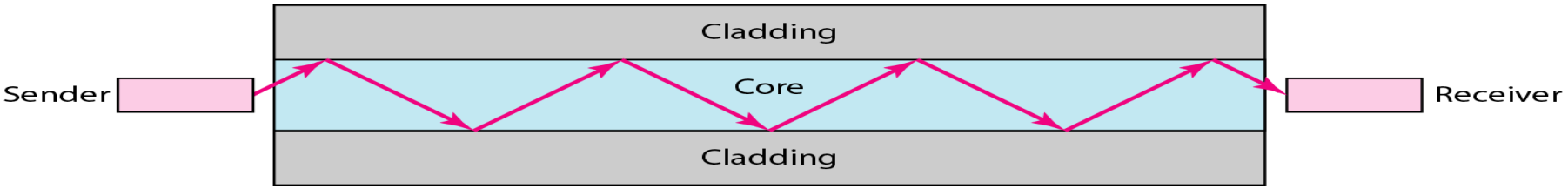
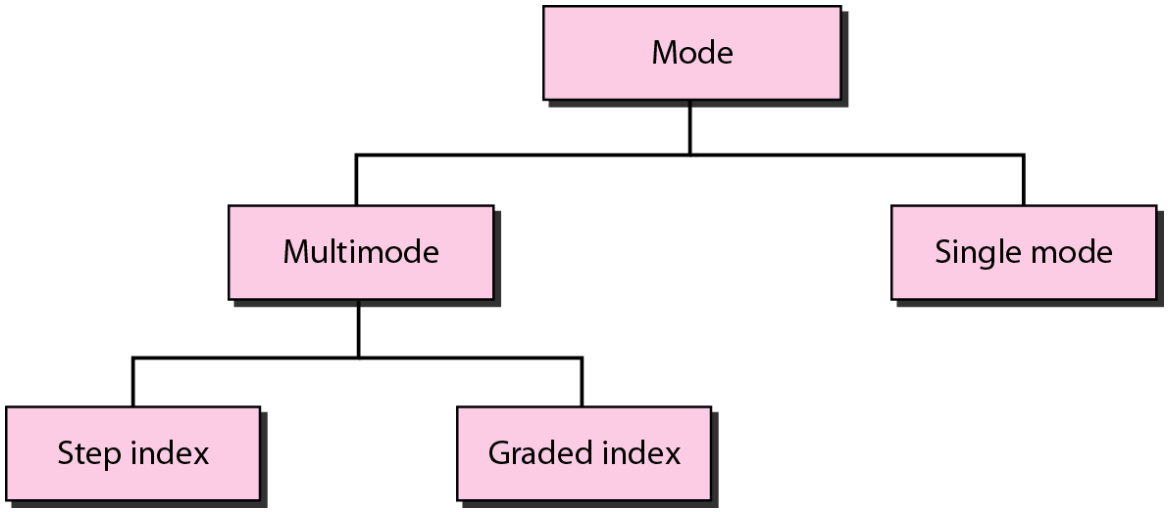
