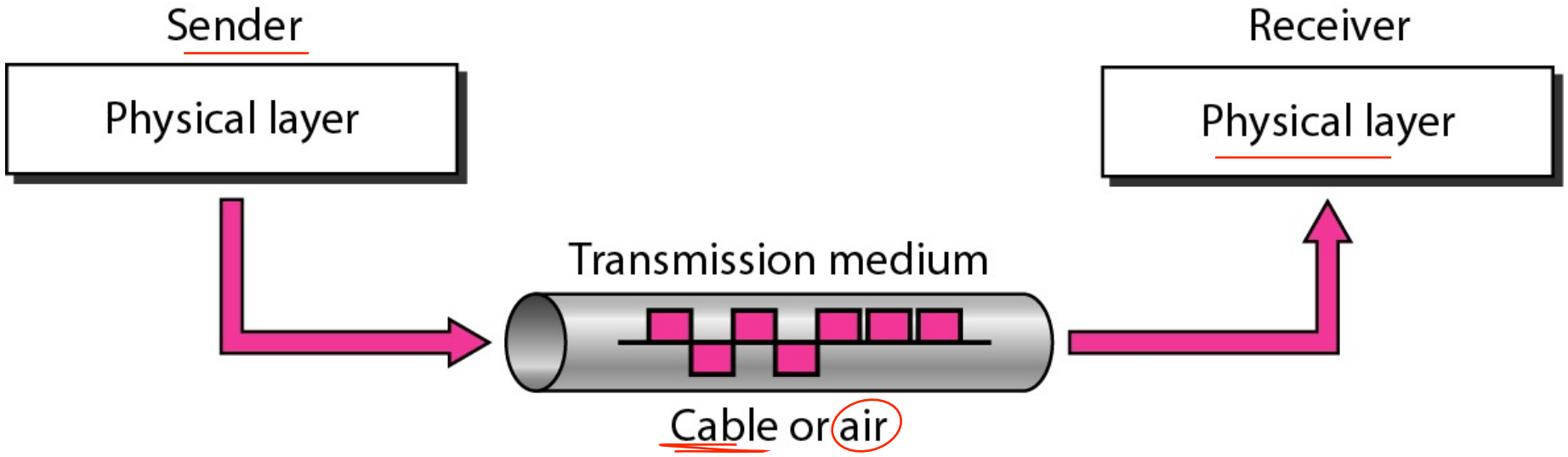
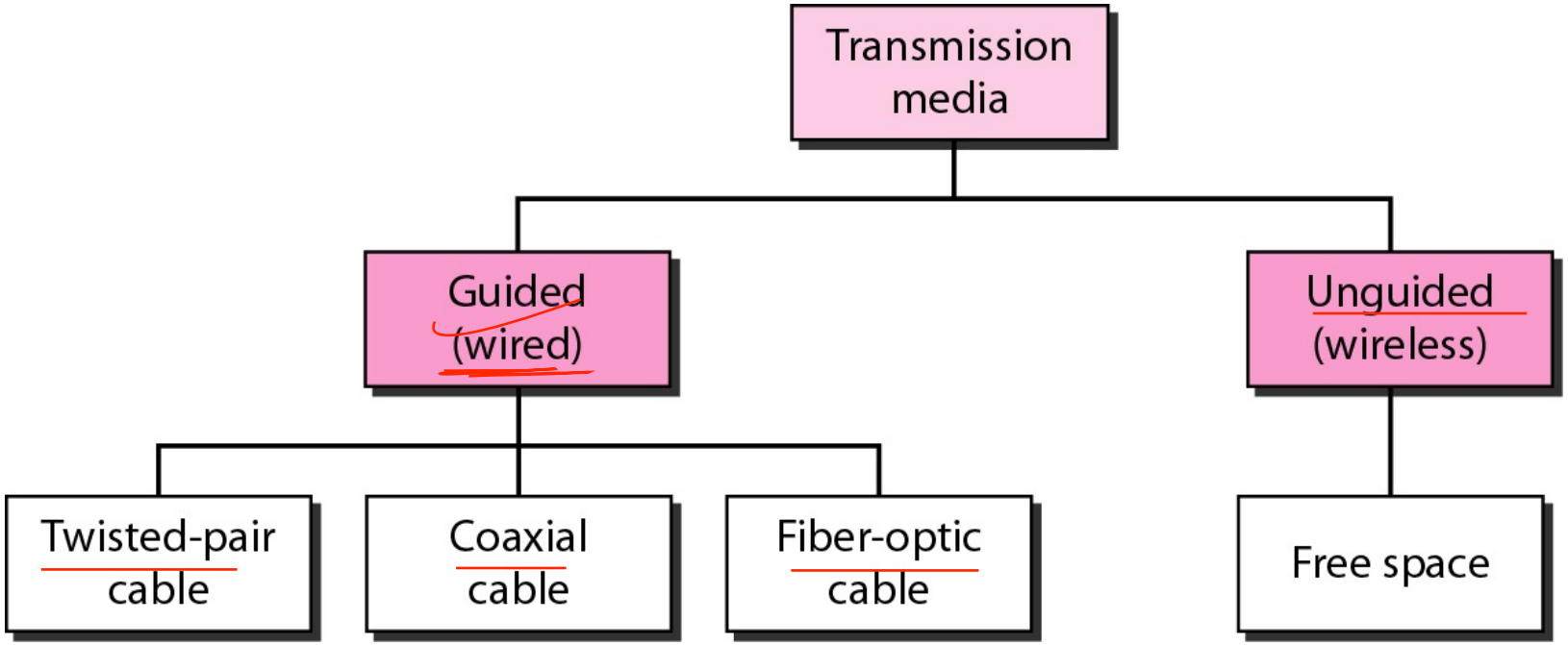
Transmission Media

