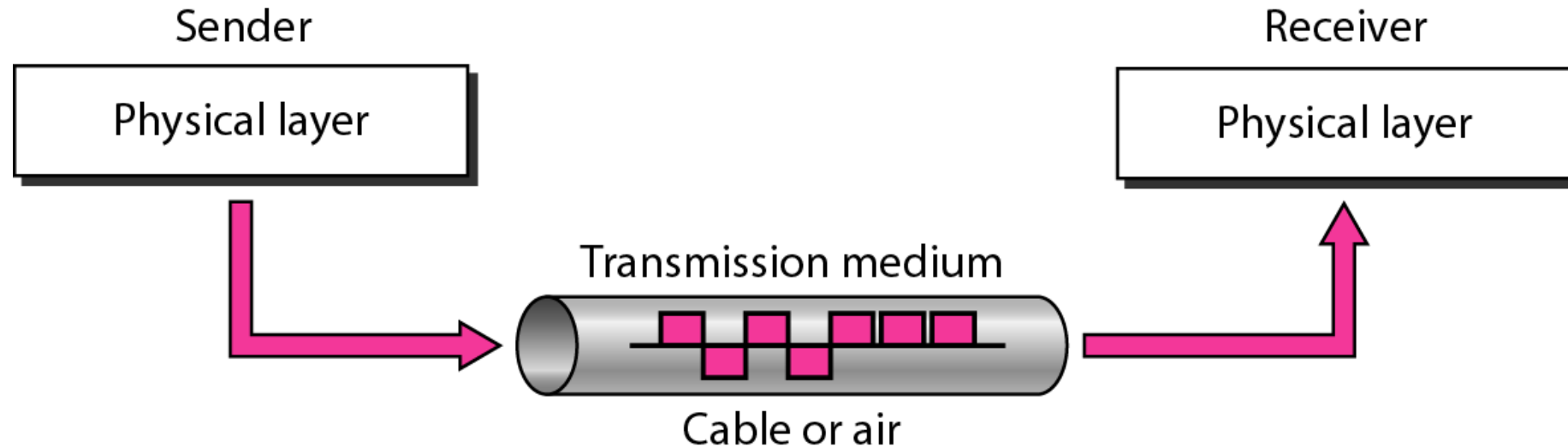


Transmission Medium

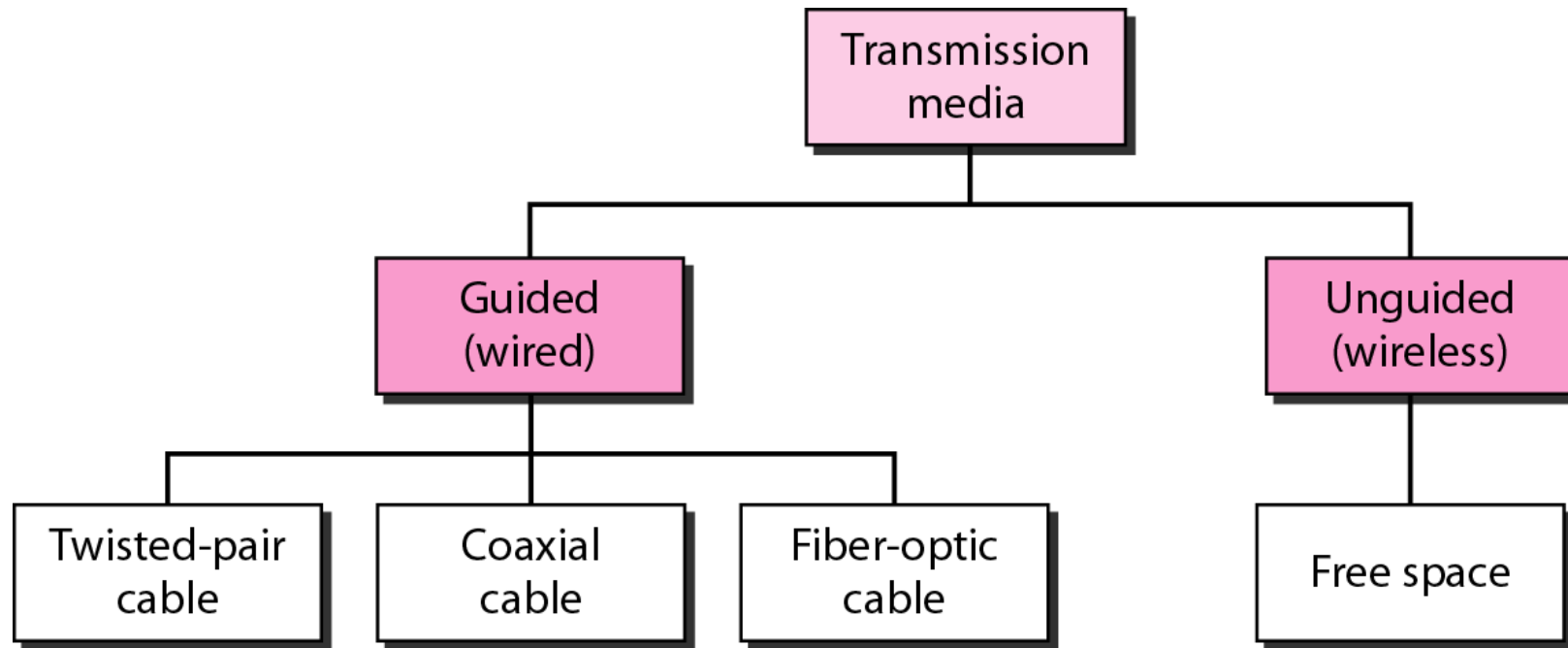
Figure *Transmission medium and physical layer*



Transmission Media

- Transmission media are actually located below the physical layer and are directly controlled by the physical layer.
- A transmission medium can be broadly defined as anything that can carry information from a source to a destination.
- The **transmission medium is usually free space, metallic cable, or fiber-optic cable.**
- The information is usually a signal that is the result of a conversion of data from another form.

Figure *Classes of transmission media*



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.