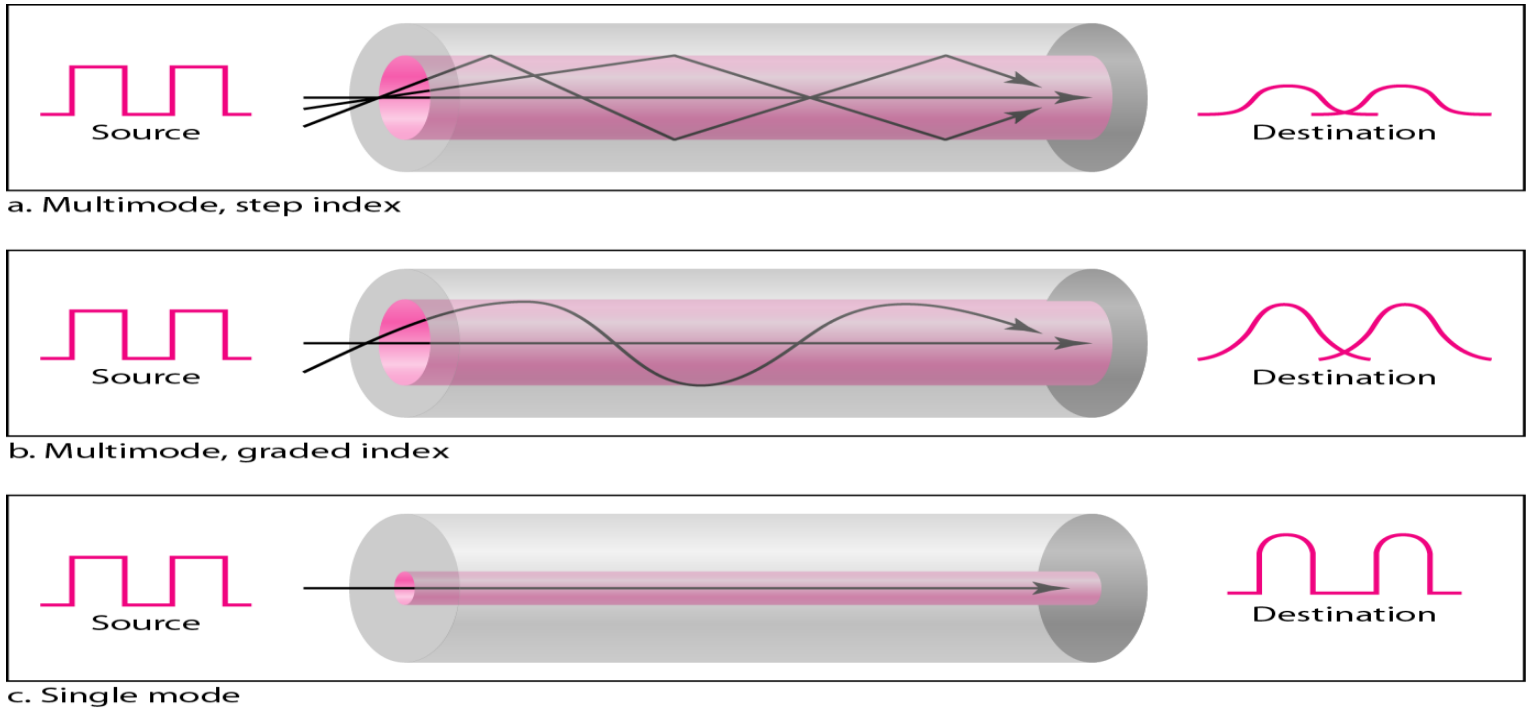


