Transmission Media

Figure 7.1 *Transmission medium and physical layer*

Transmission media is a communication channel that carries the information from the sender to the receiver. Data is transmitted through the electromagnetic signals.

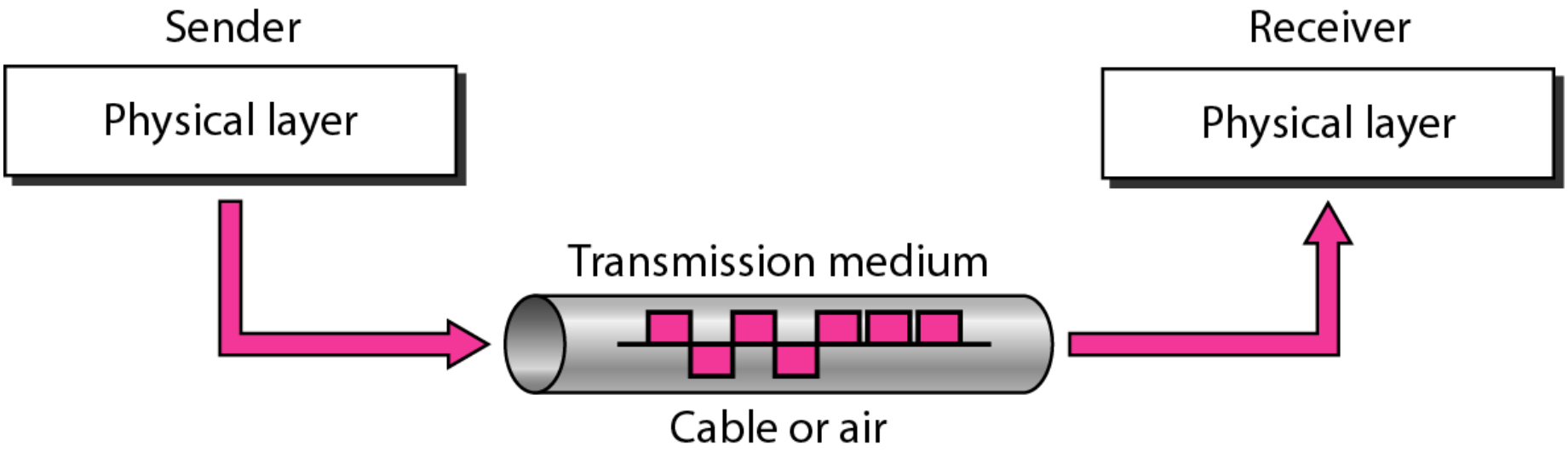
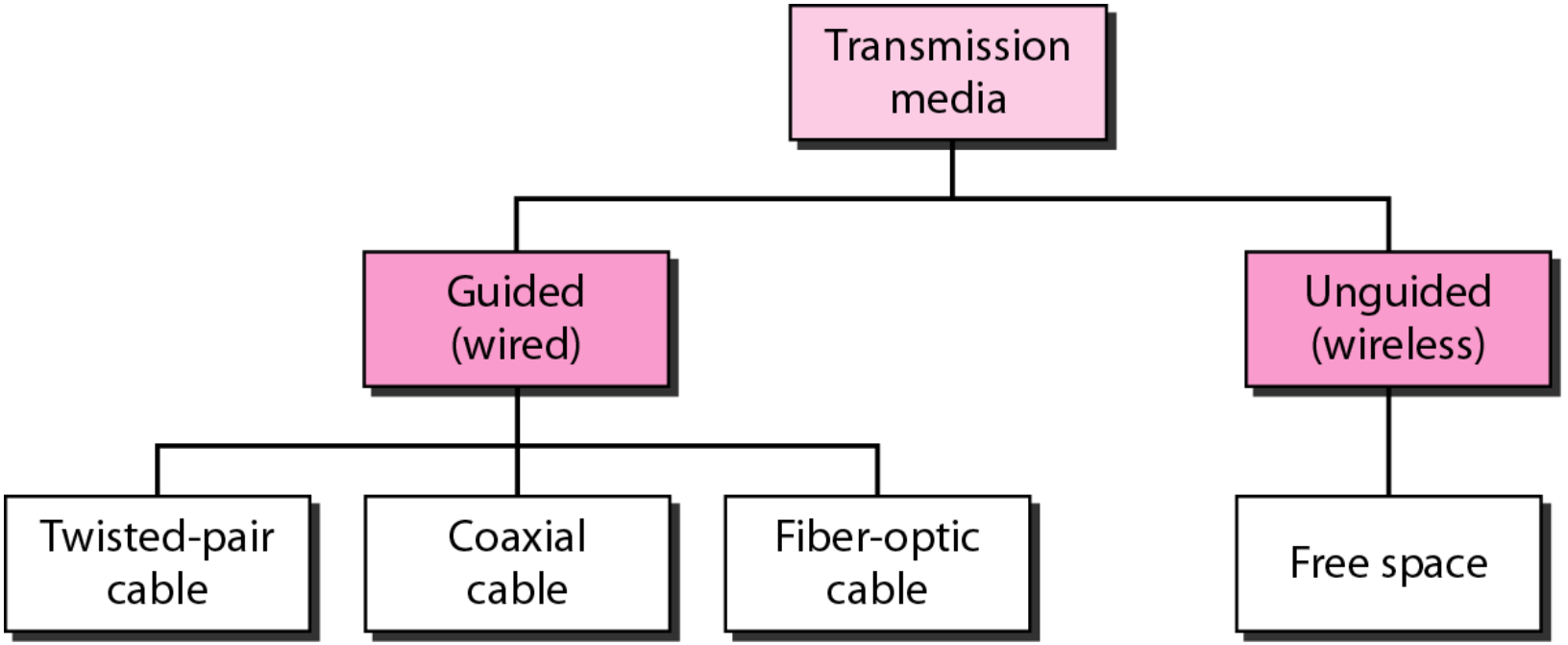
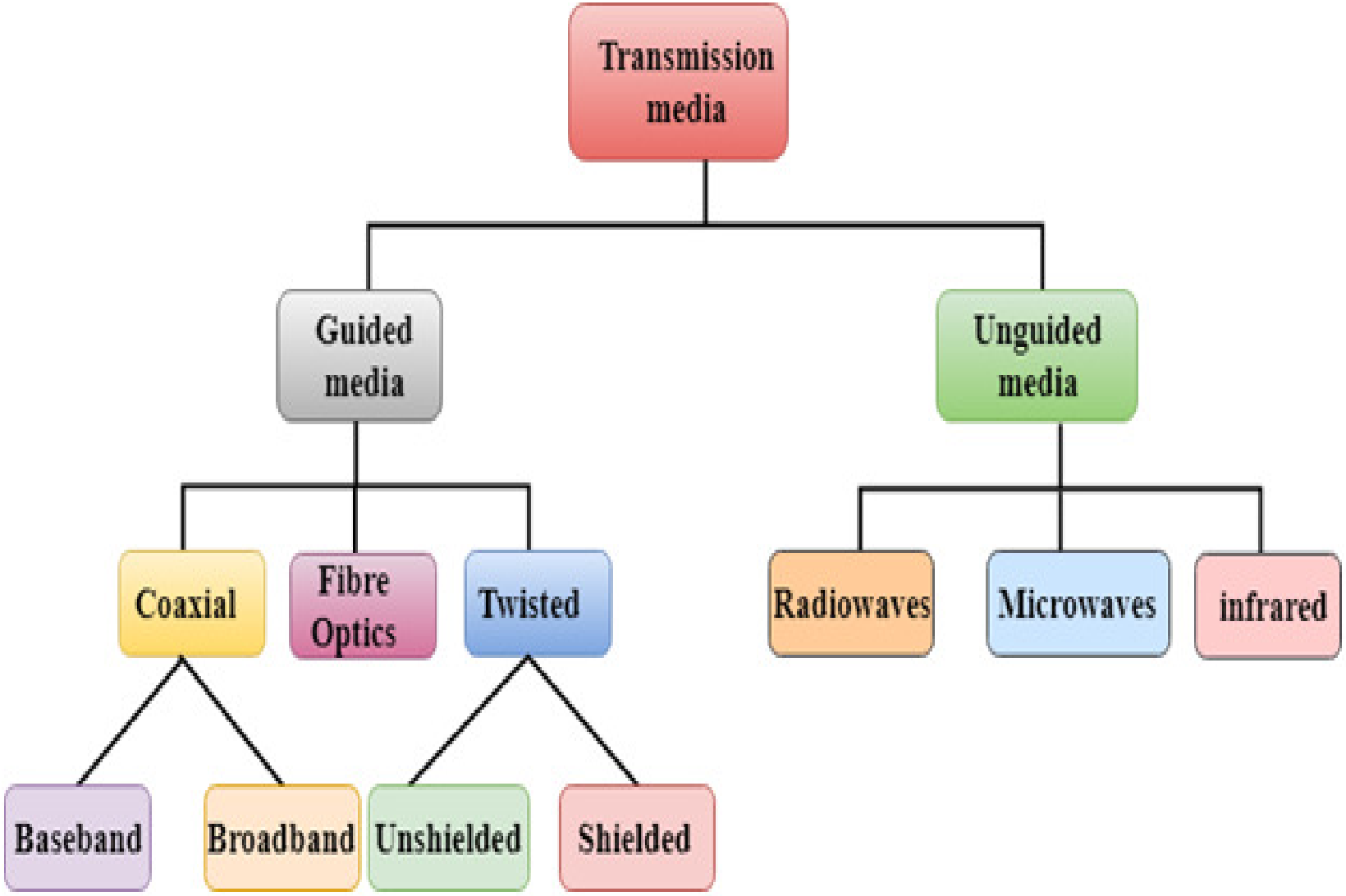


Figure 7.2 *Classes of transmission media*




Transmission media
Guided media
Unguided media
Coaxial
Fibre Optics
Twisted
Radiowaves
Microwaves
infrared
Baseband
Broadband
Unshielded
Shielded

- The characteristics and quality of data transmission are determined by the characteristics of medium and signal.
- Transmission media is of two types are wired media and wireless media. In wired media, medium characteristics are more important whereas, in wireless media, signal characteristics are more important.
- Different transmission media have different properties such as bandwidth, delay, cost and ease of installation and maintenance.
- The transmission media is available in the lowest layer of the OSI reference model, i.e., **Physical layer.**

GUIDED MEDIA

Guided media, which are those that provide a conduit from one device to another, include twisted-pair cable, coaxial cable, and fiber-optic cable.

It is defined as the physical medium through which the signals are transmitted.

It is also known as Bounded media.

Topics discussed in this section:

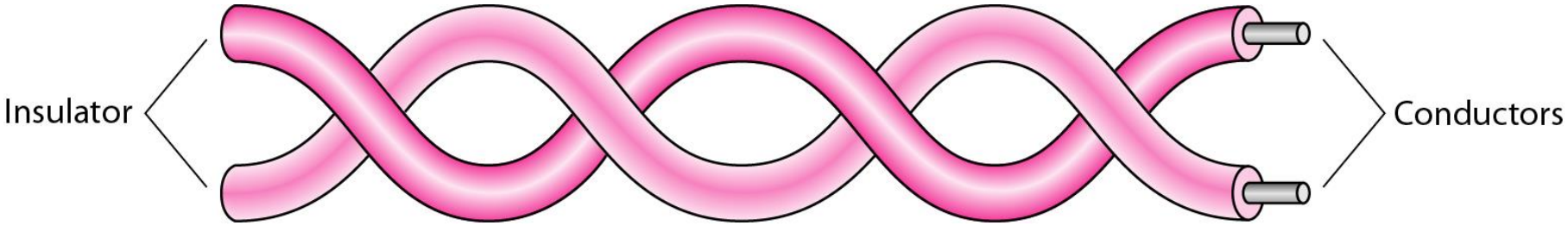
Twisted-Pair Cable
Coaxial Cable
Fiber-Optic Cable

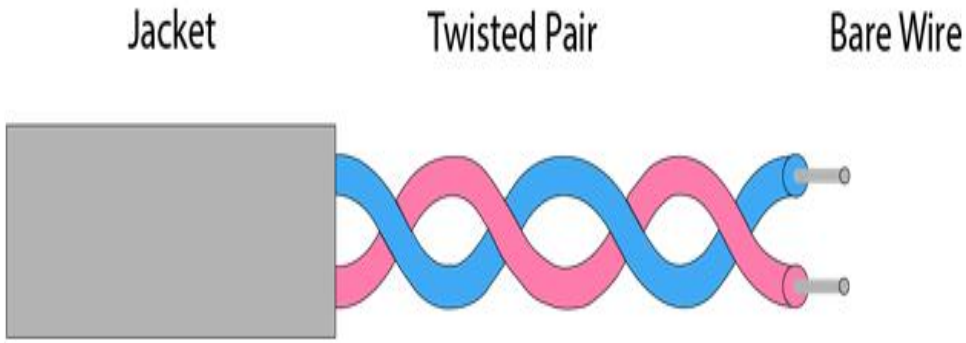
Figure 7.3 *Twisted-pair cable*

Twisted pair is a physical media made up of a pair of cables twisted with each other.