Figure *Twisted-pair cable*

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

One of the wires is used to carry signals to the receiver, and the other is used only as a ground reference

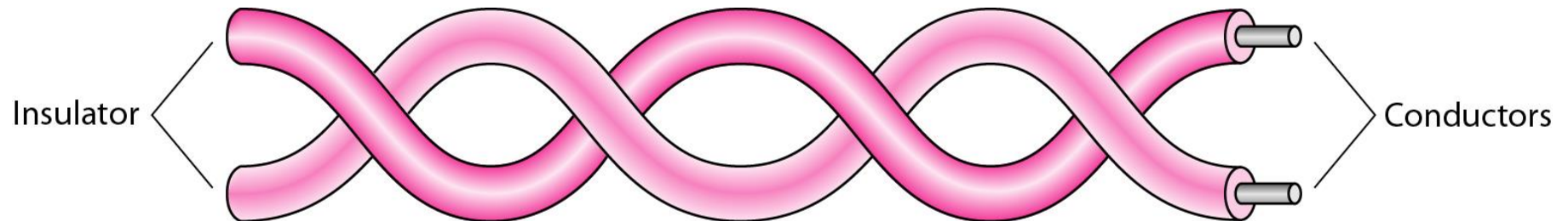
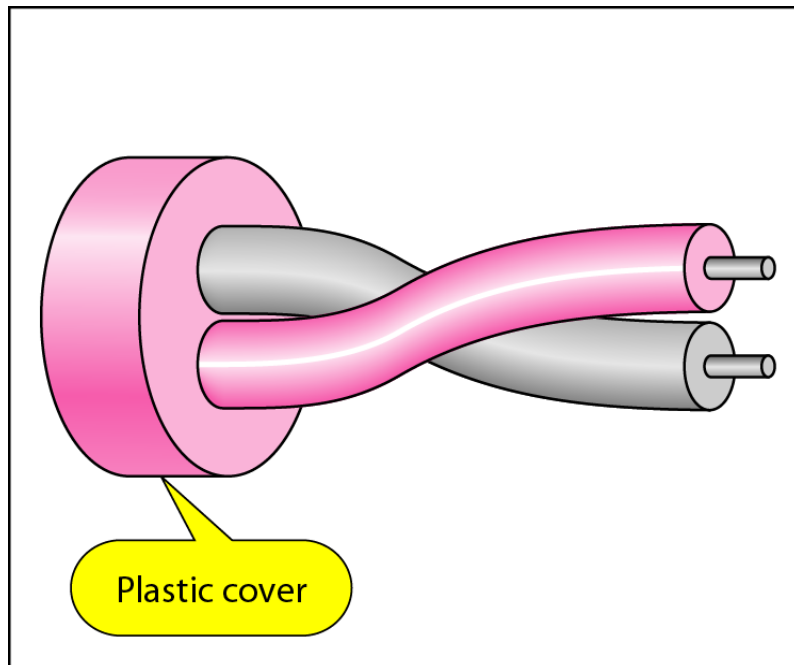
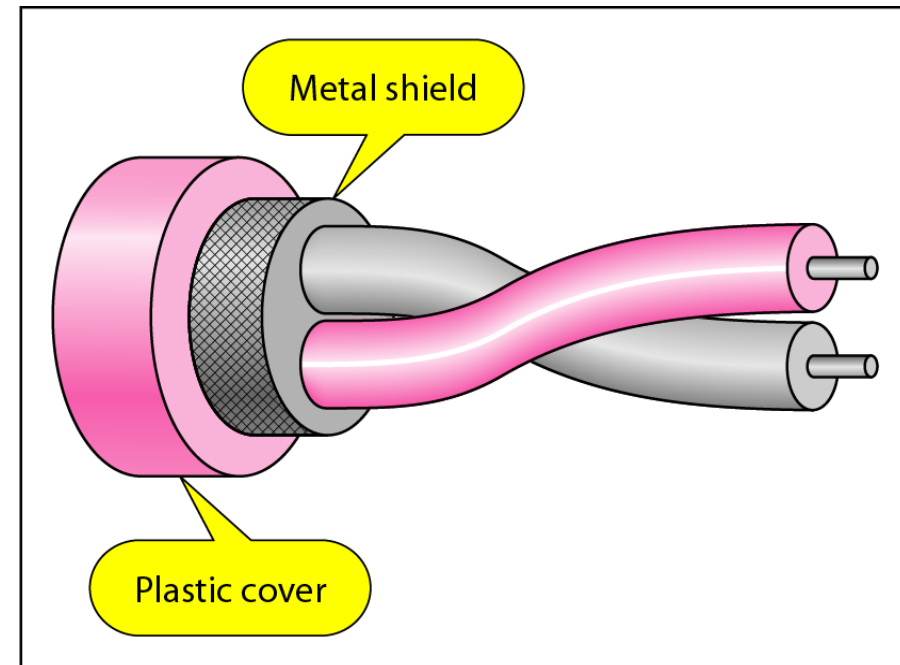


Figure *UTP and STP cables*

STP: 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

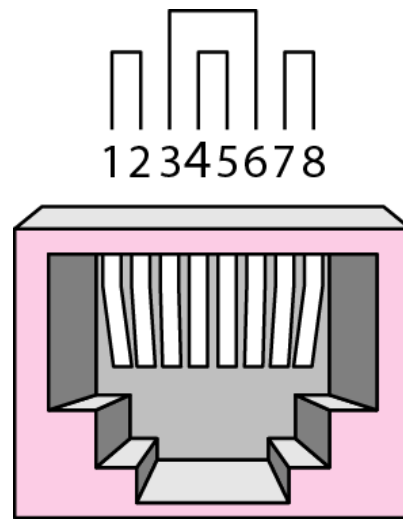
Categories

The Electronic Industries Association (EIA) has developed standards to classify unshielded twisted-pair cable into seven categories. Categories are determined by cable quality, with 1 as the lowest and 7 as the highest

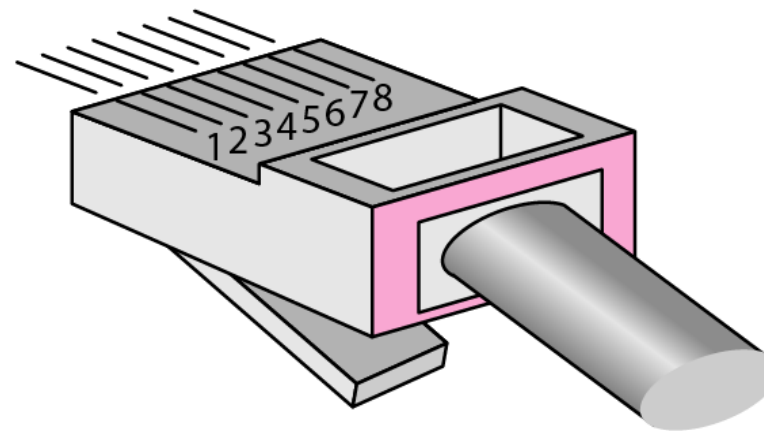
Table *Categories of unshielded twisted-pair cables*