Transmission medium and physical layer



A transmission medium is anything that can carry information from sender to receiver.

Classes of transmission media



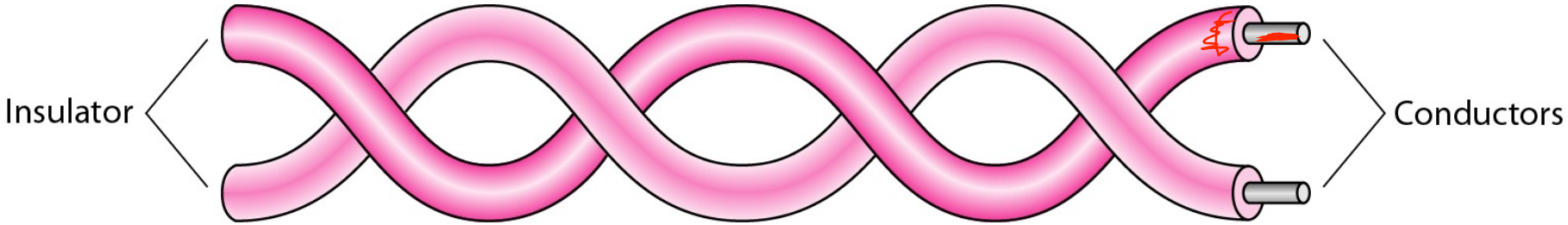
Radio waves, Microwaves, Infrared

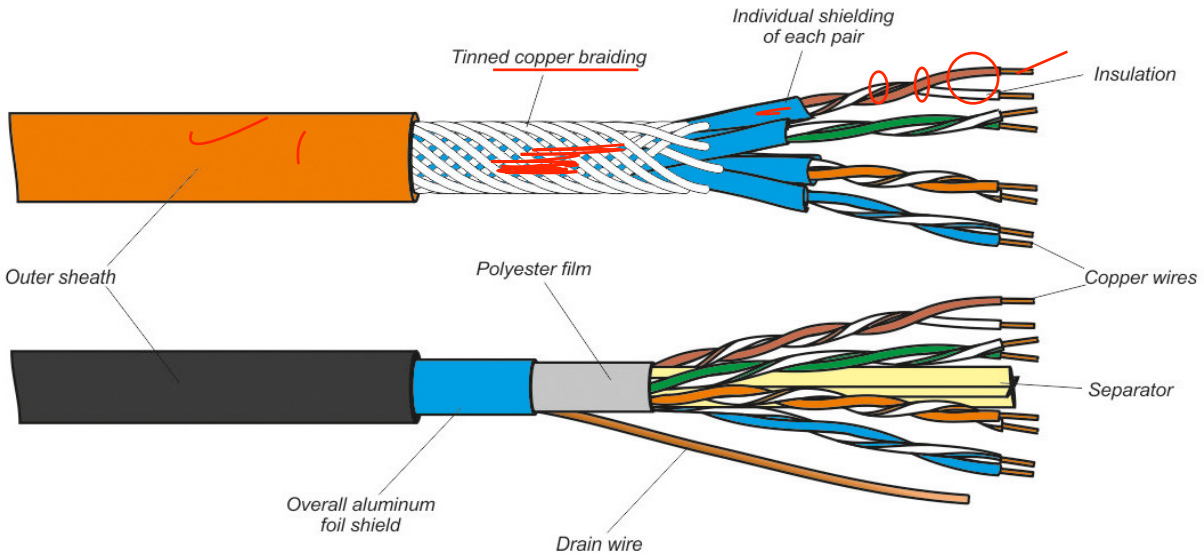
Guided Media

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

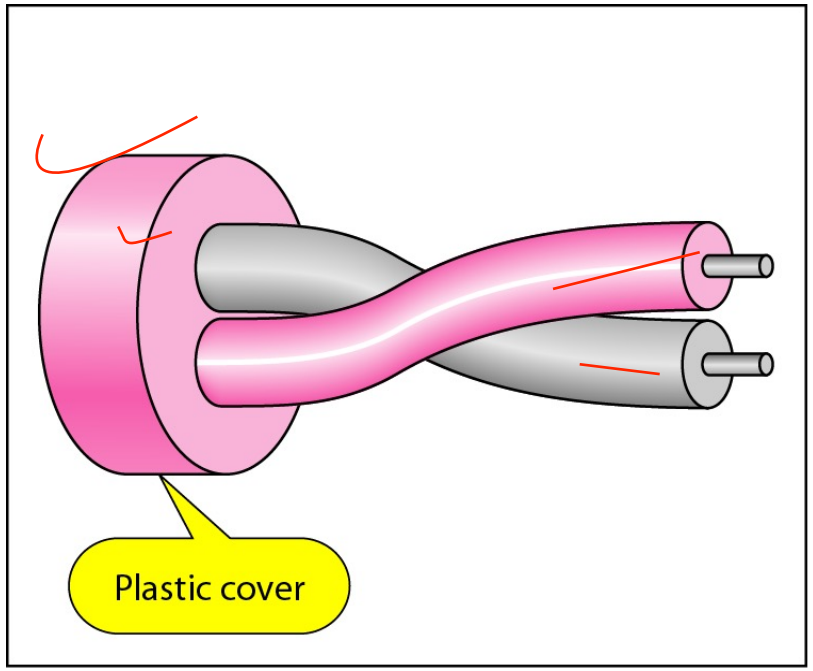
- ***A signal travelling along any of these media is directed and contained by the physical limits of the medium.***
  - **Twisted pair cable and coaxial cable :** ***Use metallic (copper) conductors that accept and transport signals in the form of electric current***
  - **Optical fiber:** ***Accepts and transport signals in the form of light***