A twisted pair cable is cheap as compared to other transmission media.

Installation of the twisted pair cable is easy, and it is a lightweight cable.





Types of Twisted pair:

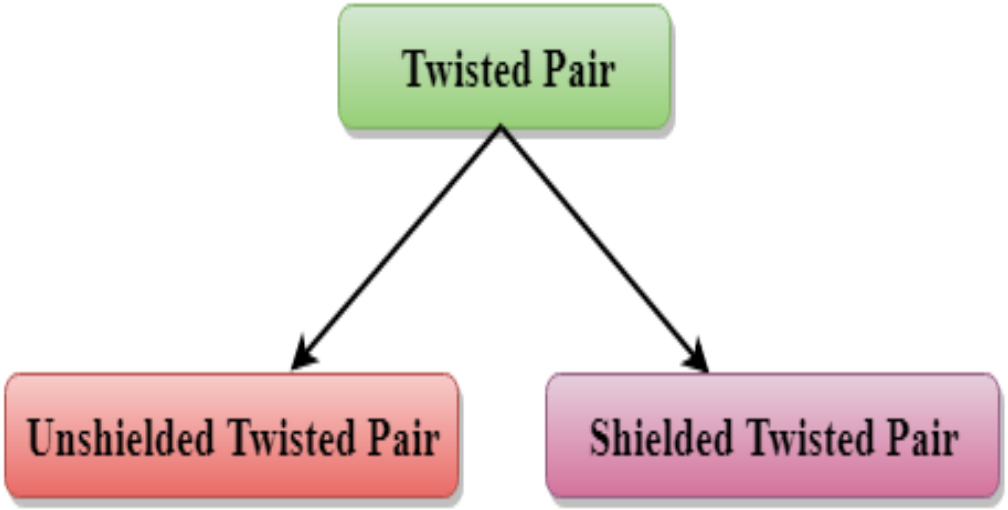
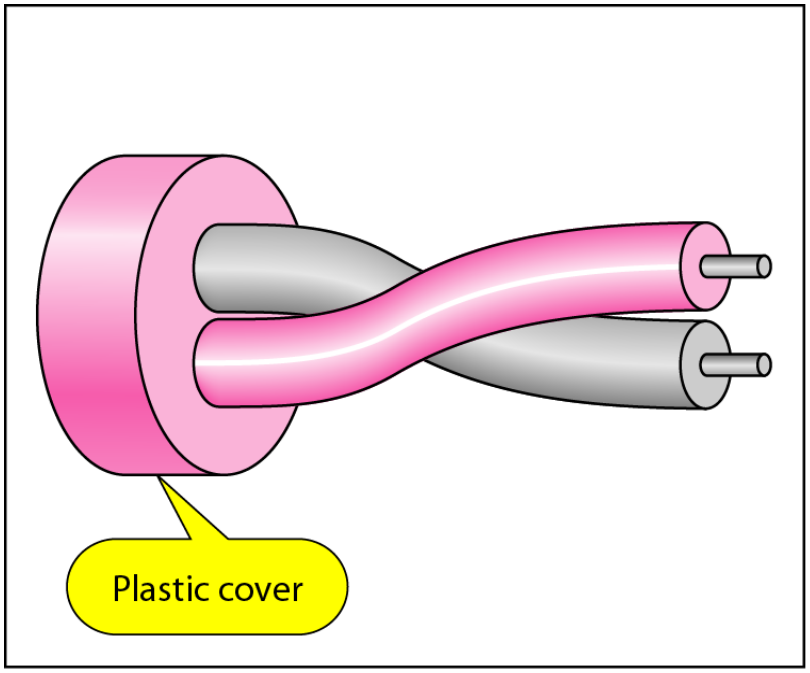
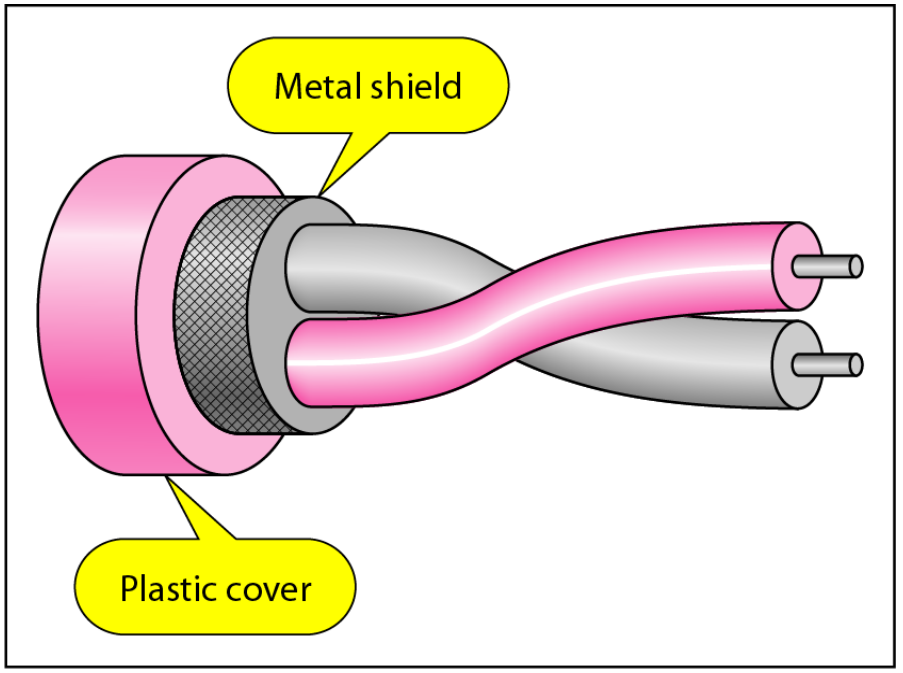


Figure 7.4 *UTP and STP cables*



a. UTP



b. STP

Table 7.1 *Categories of unshielded twisted-pair cables*

Category	*Specification*	*Data Rate (Mbps)*	*Use*
1	Unshielded twisted-pair used in telephone	< 0.1	Telephone
2	Unshielded twisted-pair originally used in T-lines	2	T-1 lines
3	Improved CAT 2 used in LANs	10	LANs
4	Improved CAT 3 used in Token Ring networks	20	LANs
5	Cable wire is normally 24 AWG with a jacket and outside sheath	100	LANs
5E	An extension to category 5 that includes extra features to minimize the crosstalk and electromagnetic interference	125	LANs
6	A new category with matched components coming from the same manufacturer. The cable must be tested at a 200-Mbps data rate.	200	LANs
7	Sometimes called SSTP (shielded screen twisted-pair). Each pair is individually wrapped in a helical metallic foil followed by a metallic foil shield in addition to the outside sheath. The shield decreases the effect of crosstalk and increases the data rate.	600	LANs

Unshielded Twisted Pair:

An unshielded twisted pair is widely used in telecommunication. Following are the categories of the unshielded twisted pair cable:

- **Category 1:** Category 1 is used for telephone lines that have low-speed data.
- **Category 2:** It can support upto 4Mbps.
- **Category 3:** It can support upto 16Mbps.
- **Category 4:** It can support upto 20Mbps. Therefore, it can be used for long-distance communication.
- **Category 5:** It can support upto 200Mbps.

Advantages Of Unshielded Twisted Pair:

- It is cheap.
- Installation of the unshielded twisted pair is easy.
- It can be used for high-speed LAN.

Disadvantage:

- This cable can only be used for shorter distances because of attenuation.

Figure 7.5 *UTP connector*

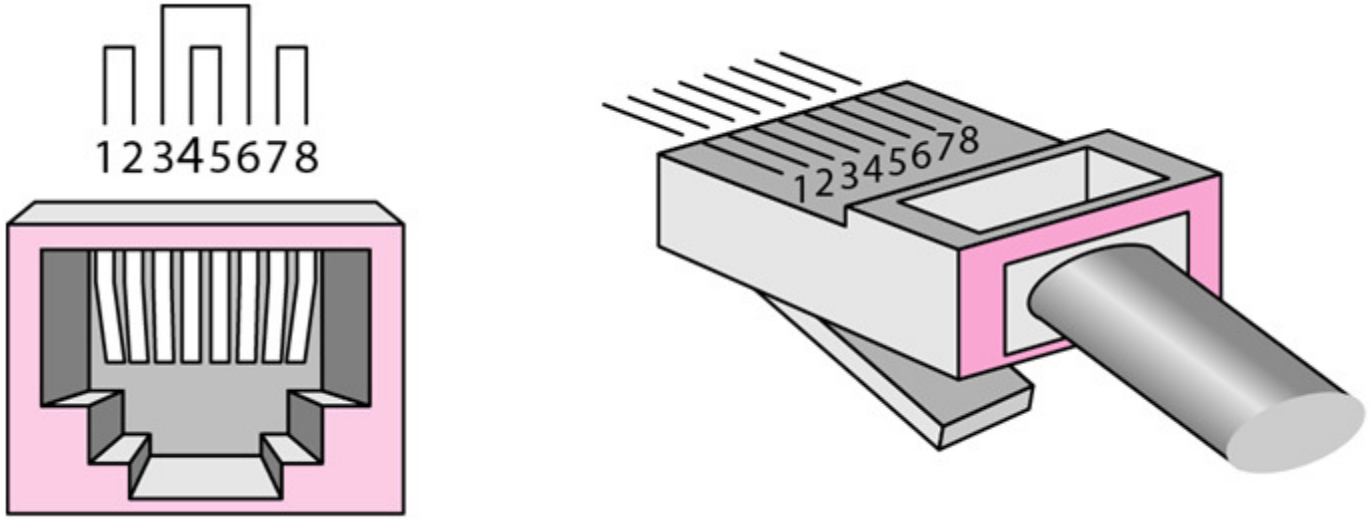
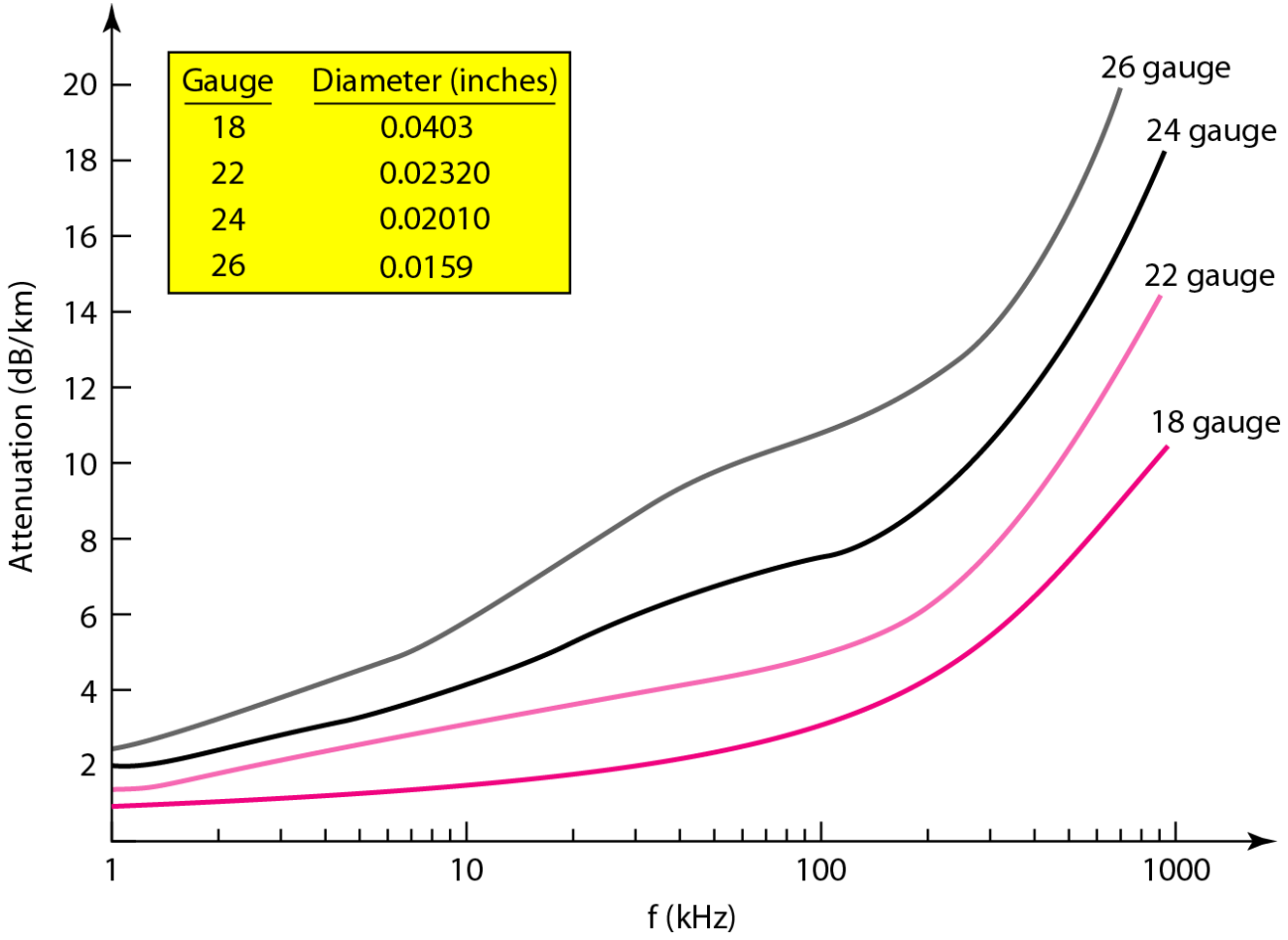