<i>Category</i>	<i>Specification</i>	<i>Data Rate (Mbps)</i>	<i>Use</i>
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

Figure *UTP connector*

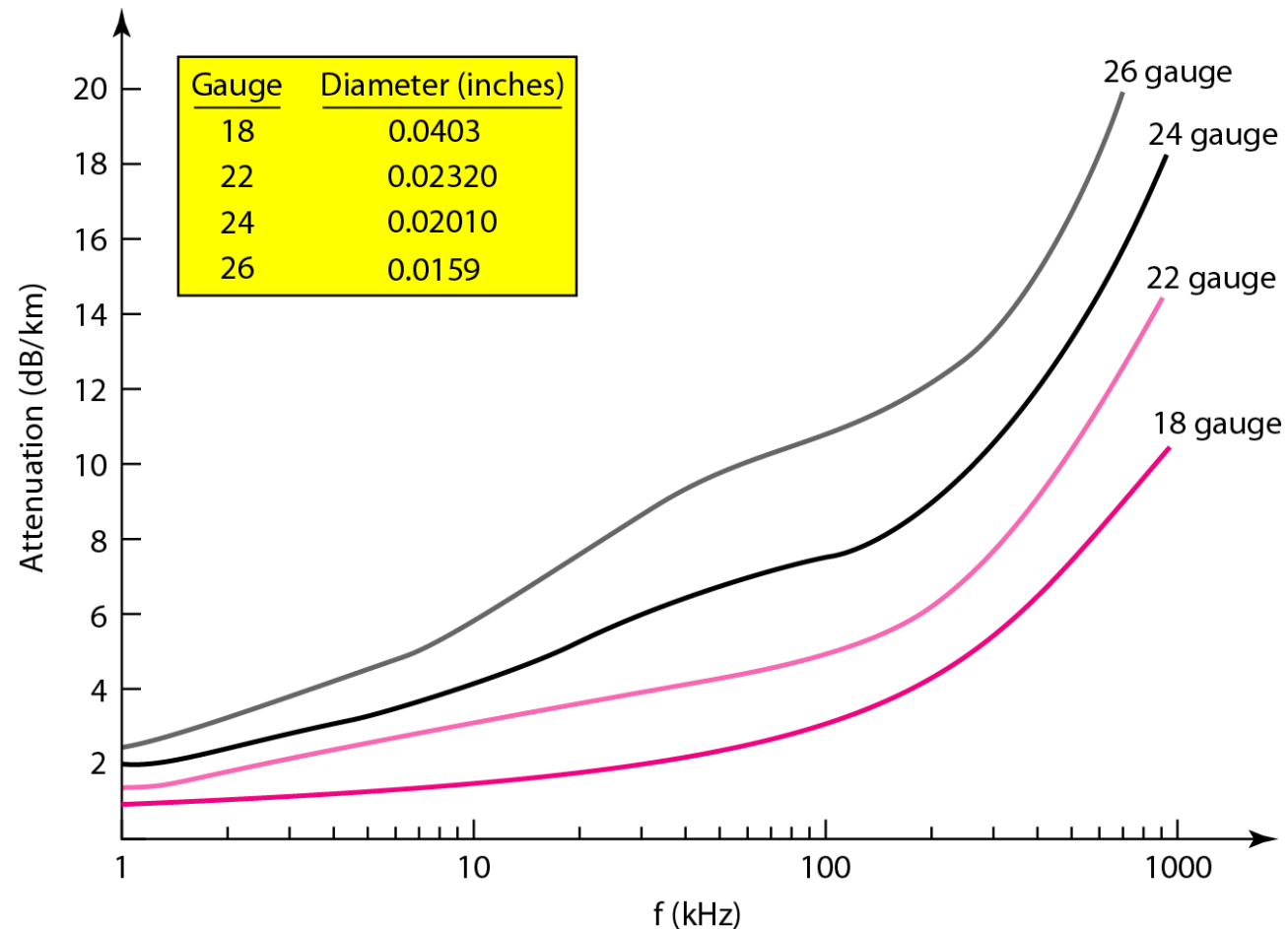


RJ-45 Female



RJ-45 Male

Figure *UTP performance: Performance One way to measure the performance of twisted-pair cable is to compare attenuation versus frequency and distance.*