Twisted-pair cable

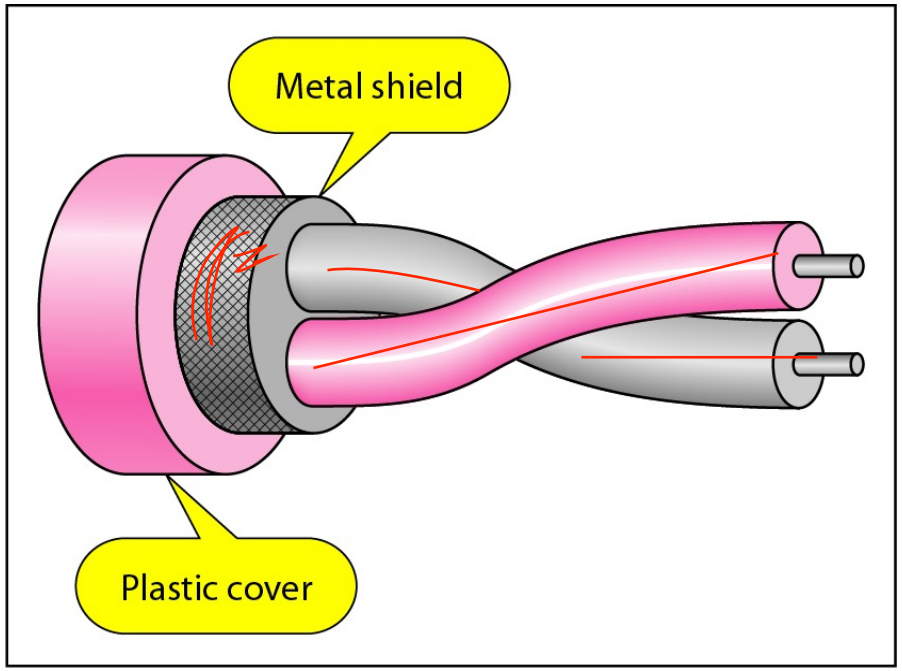




UTP and STP cables



a. UTP

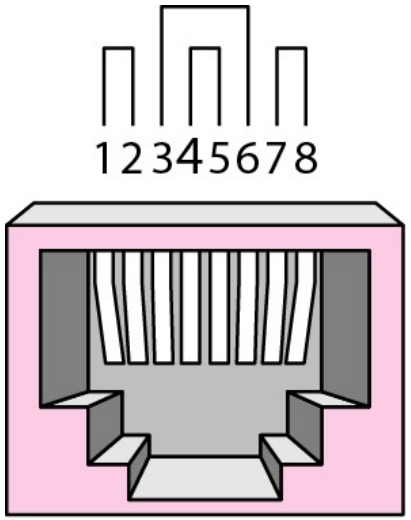


b. STP

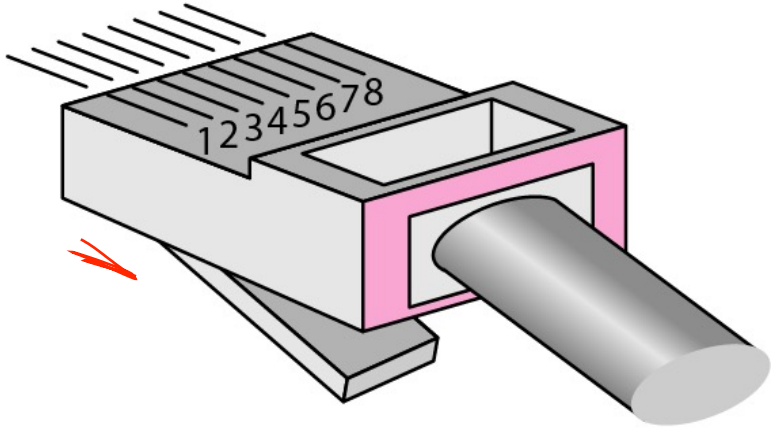
Categories of unshielded twisted-pair cables (as EIA) classified