Figure 7.6 *UTP performance*



Shielded Twisted Pair

A shielded twisted pair is a cable that contains the mesh surrounding the wire that allows the higher transmission rate.

Characteristics Of Shielded Twisted Pair:

- The cost of the shielded twisted pair cable is not very high and not very low.
- An installation of STP is easy.
- It has higher capacity as compared to unshielded twisted pair cable.
- It has a higher attenuation.
- It is shielded that provides the higher data transmission rate.

Disadvantages

- It is more expensive as compared to UTP and coaxial cable.
- It has a higher attenuation rate.

Coaxial Cable

Coaxial cables are copper cables with better **shielding** than twisted pair cables, so that transmitted signals may travel longer distances at higher speeds. A coaxial cable consists of these layers, starting from the innermost –

- Stiff copper wire as **core**
- **Insulating material** surrounding the core
- Closely woven braided mesh of **conducting material** surrounding the **insulator**
- Protective **plastic sheath** encasing the wire

Coaxial cables are widely used for **cable TV** connections and **LANs**.

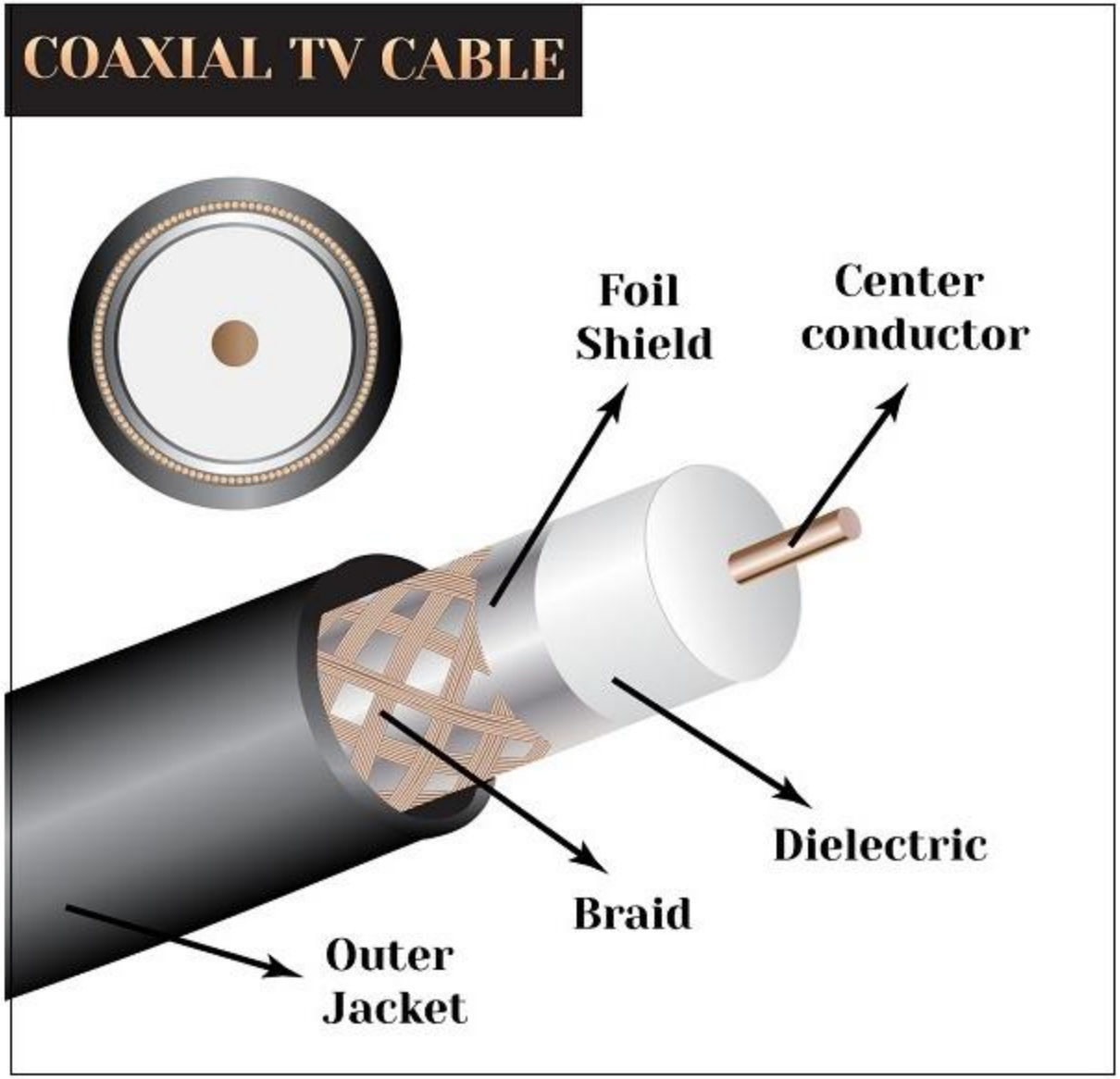


Figure 7.7 *Coaxial cable*

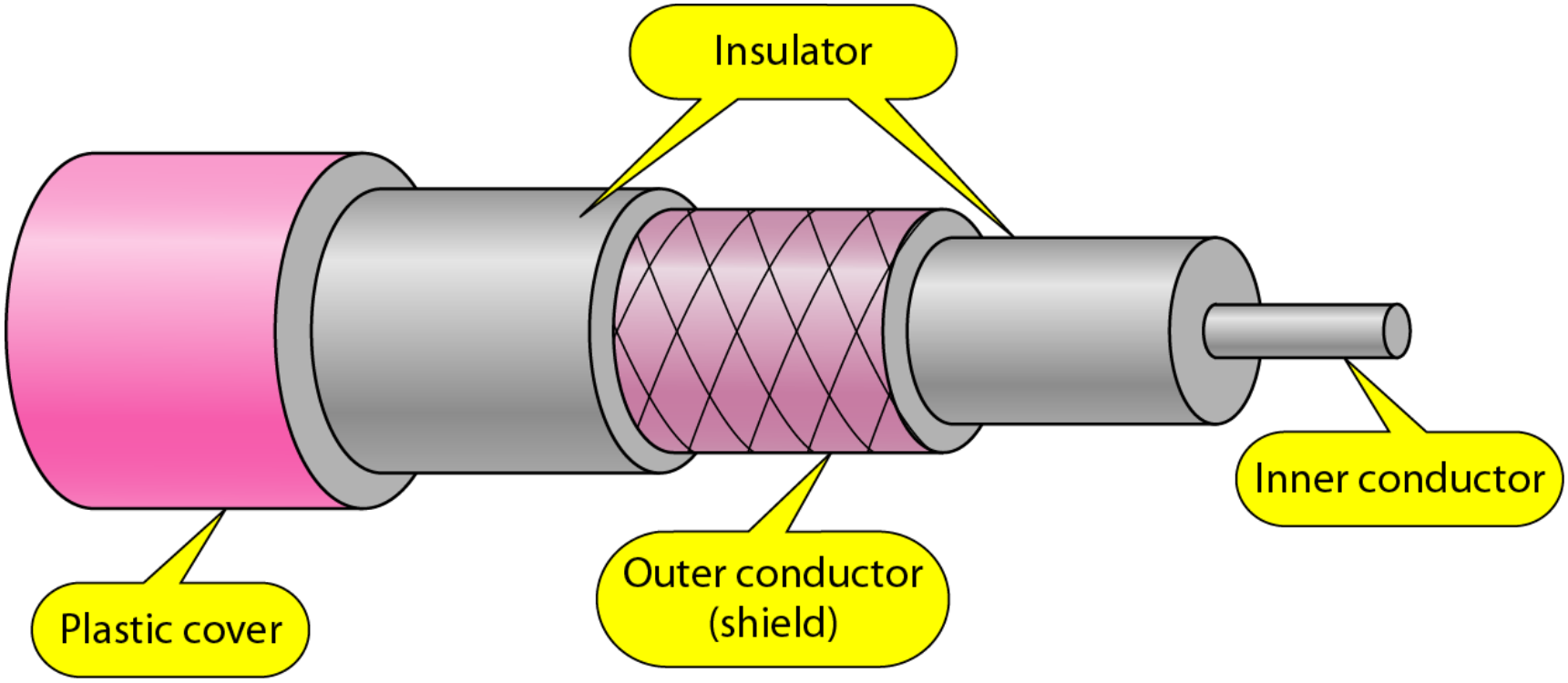
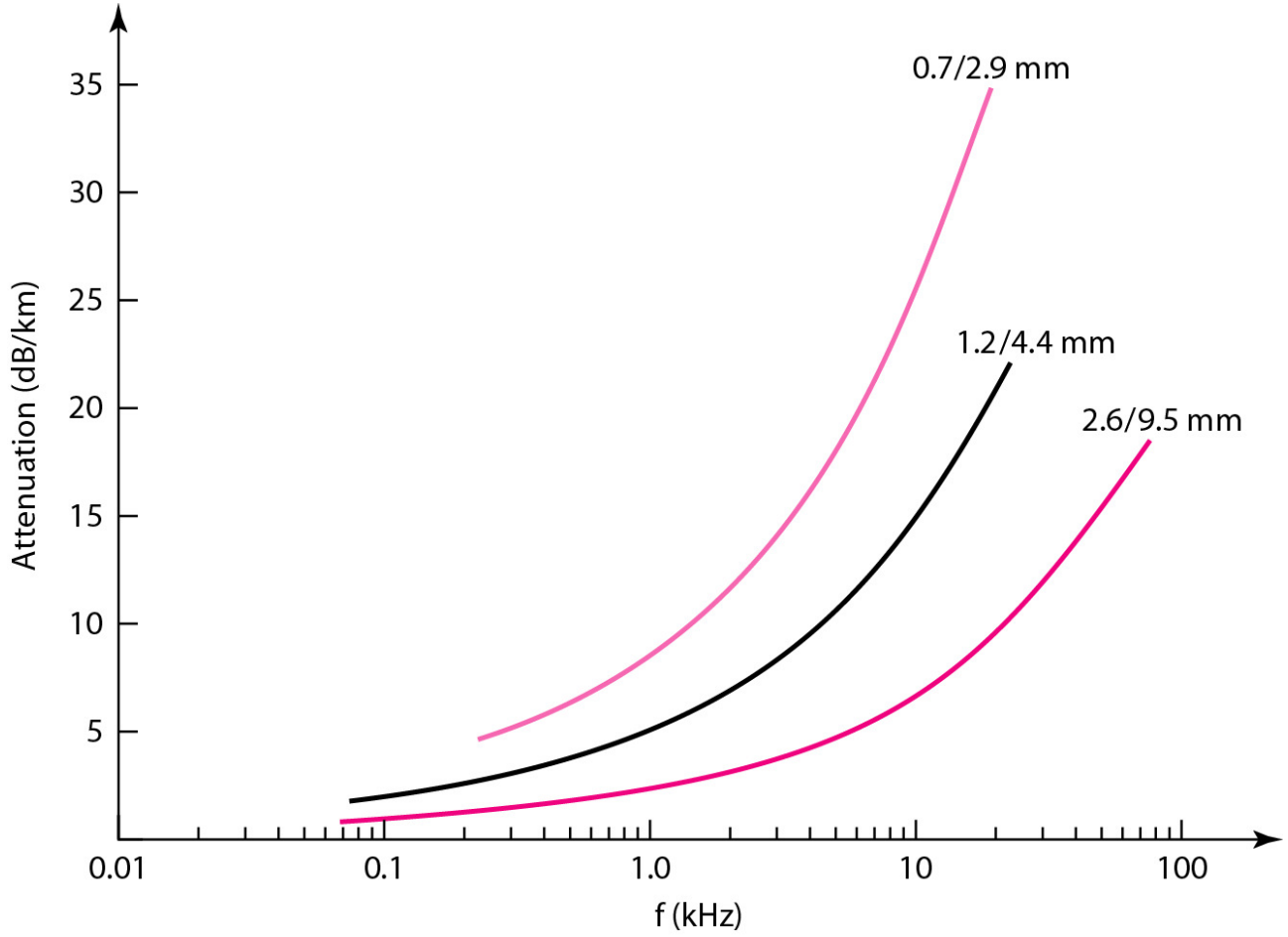