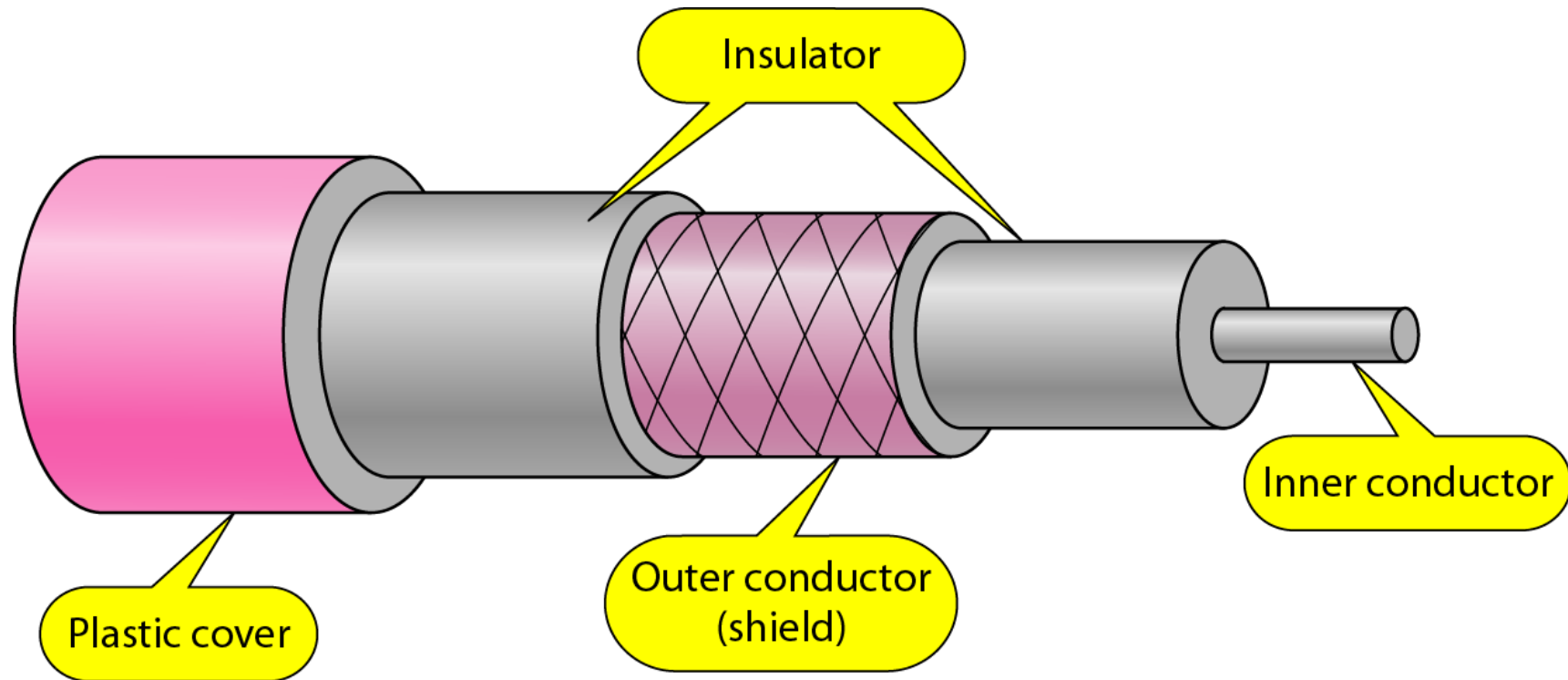
Applications

- Twisted-pair cables are used in telephone lines to provide voice and data channels.
- Local-area networks, such as IOBase-T and IOOBase-T.
- 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.
- TPC 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.
- 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.

Figure *Coaxial cable*



Categories of coaxial cables

Coaxial cables are categorized by their radio government (RG) ratings. Each RG number denotes a unique set of physical specifications

<i>Category</i>	<i>Impedance</i>	<i>Use</i>
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet
RG-11	50 Ω	Thick Ethernet

Figure *BNC connectors*

The BNC connector is used to connect the end of the cable to a device, such as a TV set.

The BNC T connector is used in Ethernet networks (see Chapter 13) to branch out to a connection to a computer or other device.

The BNC terminator is used at the end of the cable to prevent the reflection of the signal

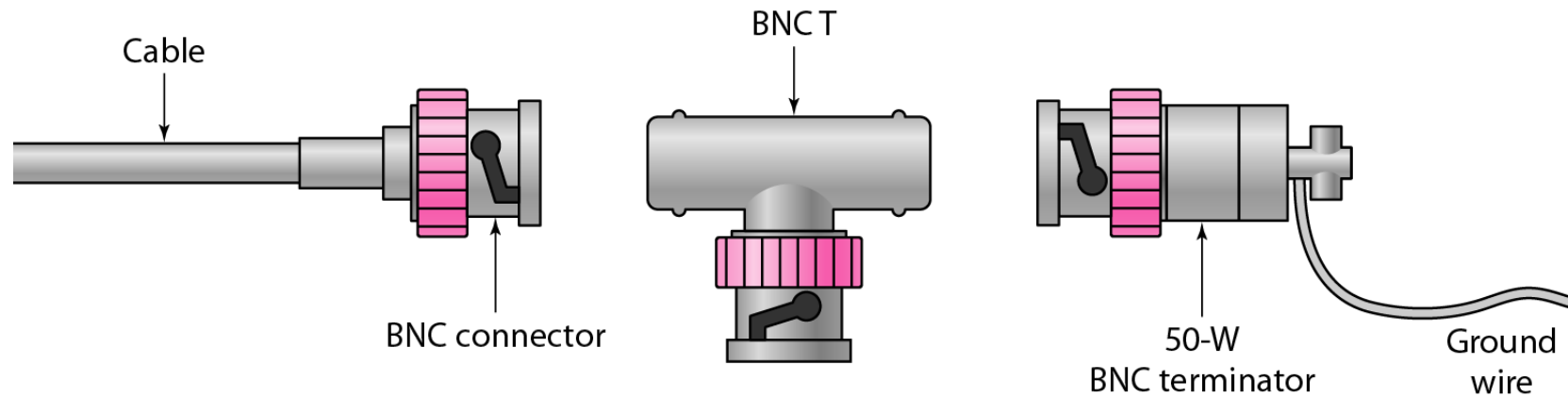
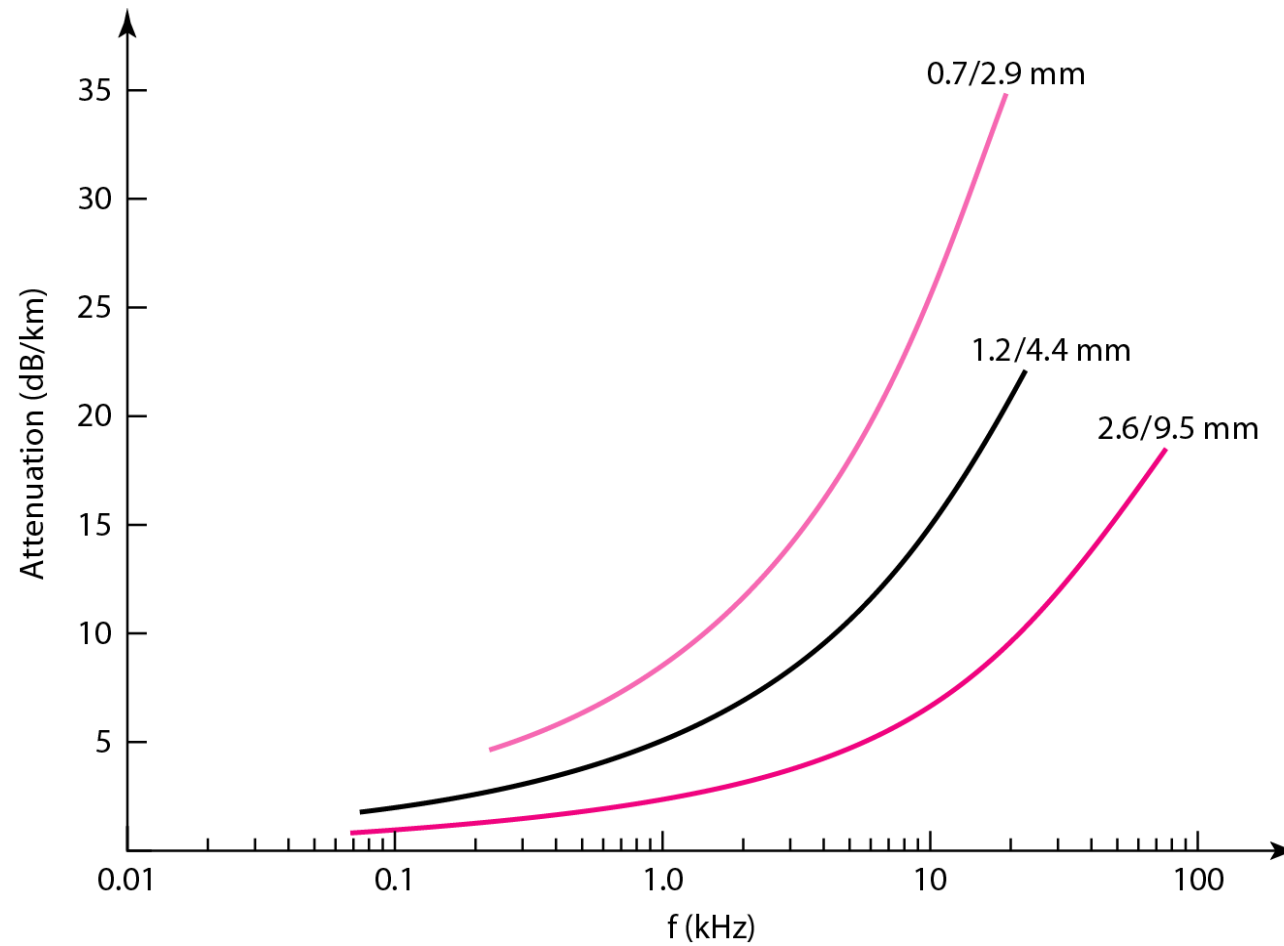