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

UTP connector



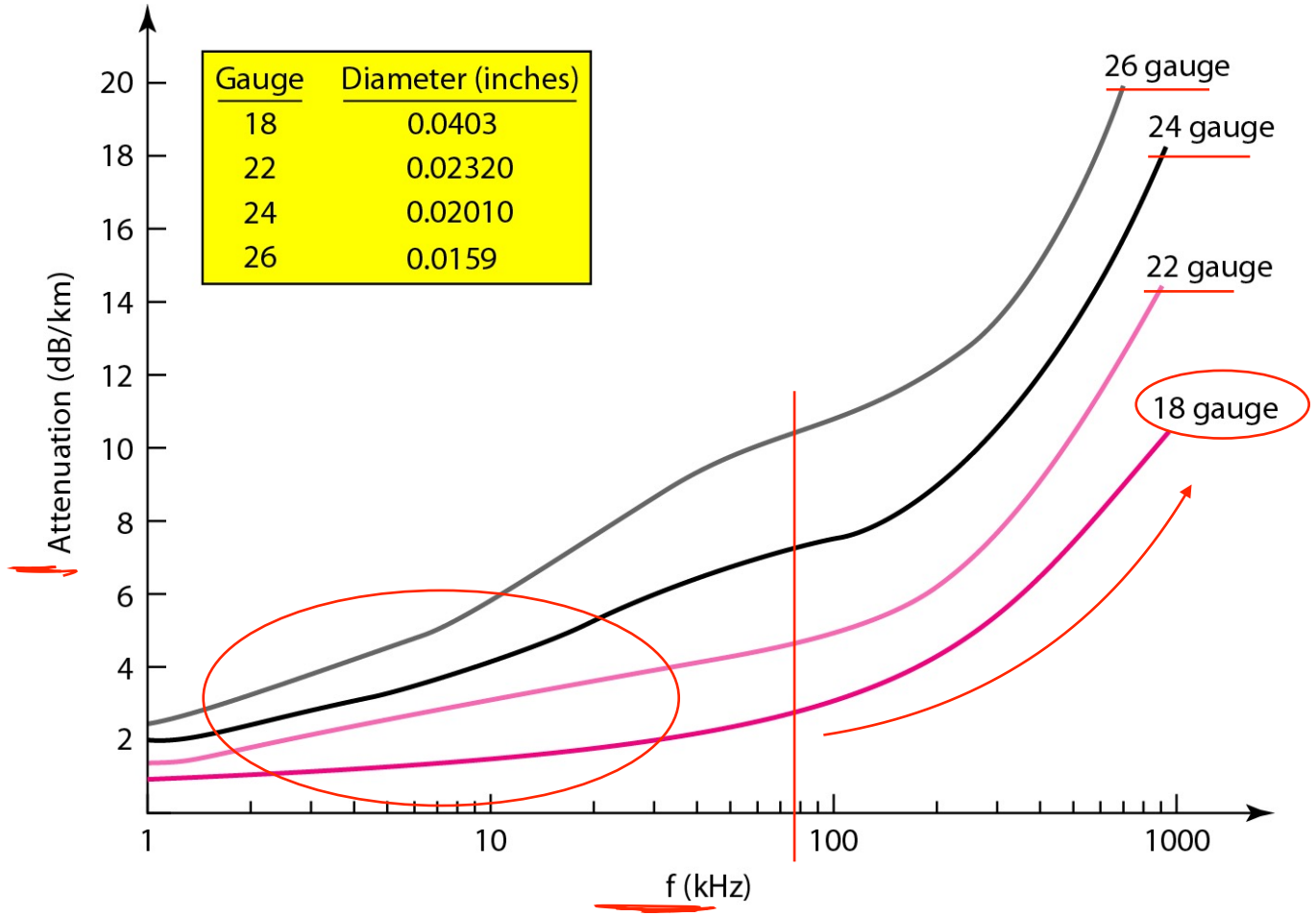
RJ-45 Female



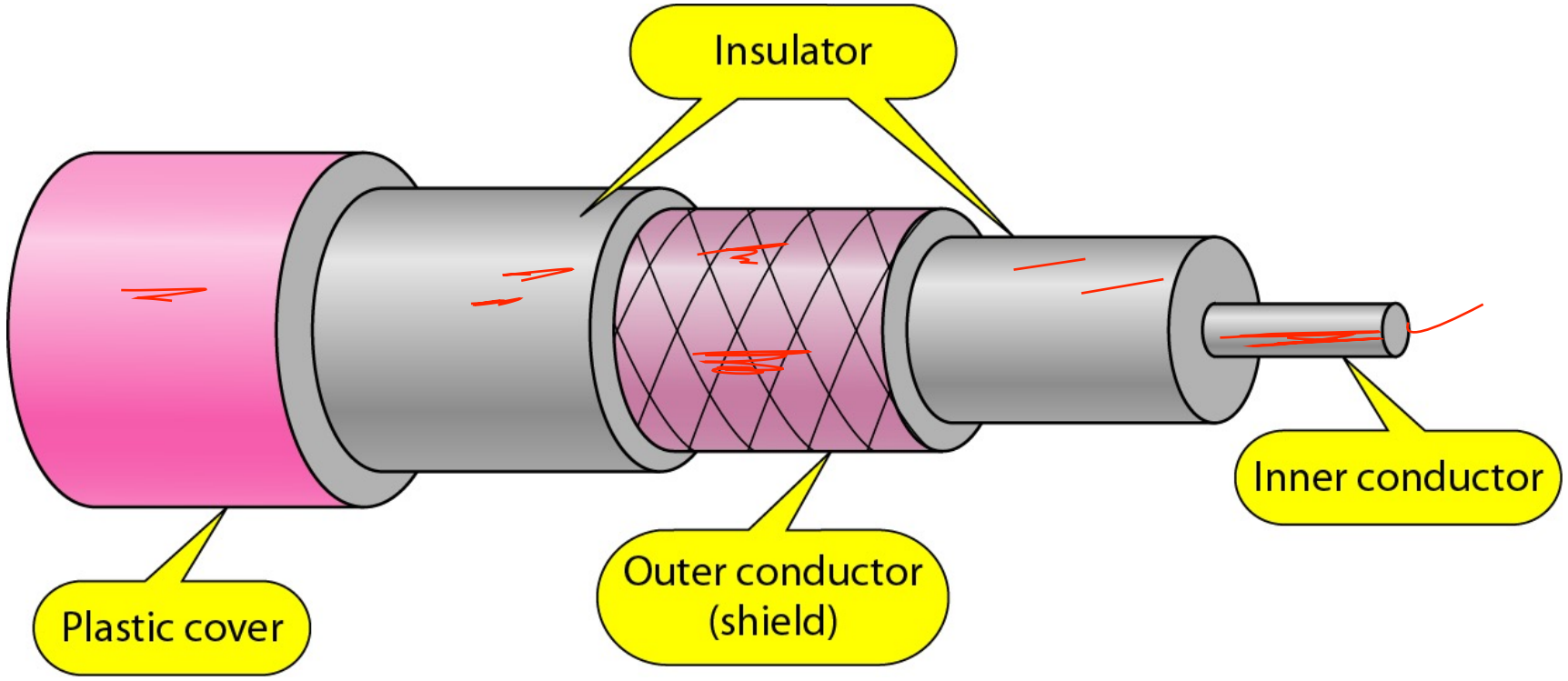
RJ-45 Male

RJ – Registered jack

UTP performance



Coaxial cable



Coaxial Cable standards

- Categorized by the Radio government (RG) ratings
  - Each RG number denotes a unique set of physical specifications
    - The wire gauge of the inner conductor
    - The thickness and type of the inner insulator
    - The construction of shield
    - The size and type of the inner casting