Table 7.2 ***Categories of coaxial cables***

Category	*Impedance*	*Use*
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet
RG-11	50 Ω	Thick Ethernet

Figure 7.9 *Coaxial cable performance*



Coaxial cable is of two types:

1. **Baseband transmission:** It is defined as the process of transmitting a single signal at high speed.
2. **Broadband transmission:** It is defined as the process of transmitting multiple signals simultaneously.

Advantages Of Coaxial cable:

- The data can be transmitted at high speed.
- It has better shielding as compared to twisted pair cable.
- It provides higher bandwidth.

Disadvantages Of Coaxial cable:

- It is more expensive as compared to twisted pair cable.
- If any fault occurs in the cable causes the failure in the entire network.

Fibre Optic

- Fibre optic cable is a cable that uses electrical signals for communication.

Thin glass or plastic threads used to transmit data using light waves are called **optical fibre**. Light Emitting Diodes (LEDs) or Laser Diodes (LDs) emit light waves at the **source**, which is read by a **detector** at the other end. **Optical fibre cable** has a bundle of such threads or fibres bundled together in a protective covering. Each fibre is made up of these three layers, starting with the innermost layer –

- **Core** made of high quality **silica glass** or **plastic**
- **Cladding** made of high quality **silica glass** or **plastic**, with a lower refractive index than the core
- Protective outer covering called **buffer**

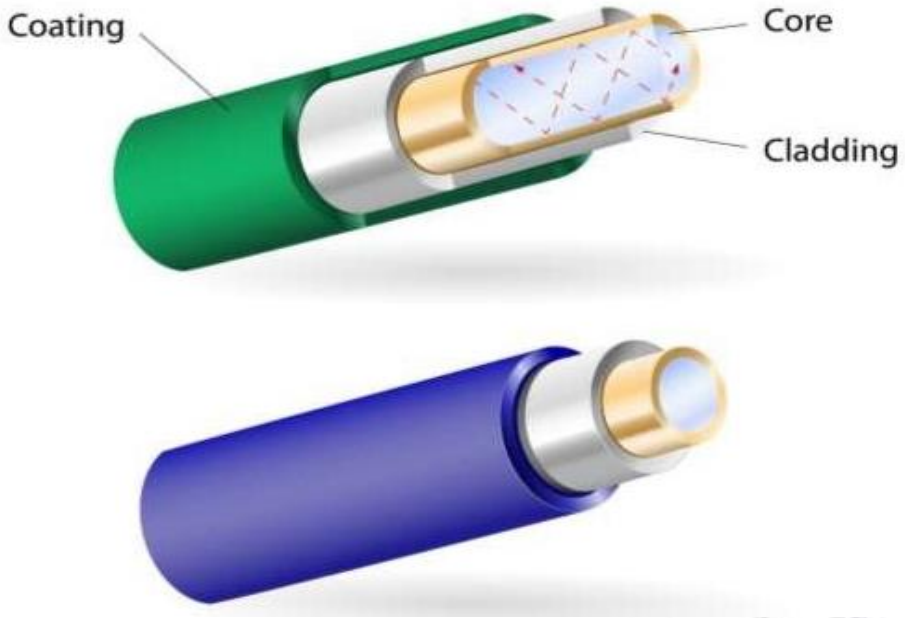

Coating
Core
Cladding

Figure 7.11 *Optical fiber*

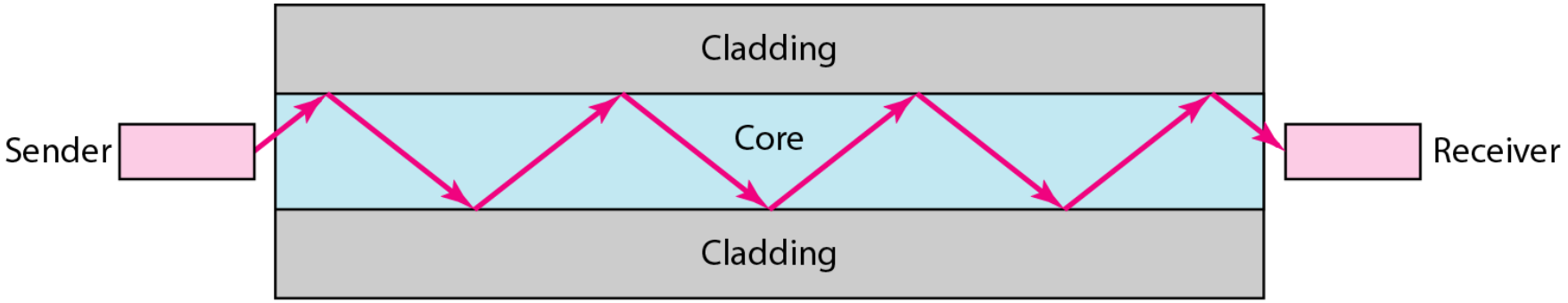


Figure 7.12 *Propagation modes*

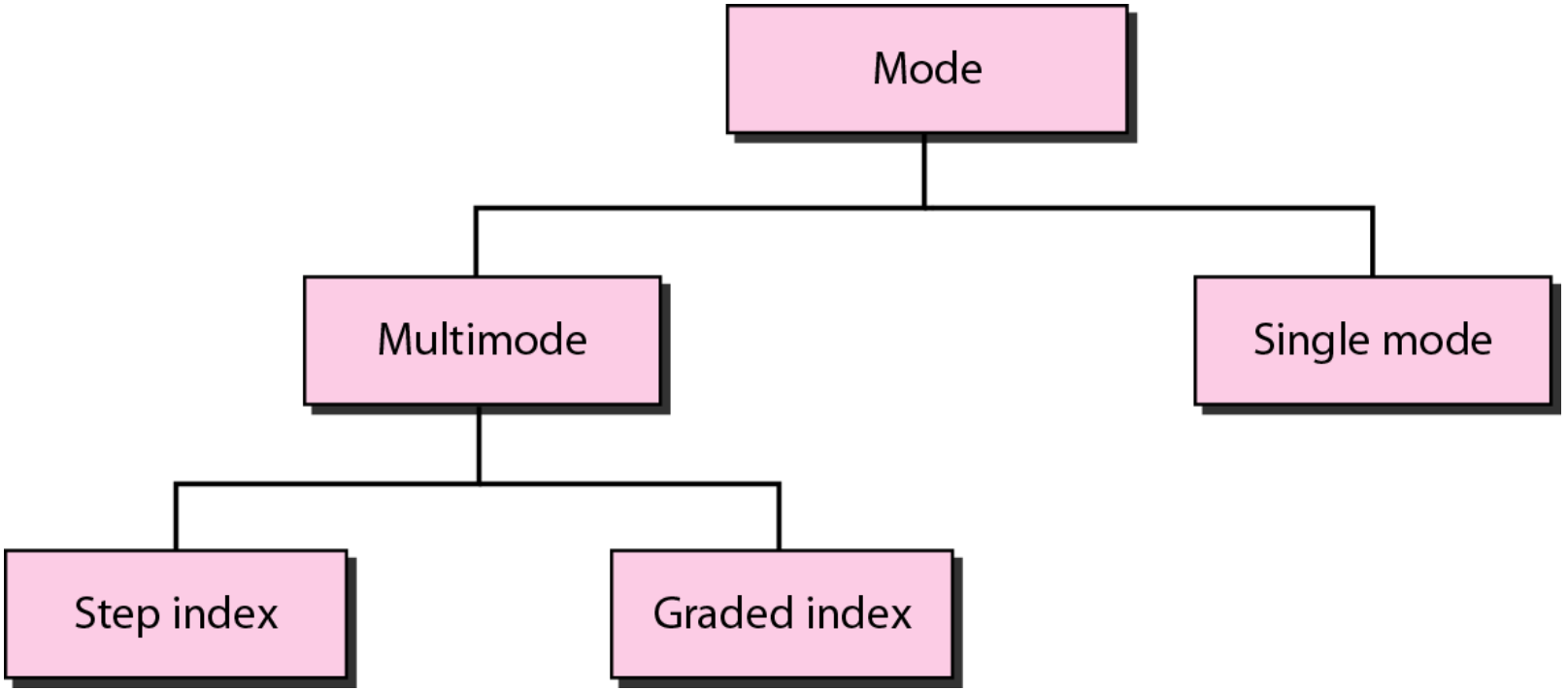
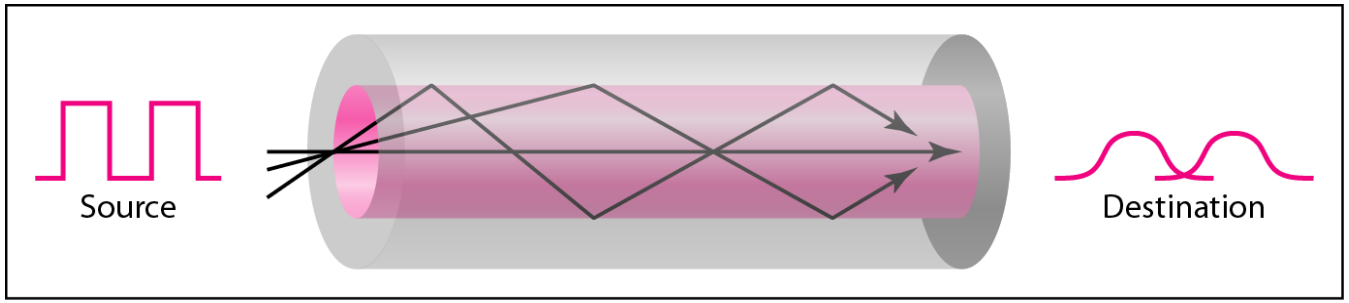
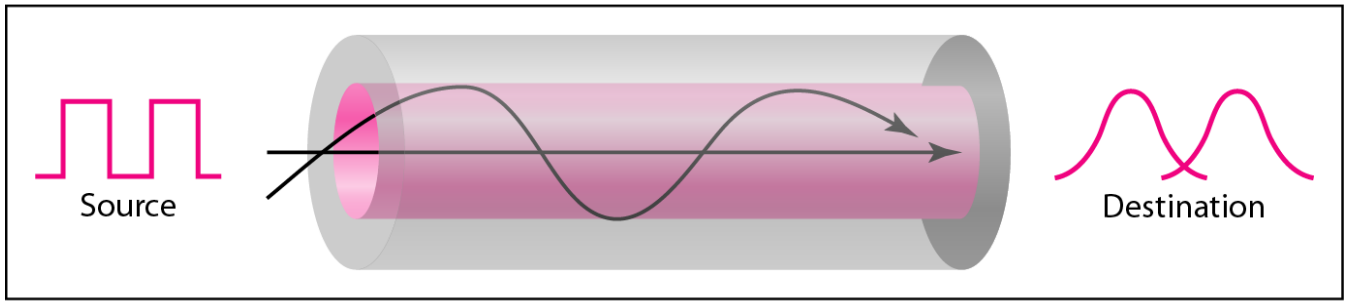