Figure *Coaxial cable performance*



Application

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

Fiber-Optic Cable

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

Figure: Fiber optics: *Bending of light ray*

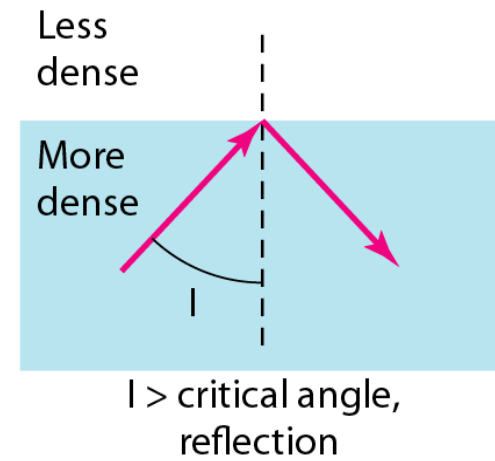
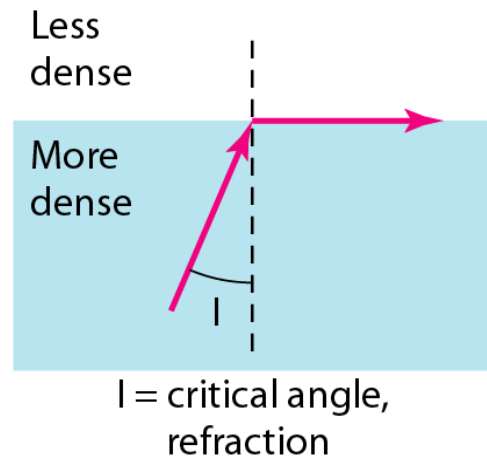
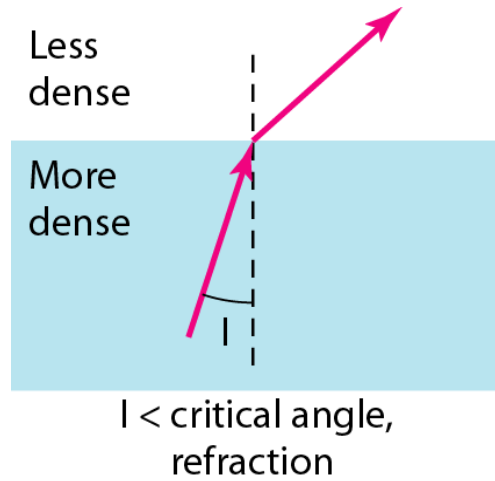


Figure *Optical fiber*

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

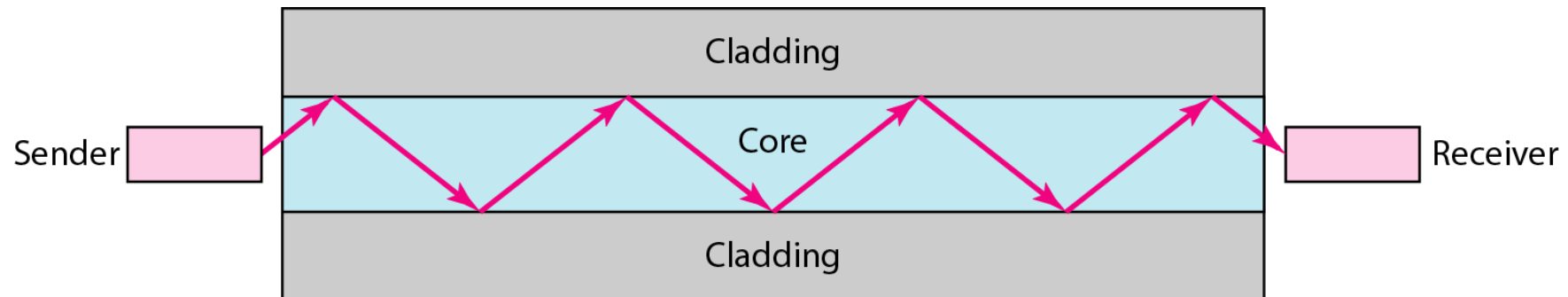
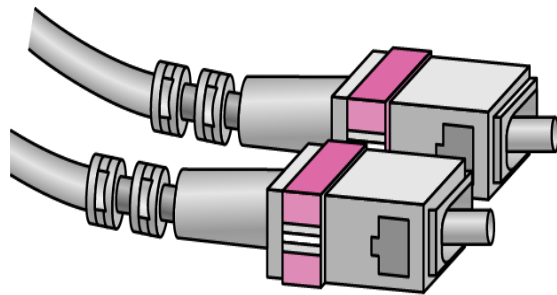
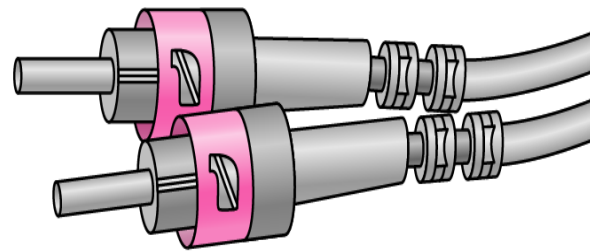