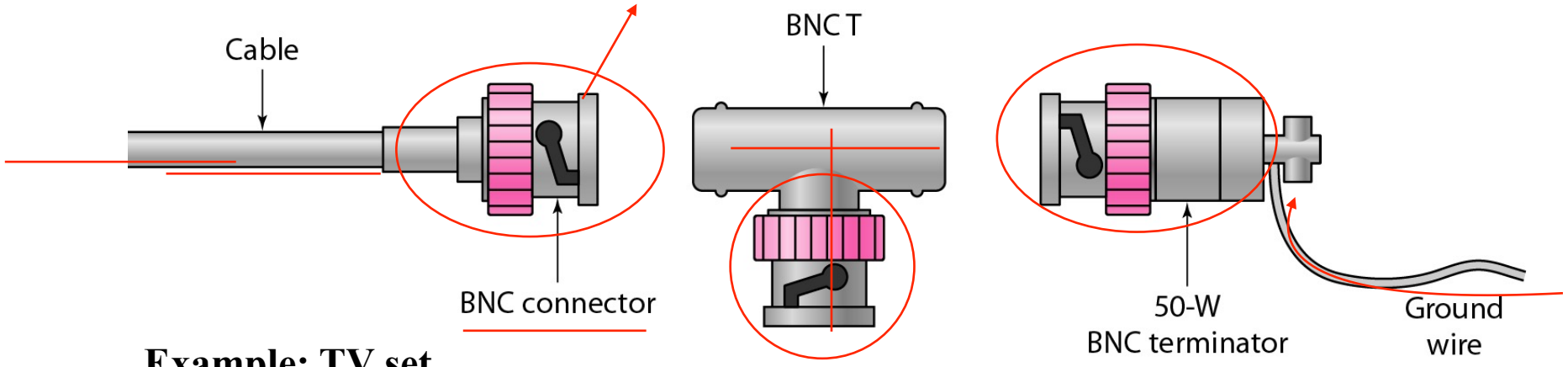
Categories of coaxial cables

Category	*Impedance*	*Use*
RG-59	75 Ω	Cable TV
RG-58 **(10Base2)**	50 Ω	Thin Ethernet
RG-11 **(10Base5)**	50 Ω	Thick Ethernet

10Mbps with a range of 185m.

10Mbps with a range of 5000m.