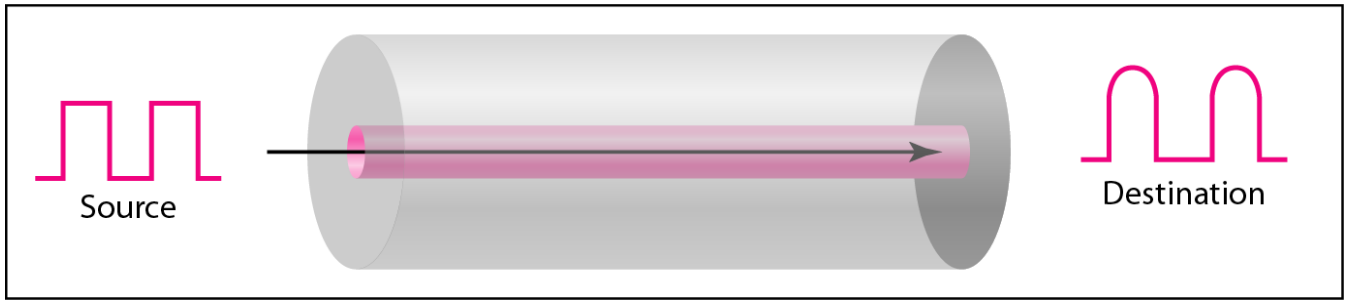
Figure 7.13 *Modes*



a. Multimode, step index



b. Multimode, graded index



c. Single mode

Table 7.3 *Fiber types*

Type	*Core (μm)*	*Cladding (μm)*	*Mode*
50/125	50.0	125	Multimode, graded index
62.5/125	62.5	125	Multimode, graded index
100/125	100.0	125	Multimode, graded index
7/125	7.0	125	Single mode

Figure 7.14 *Fiber construction*

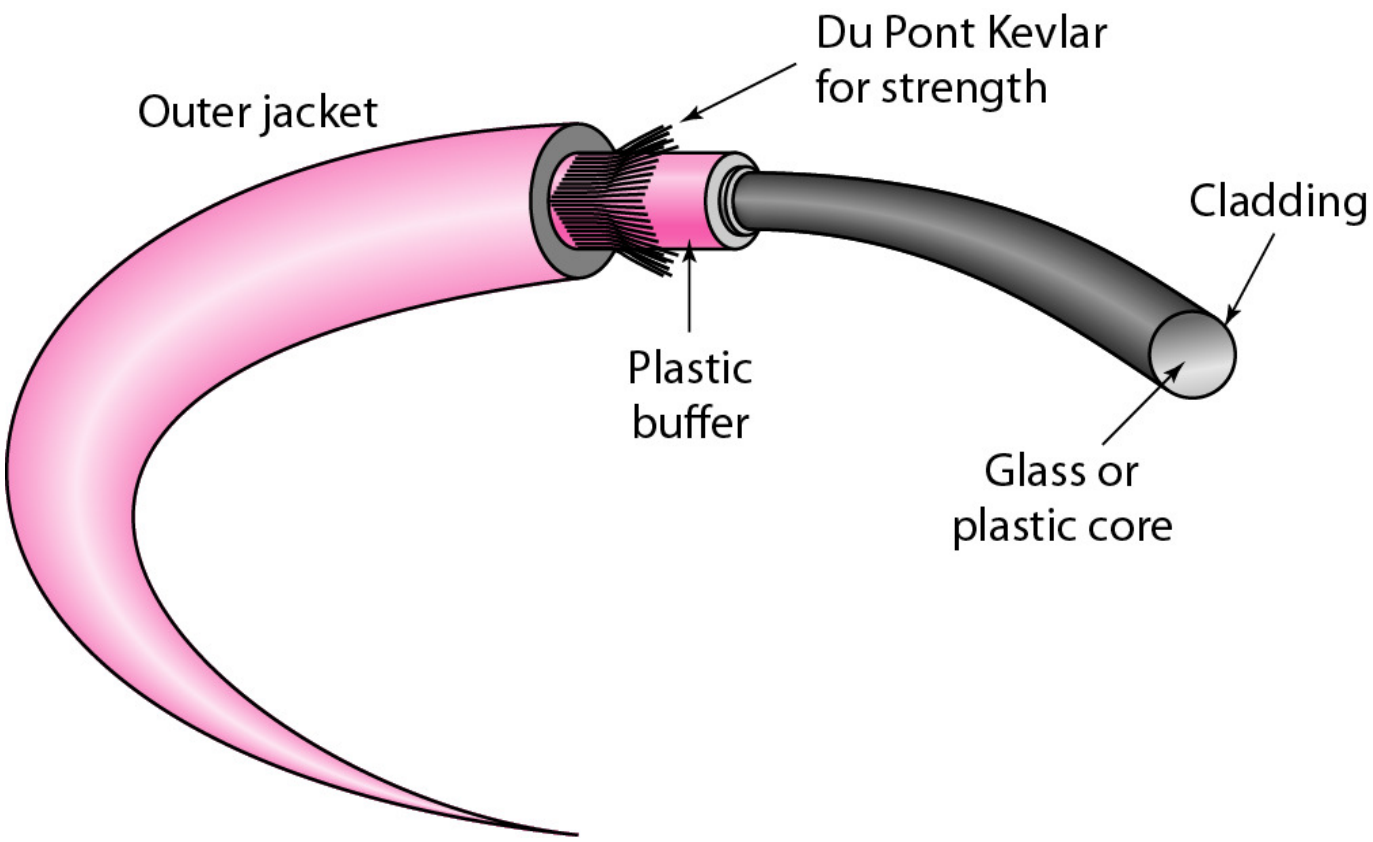


Figure 7.15 *Fiber-optic cable connectors*

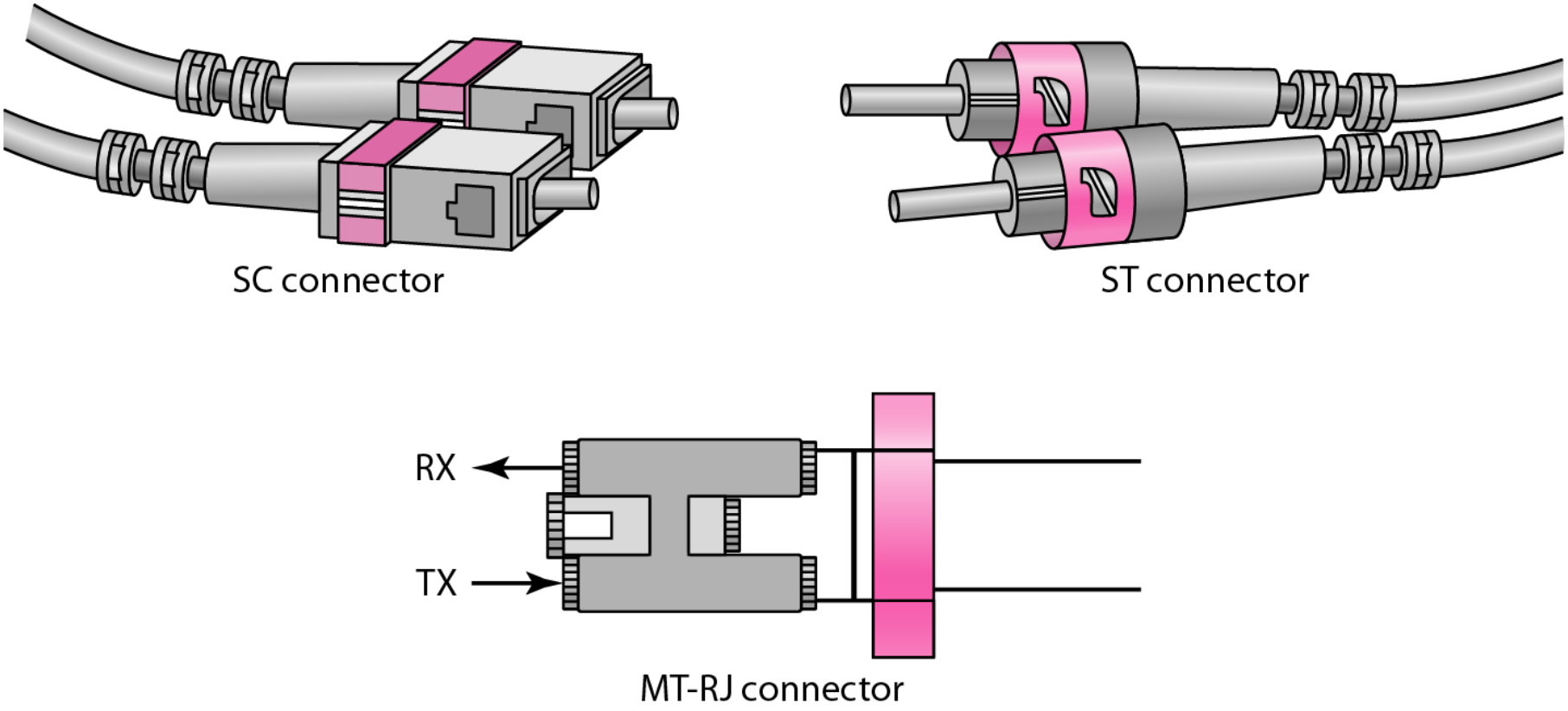
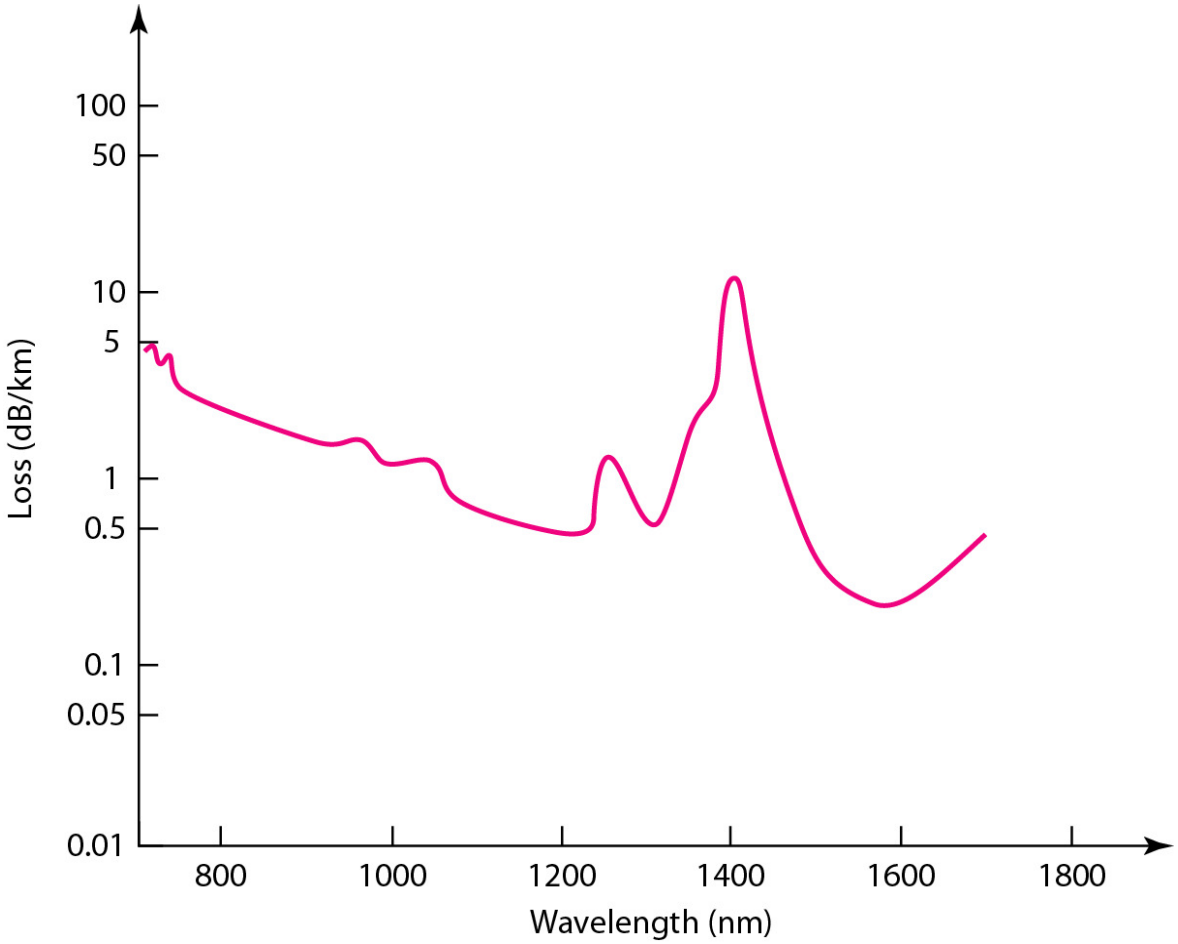