Figure *Fiber-optic cable connectors*



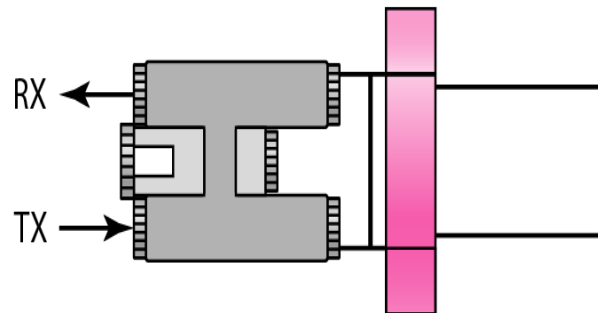
SC connector



ST connector

The subscriber channel (SC) connector is used for cable TV. It uses a push/pull locking system.

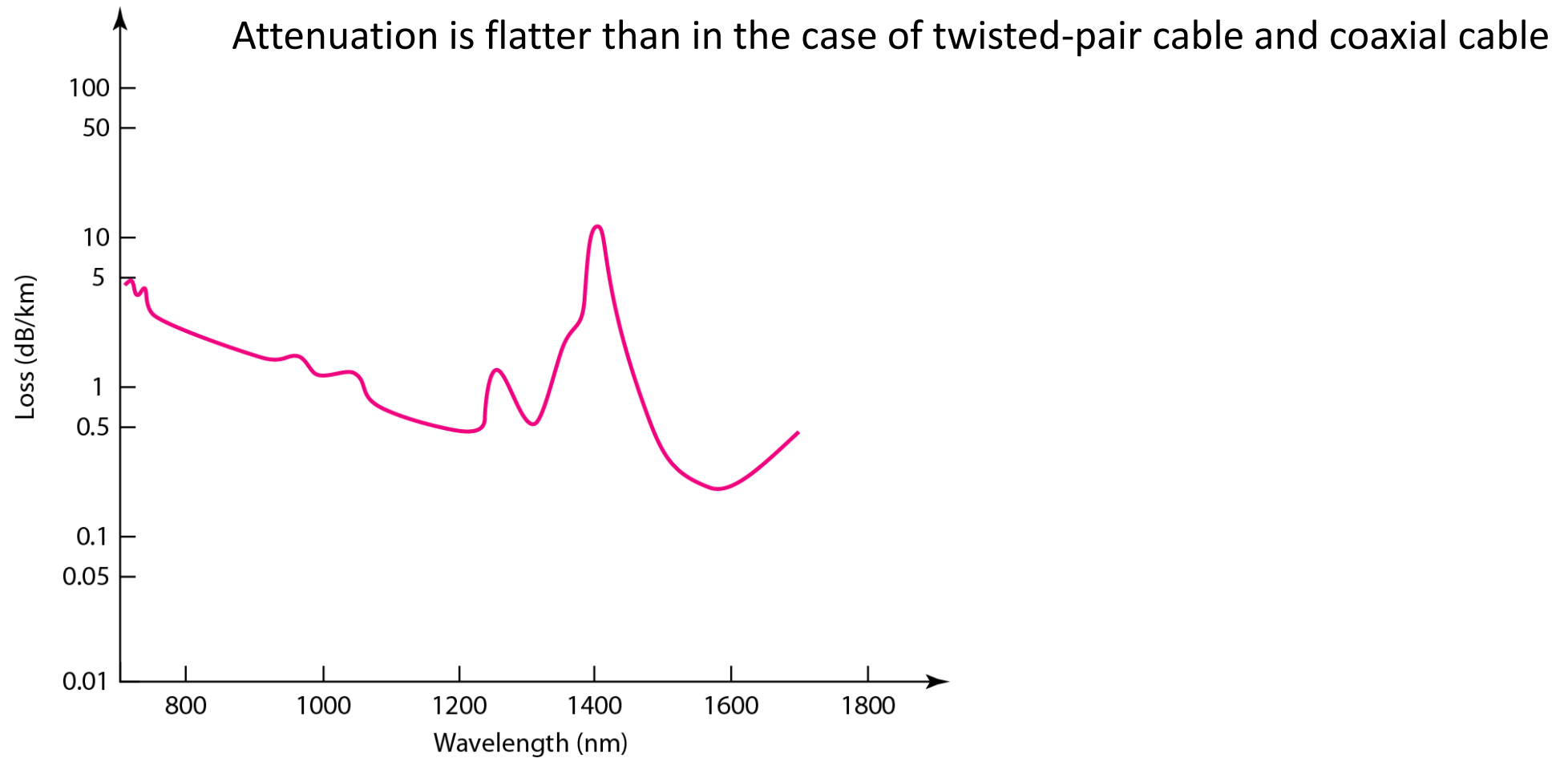
The straight-tip (ST) connector is used for connecting cable to networking devices. It uses a bayonet locking system and is more reliable than SC.



MT-RJ connector

MT-RJ is a connector that is the same size as RJ45

Figure *Optical fiber performance*



Application

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

- **Adv:**

- Higher bandwidth
- Less signal attenuation
- Immunity to electromagnetic interference
- Light weight

- **Dis:**

- Unidirectional light propagation
- Cost.