Bayonet Neill-Concelman(BNC) connectors

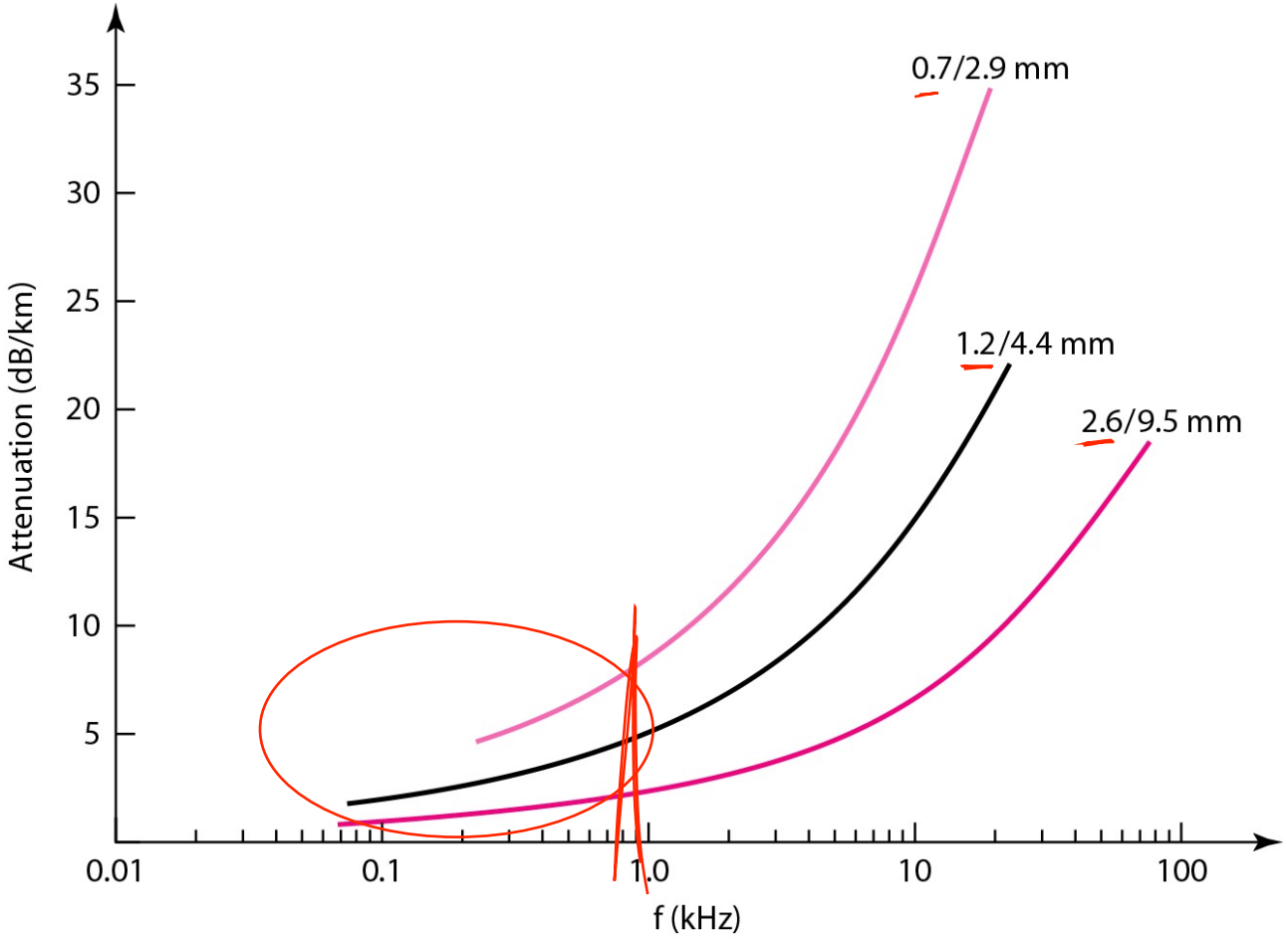


Example: TV set

Ex: Ethernet branching

End of the cable

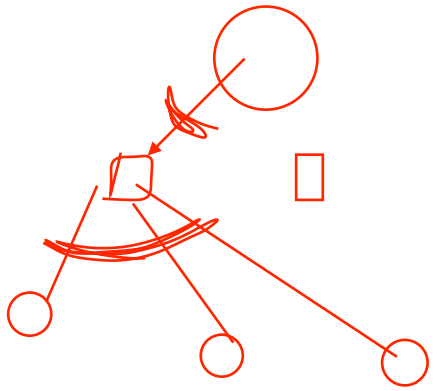
Coaxial cable performance



Applications