Figure 7.16 *Optical fiber performance*



UNGUIDED MEDIA: WIRELESS

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

Topics discussed in this section:

Radio Waves
Microwaves
Infrared

Radio waves

Figure 7.19 *Wireless transmission waves*

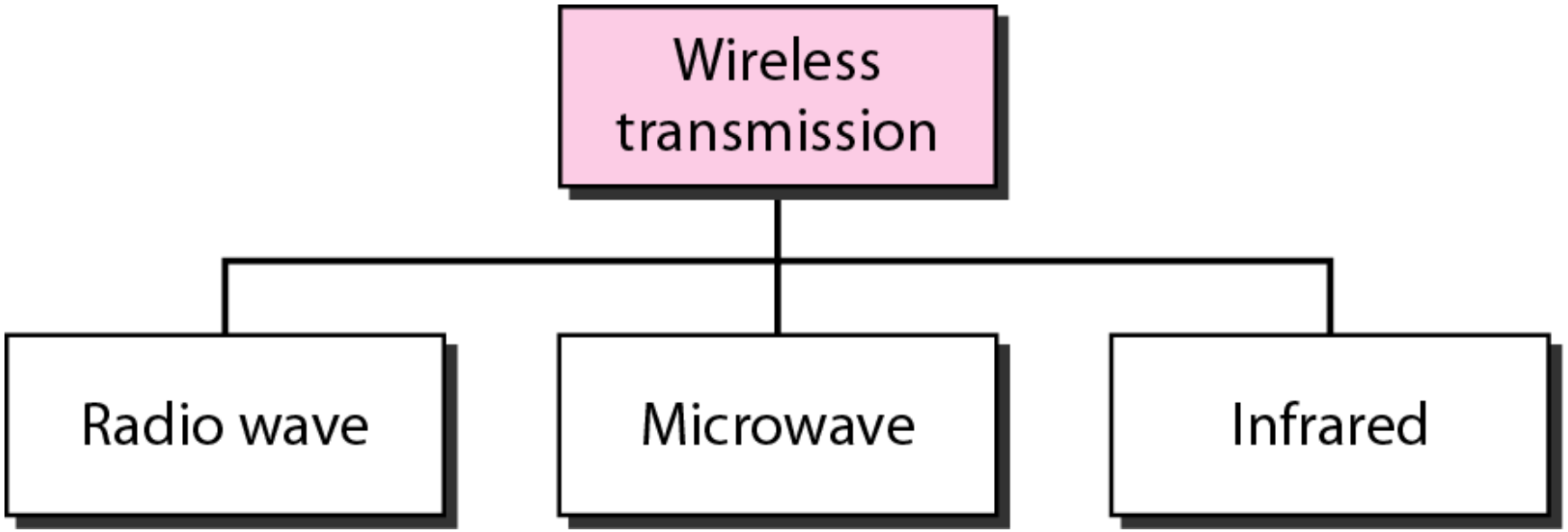


Figure 7.17 *Electromagnetic spectrum for wireless communication*

- An unguided transmission transmits the electromagnetic waves without using any physical medium. Therefore it is also known as **wireless transmission.**
- In unguided media, air is the media through which the electromagnetic energy can flow easily.

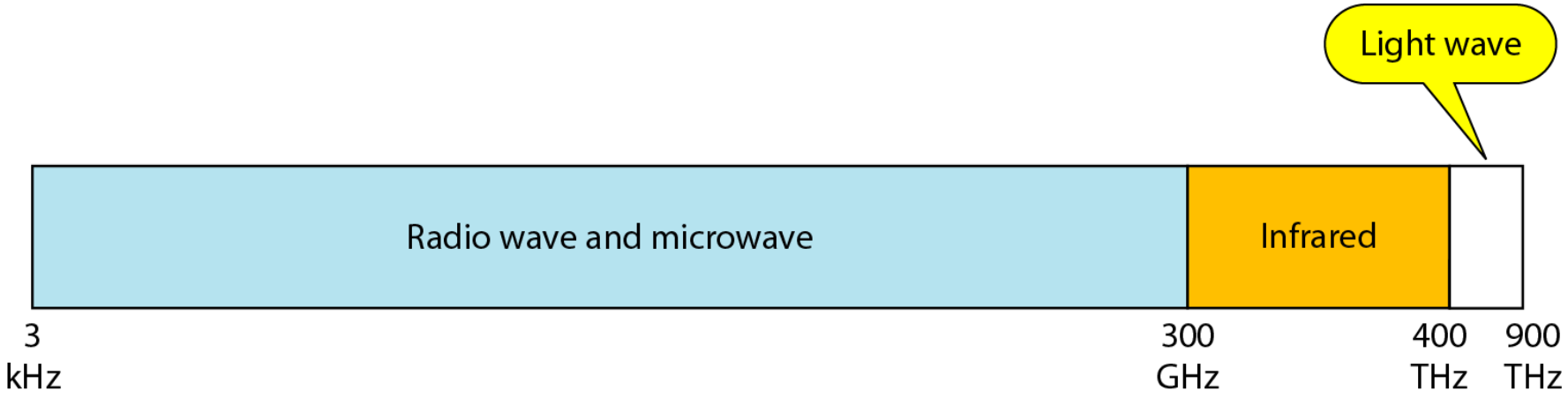
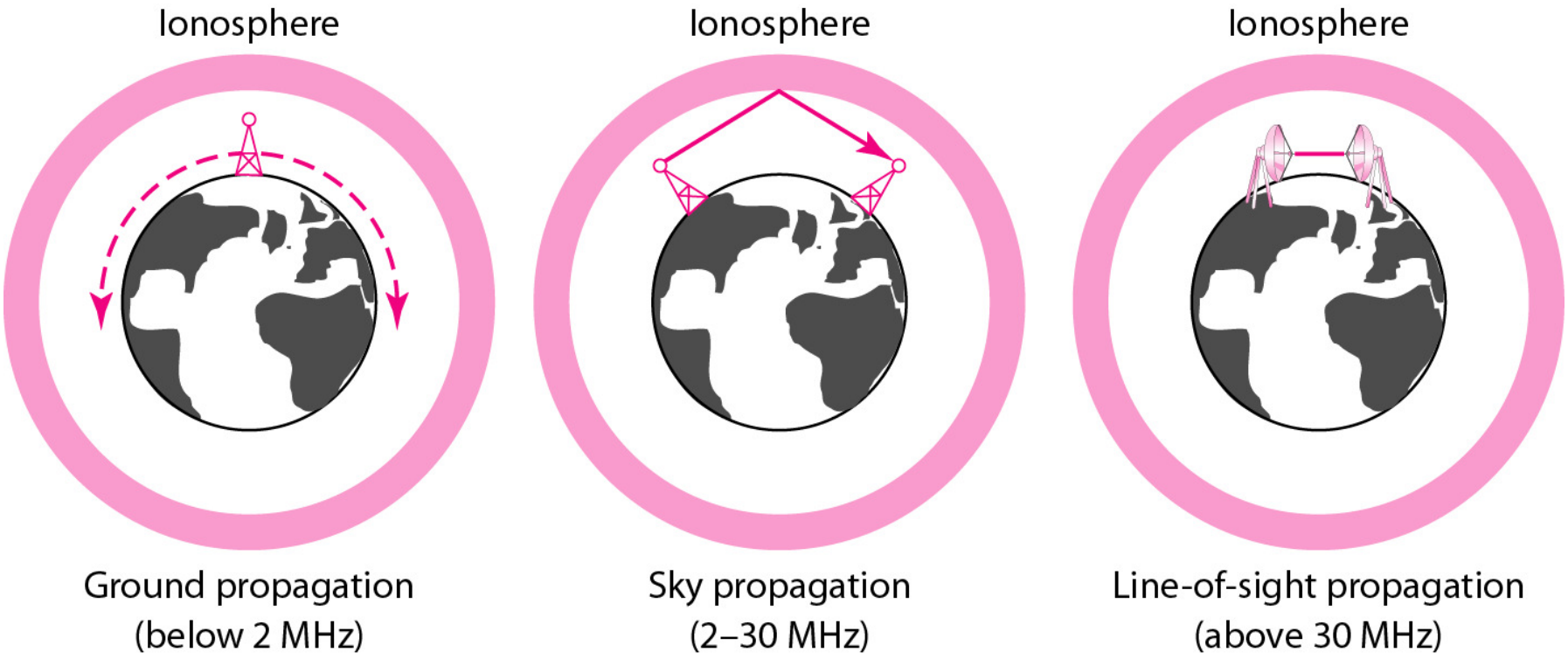
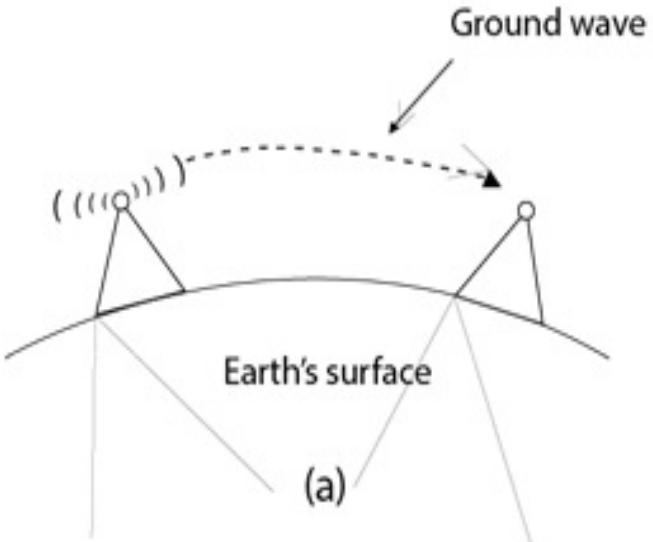
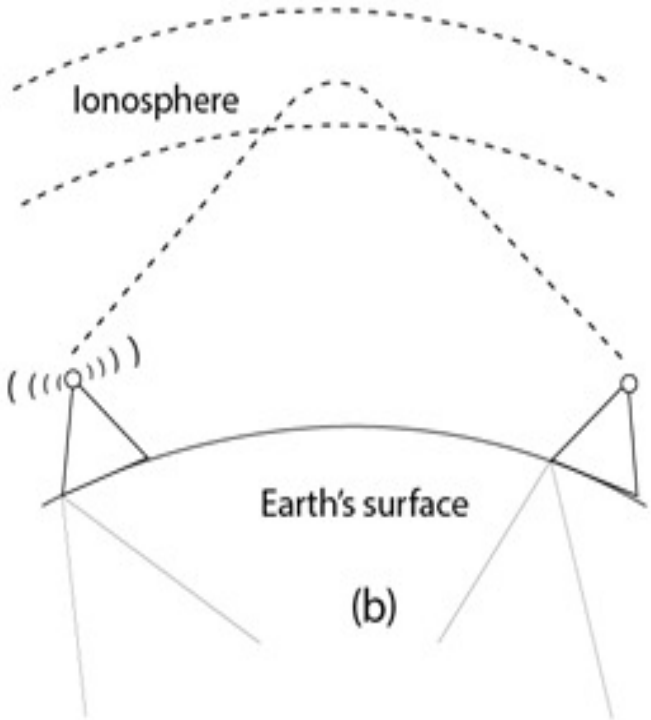