UNGUIDED MEDIA: WIRELESS

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

Figure *Electromagnetic spectrum for wireless communication*

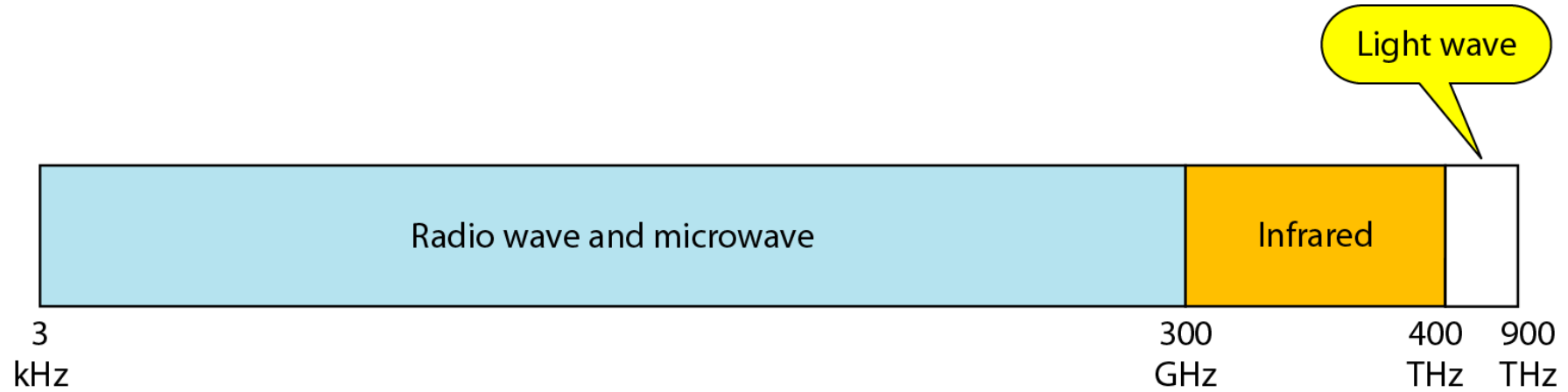


Figure *Propagation methods*

Unguided signals can travel from the source to destination in several ways

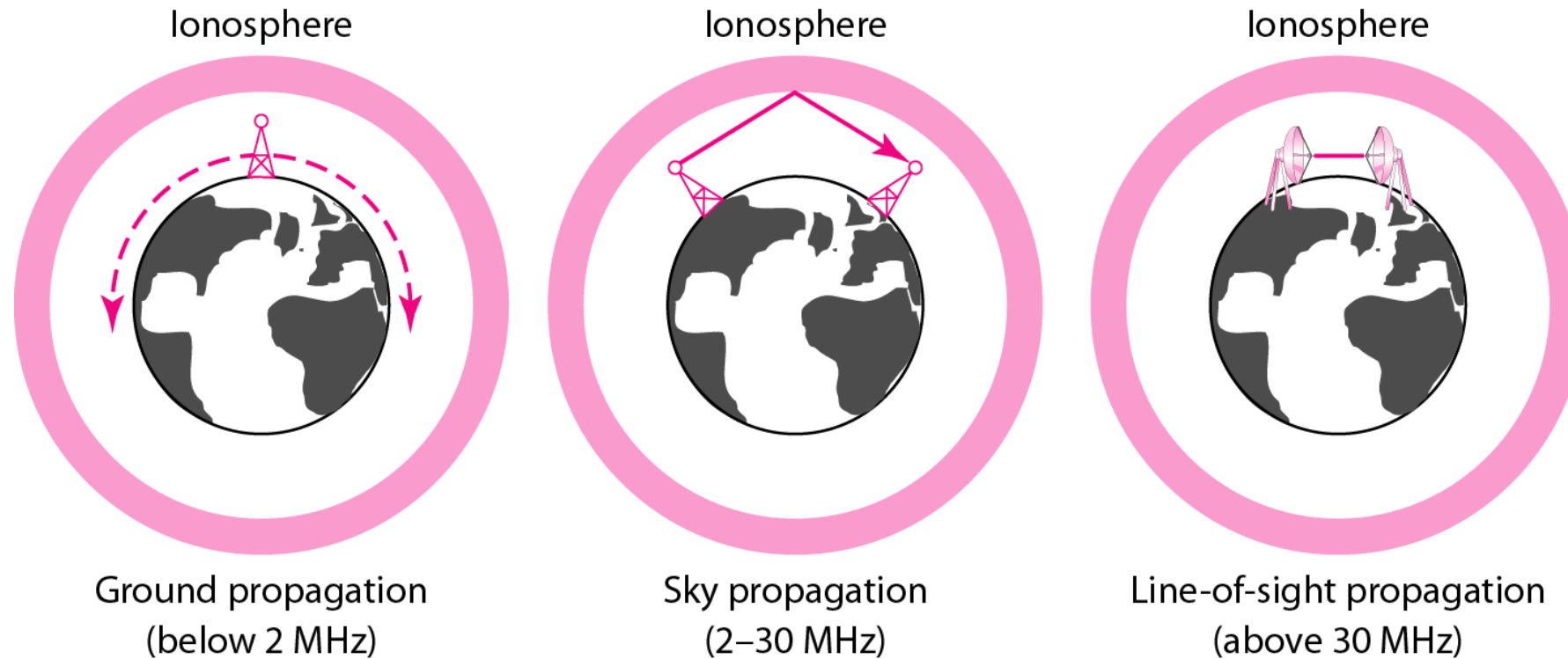
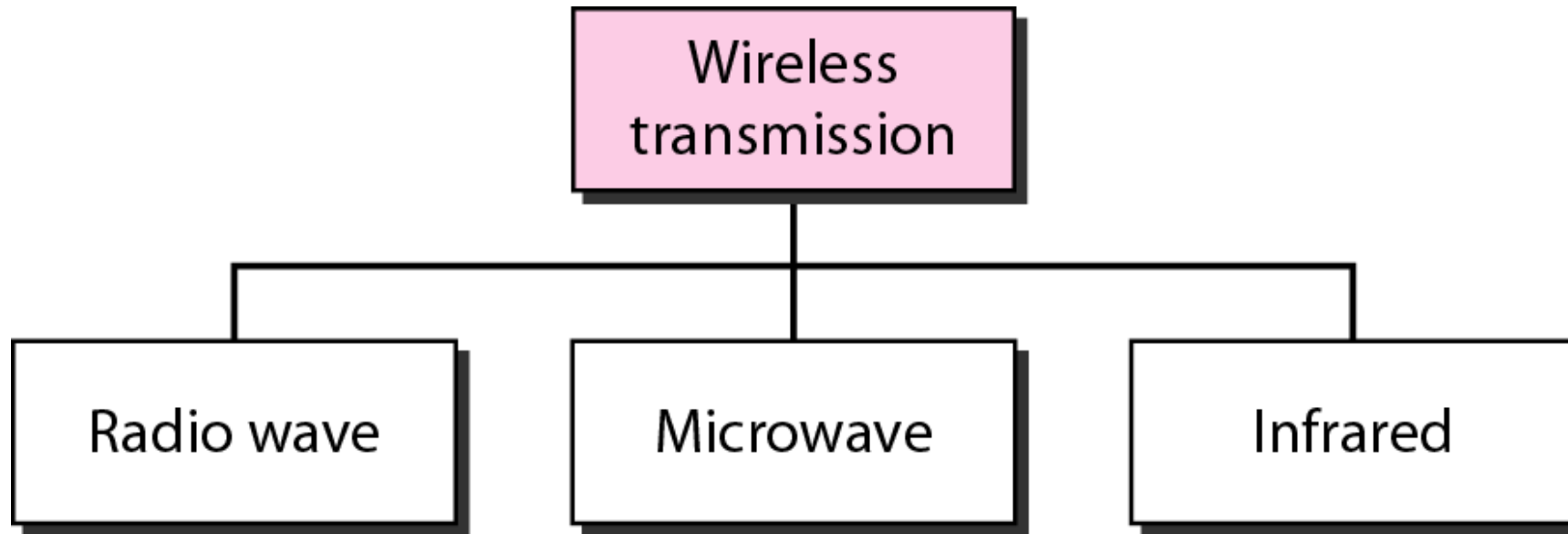