Figure 7.12 *Propagation modes*



1. Single-mode fiber
   Carries light pulses along single path.
2. Multimode fiber
   Many pulses of light travel at different angles

Figure 7.13 *Modes*



7-1 GUIDED MEDIA

- ***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.
- At the interface, there is an abrupt(sudden/unwanted) change due to a lower density; this alters the angle of the beam's motion.
- 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.
- ***In multimode graded-index fiber***, decreases this distortion of the signal through the cable. The word index here refers to the index of refraction. As we saw above, the index of refraction is related to density.
- A graded-index fiber, therefore, is one with varying densities. Density is highest at the center of the core and decreases gradually to its lowest at the edge.

- ***Applications:*** 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.

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

  1. Higher bandwidth.
  2. Less signal attenuation.
  3. Immunity to electromagnetic interference.
  4. Light weight.
  6. Greater immunity to tapping(Extract the signal without breaking connection).

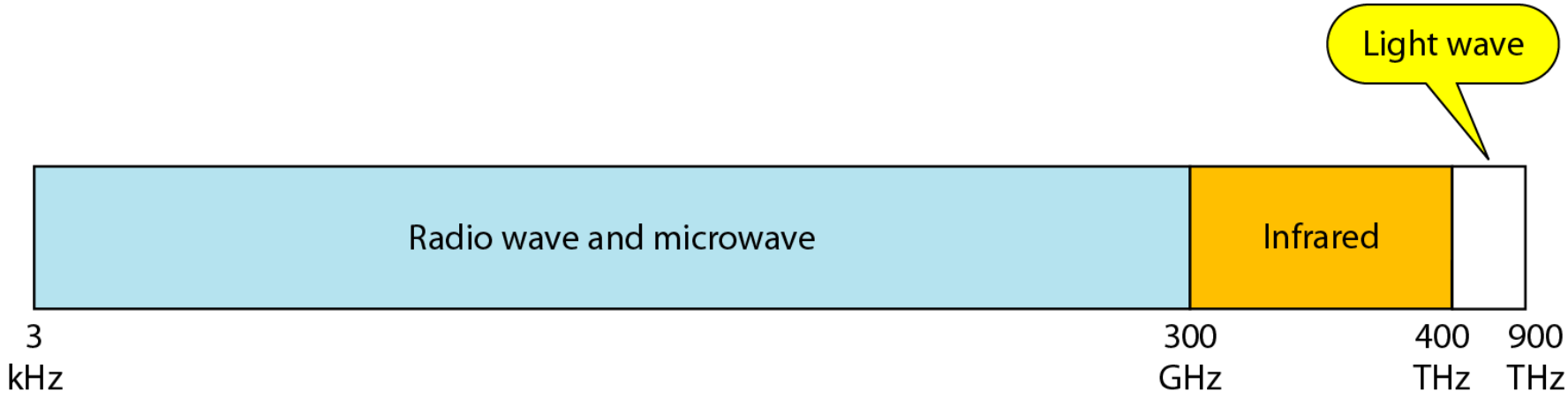
- **Disadvantages** There are some disadvantages in the use of optical fiber.

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. 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.



Radio, satellite microwave,, Bluetooth, and infrared light are all different forms of electromagnetic waves that are used to transmit data

unguided signal can travel from the source to destination in several ways:

1.Ground Propagation:

- Radio waves travel through the lowest portion of the atmosphere, hugging the earth.
- The low frequency signal follow the curvature of the planet.
- Distance depends on the amount of the power.

2.Sky Propagation:

- Higher frequency radio radiate upward into the ionosphere where they are reflected back to the earth.
- Sky propagation allow for greater distance with lower power output.

3.line-of-sight Propagation: Very high frequency signals are transmitted in straight lines directly from antenna to antenna.