Figure 7.18 *Propagation methods*



- An example of the radio wave is **FM radio**.





Applications Of Radio waves:

- A Radio wave is useful for multicasting when there is one sender and many receivers.
- An FM radio, television, cordless phones are examples of a radio wave.

Table 7.4 *Bands*

Band	*Range*	*Propagation*	*Application*
VLF (very low frequency)	3–30 kHz	Ground	Long-range radio navigation
LF (low frequency)	30–300 kHz	Ground	Radio beacons and navigational locators
MF (middle frequency)	300 kHz–3 MHz	Sky	AM radio
HF (high frequency)	3–30 MHz	Sky	Citizens band (CB), ship/aircraft communication
VHF (very high frequency)	30–300 MHz	Sky and line-of-sight	VHF TV, FM radio
UHF (ultrahigh frequency)	300 MHz–3 GHz	Line-of-sight	UHF TV, cellular phones, paging, satellite
SHF (superhigh frequency)	3–30 GHz	Line-of-sight	Satellite communication
EHF (extremely high frequency)	30–300 GHz	Line-of-sight	Radar, satellite

Note

Radio waves are used for multicast communications, such as radio and television, and paging systems. They can penetrate through walls. Highly regulated. Use omni directional antennas

Note

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

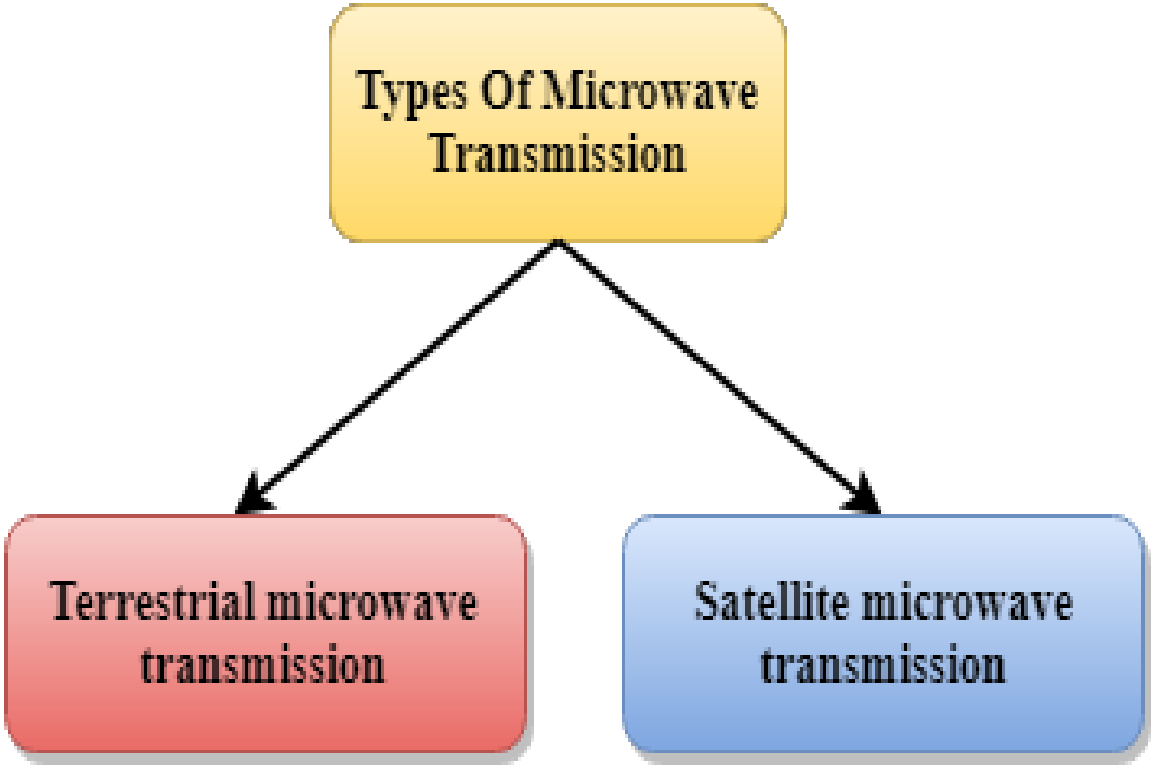
Higher frequency ranges cannot penetrate walls.

Use directional antennas - point to point line of sight communications.

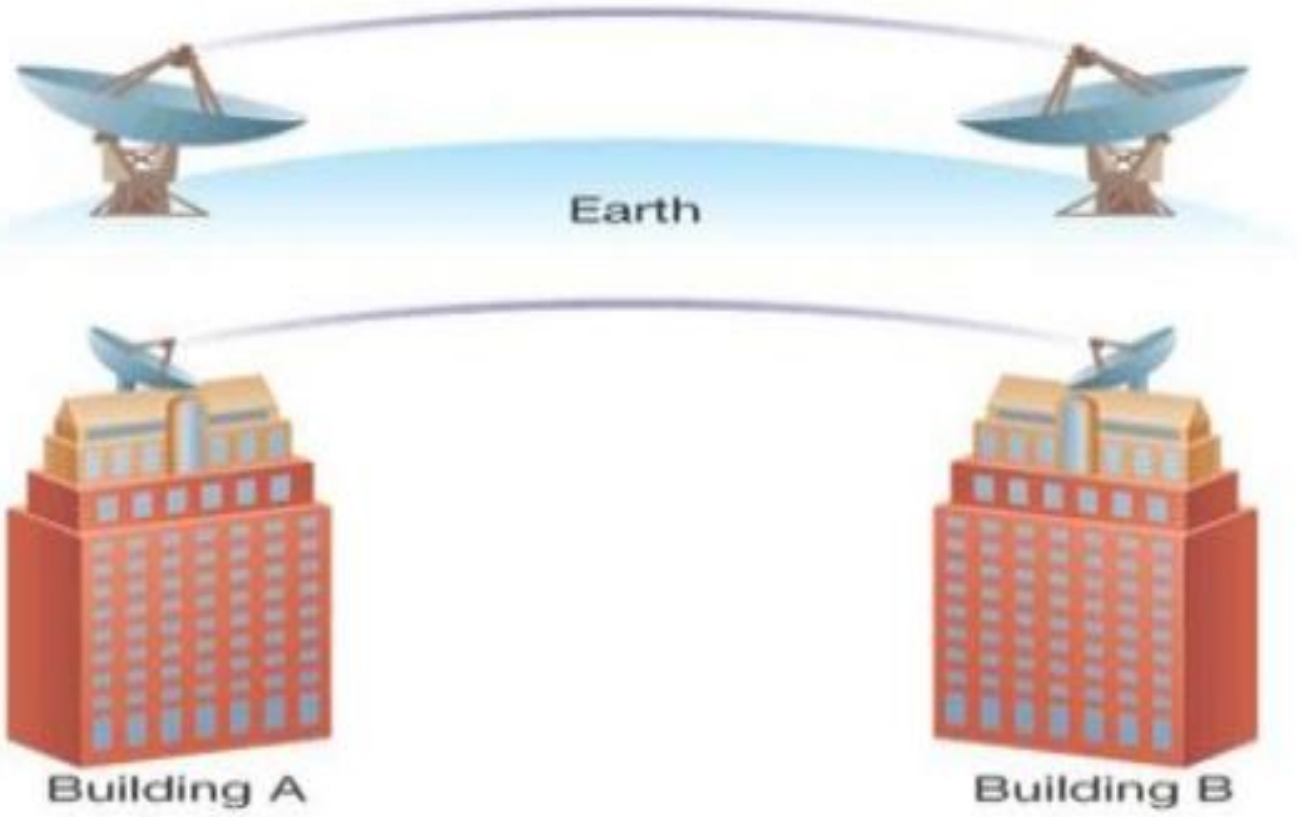
Microwaves

- Unidirectional
- Propagation is line-of sight.
- Repeaters are needed for long distance communication.
- Very high frequency microwaves cannot penetrate walls.
- Wave band is relatively wide almost 299GHZ → a high data rate
- Use of certain portion of the band requires permission from authorities.