Table *Bands*

<i>Band</i>	<i>Range</i>	<i>Propagation</i>	<i>Application</i>
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

Figure *Wireless transmission waves*

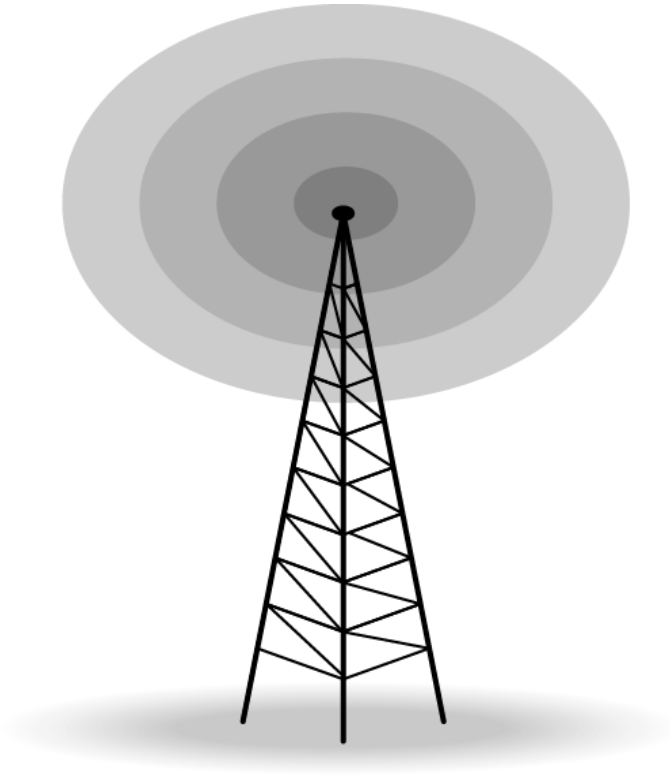


Note

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

Electromagnetic waves ranging in frequencies between 3 kHz and 1 GHz are normally called radio waves

Figure *Omnidirectional antenna*



Radio waves use omnidirectional antennas that send out signals in all directions. Based on the wavelength, strength, and the purpose of transmission

Application

- The omnidirectional characteristics of radio waves make them useful for multicasting, in which there is one sender but many receivers.
- AM and FM radio, television, maritime radio, cordless phones are examples of multicasting.

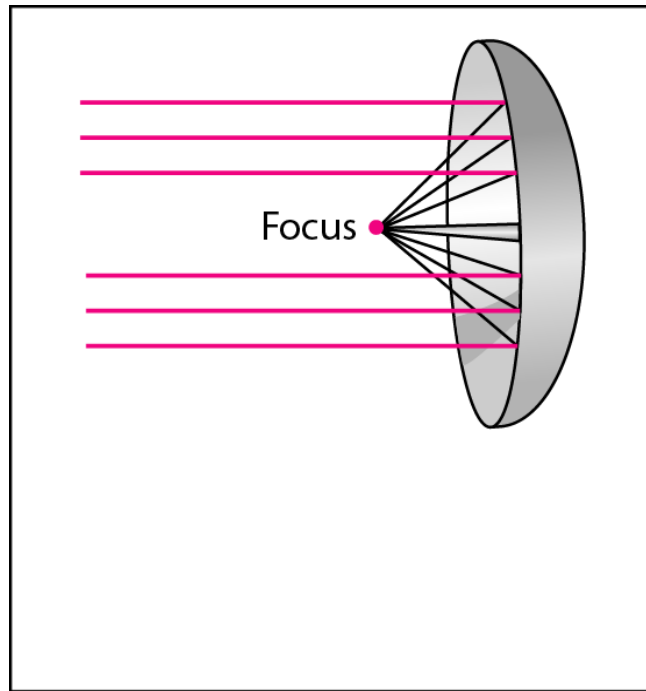
Note

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

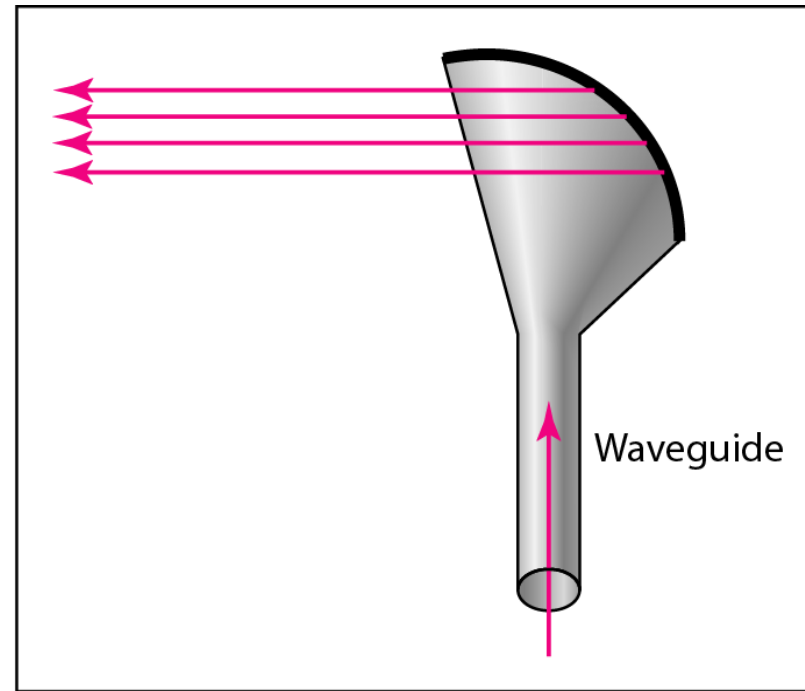
Higher frequency ranges cannot penetrate walls.
Use directional antennas - point to point line of sight communications.

Electromagnetic waves having frequencies between 1 and 300 GHz are called microwaves.

Figure *Unidirectional antennas*



a. Dish antenna



b. Horn antenna



Note

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