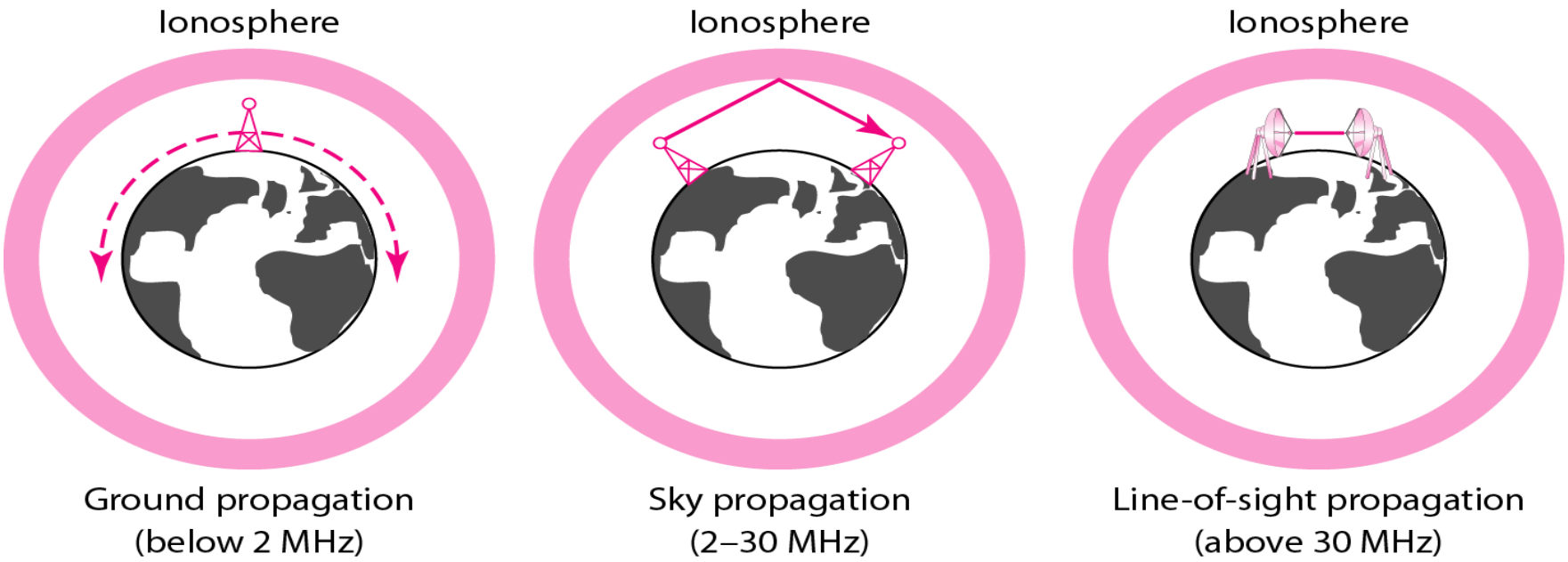
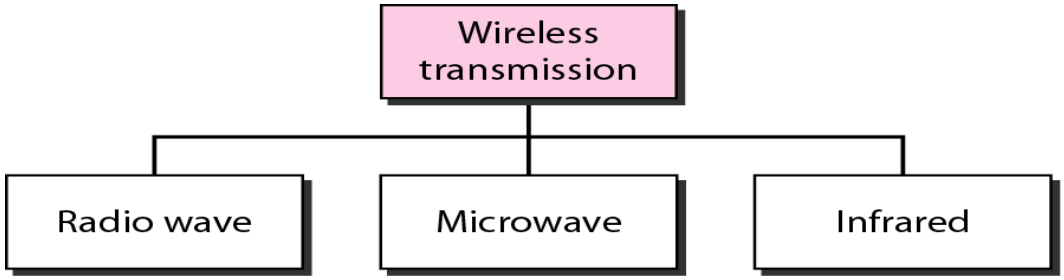


Figure 7.19 *Wireless transmission waves*



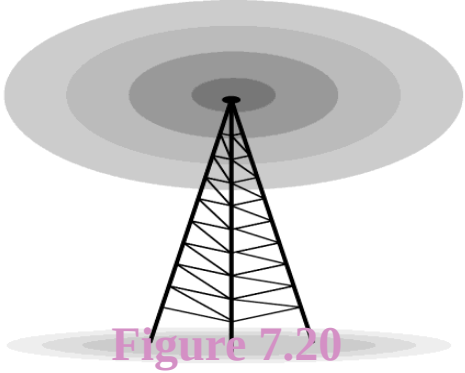


Figure 7.20

Omnidirectional antenna

- **Radio Waves**
- 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.

- Radio waves, for the most part, are omnidirectional(one way). 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.

- ***The following describes some characteristics of microwave propagation:***
- 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(to go through) walls. This characteristic can be a disadvantage if receivers are inside buildings.
- The microwave band is relatively wide, almost 299 GHz.
- Use of certain portions of the band requires permission from authorities.

- ***Unidirectional*** 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**.

- **Infrared waves**

- with frequencies from 300 GHz to 400 THz 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 neighbours
- However, this same characteristic makes 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.

- Between 300 GHz-400 THz
- Used for short-range communication.
- Very common with remote control devices, but can also be used for device-to-device transfers,
- Line-of-sight propagation.