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

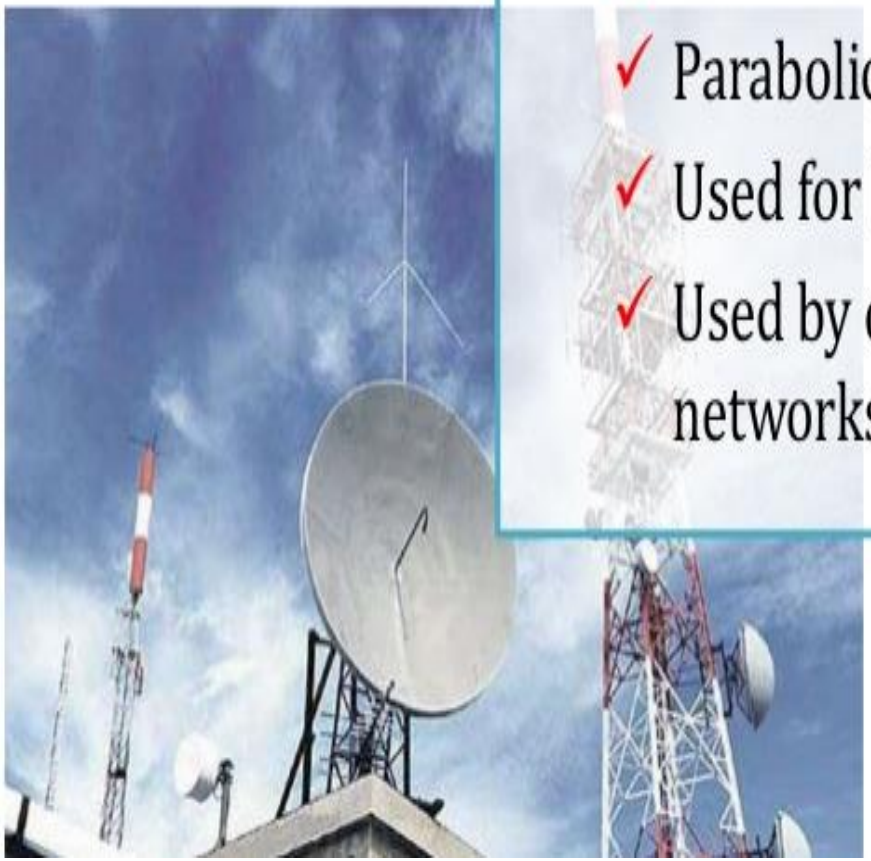

Types Of Microwave Transmission
Terrestrial microwave transmission
Satellite microwave transmission

Terrestrial microwave requires a line of sight path between a sender and a receiver



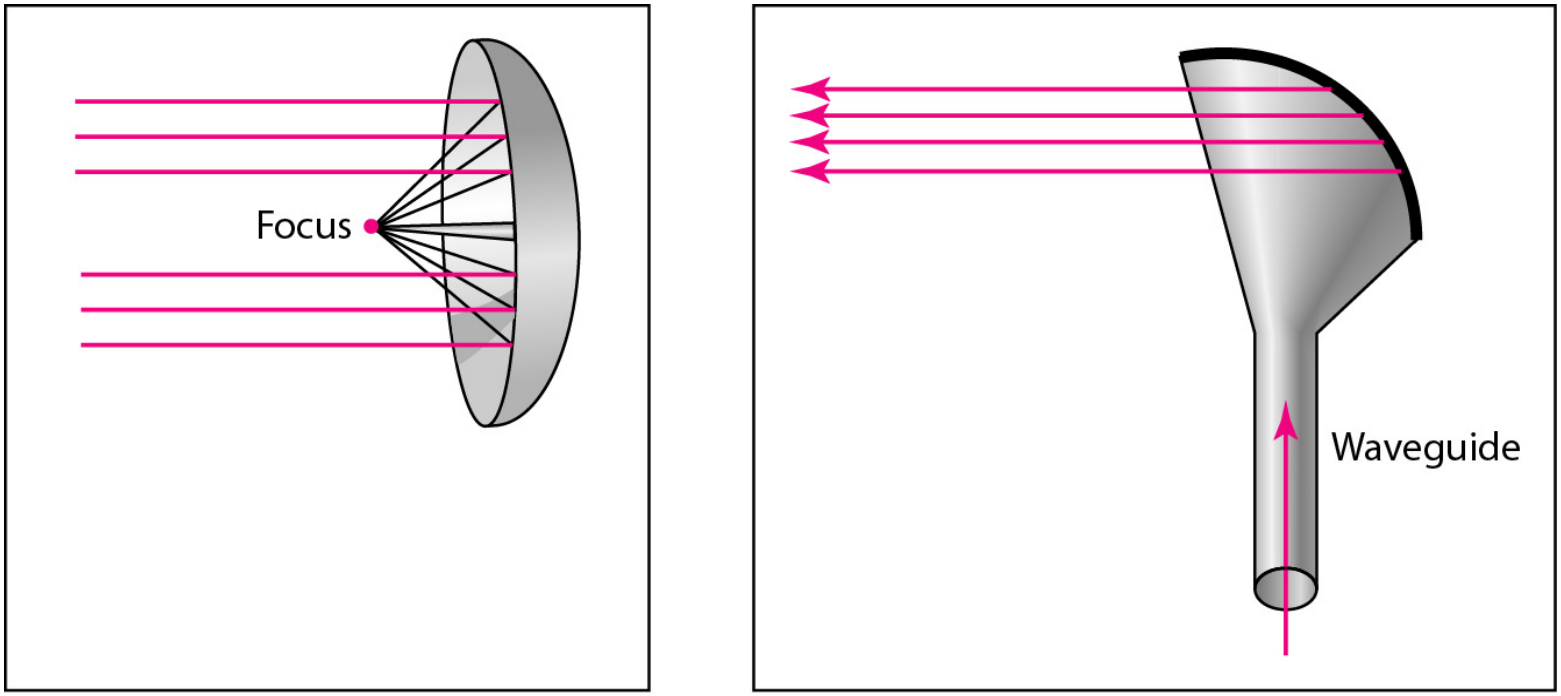
- Terrestrial microwave transmissions are sent between two microwave stations on the earth (earth station).
- It is the most common form of long-distance communication.
- Use a parabolic dish to focus a narrow beam onto a receiver antenna

Applications



- ✓ Used for long-distance telephone service
- ✓ Parabolic dish transmitter, mounted high
- ✓ Used for both voice and TV transmission
- ✓ Used by common carriers as well as private networks

Figure 7.21 *Unidirectional antennas*



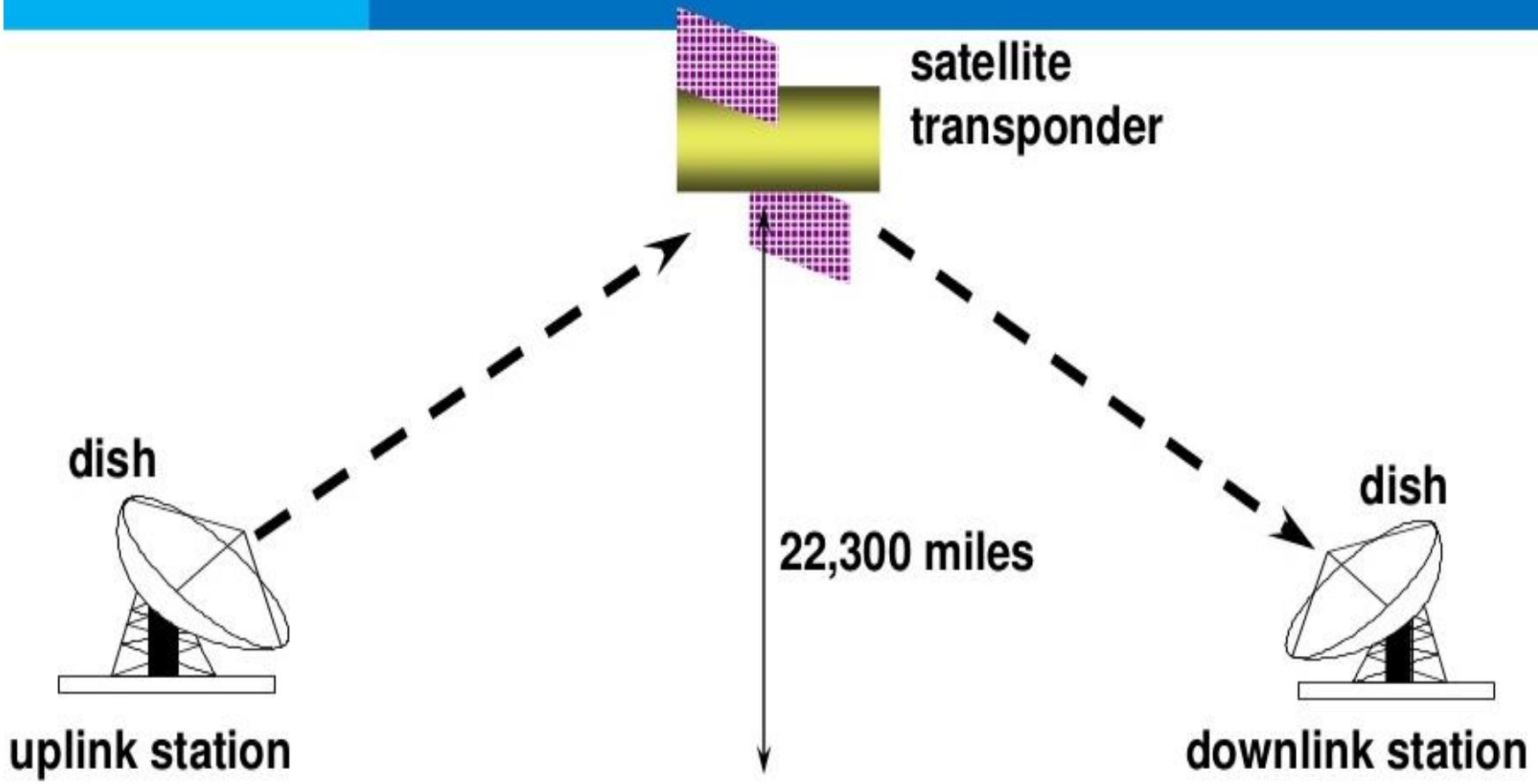
a. Dish antenna

b. Horn antenna


Satellite Microwave

- A communication satellite is a microwave relay station
- Used to link two or more ground stations
- Receives on one frequency (uplink), amplifies or repeats signal and transmits on another frequency (downlink)
  - ✓ eg. uplink 5.925-6.425 GHz & downlink 3.7-4.2 GHz
  - ✓ frequency bands are called transponder channels
- Requires geo-stationary orbit
  - ✓ rotation match occurs at a height of 35,863 km at the equator
  - ✓ need to be spaced at least 3° - 4° apart to avoid interfering with each other
  - ✓ spacing limits the number of possible satellites

Satellite Transmission Process



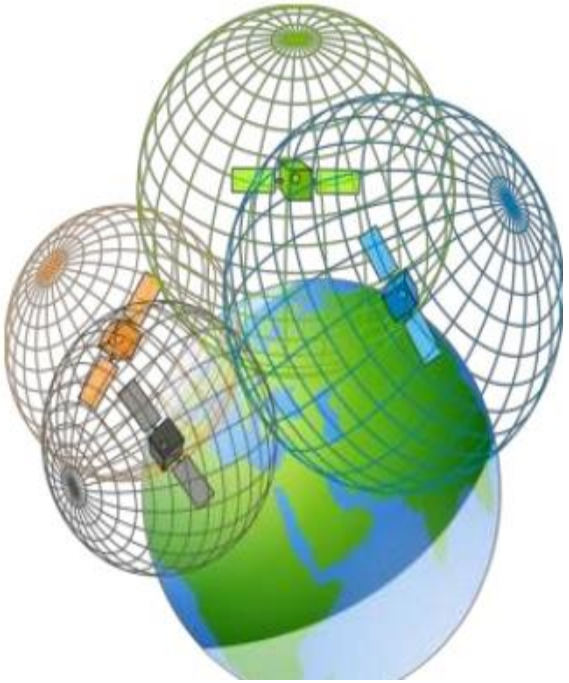

Satellite Microwave cont.

Applications

- **Private business networks**
  - ✓ satellite providers can divide capacity into channels to lease to individual business users
- **Television distribution**
  - ✓ programs are transmitted to the satellite then broadcast down to a number of stations which then distributes the programs to individual viewers
  - ✓ Direct Broadcast Satellite (DBS) transmits video signals directly to the home user
- **Long-distance telephone transmission**
  - ✓ high-usage international trunks
- **Global positioning**
  - ✓ Navstar Global Positioning System (GPS)


Microwave Transmission advantages

- No cables needed
- Multiple channels available
- Wide bandwidth



Microwave Transmission Disadvantages

- line of sight requirement
  - ✓ They require no obstacle is present in the transmission path
- expensive towers and repeaters
- subject to interference such as passing airplanes and rain

Infrared

- An infrared transmission is a wireless technology used for communication over short ranges.
- The frequency of the infrared in the range from 300 GHz to 400 THz.
- It is used for short-range communication such as data transfer between two cell phones, TV remote operation, data transfer between a computer and cell phone resides in the same closed area.

Note

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

Wireless Channels

- Are subject to a lot more errors than guided media channels.
- Interference is one cause for errors, can be circumvented with high SNR.
- The higher the SNR the less capacity is available for transmission due to the broadcast nature of the channel.
- Channel also subject to fading and no coverage holes.