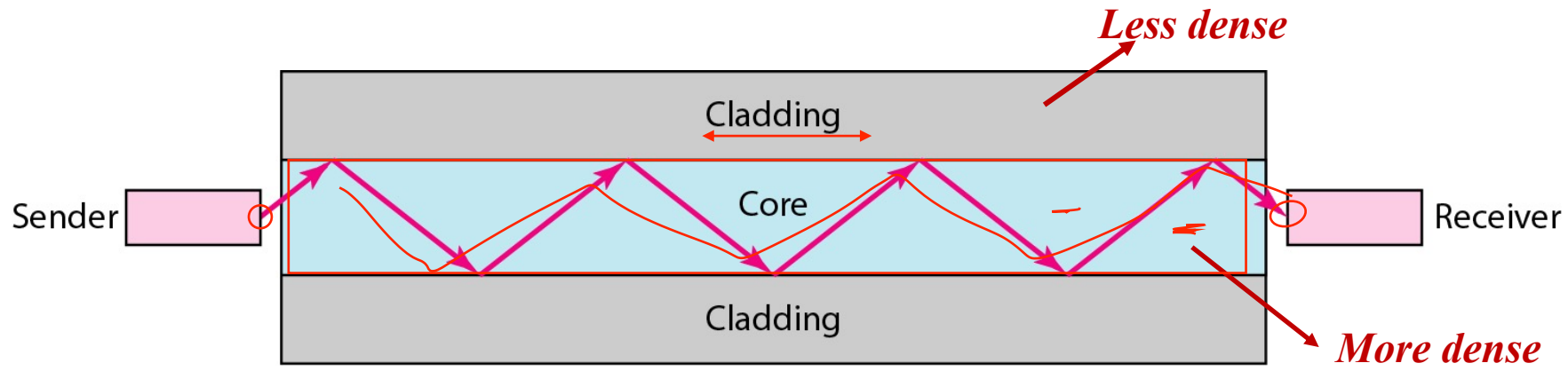
- Widely used in analog telephone networks
  - A single coaxial cable could carry 10000 voice signals.

- Later used in digital telephone networks
  - A single coaxial cable could carry digital data up to 600Mbps



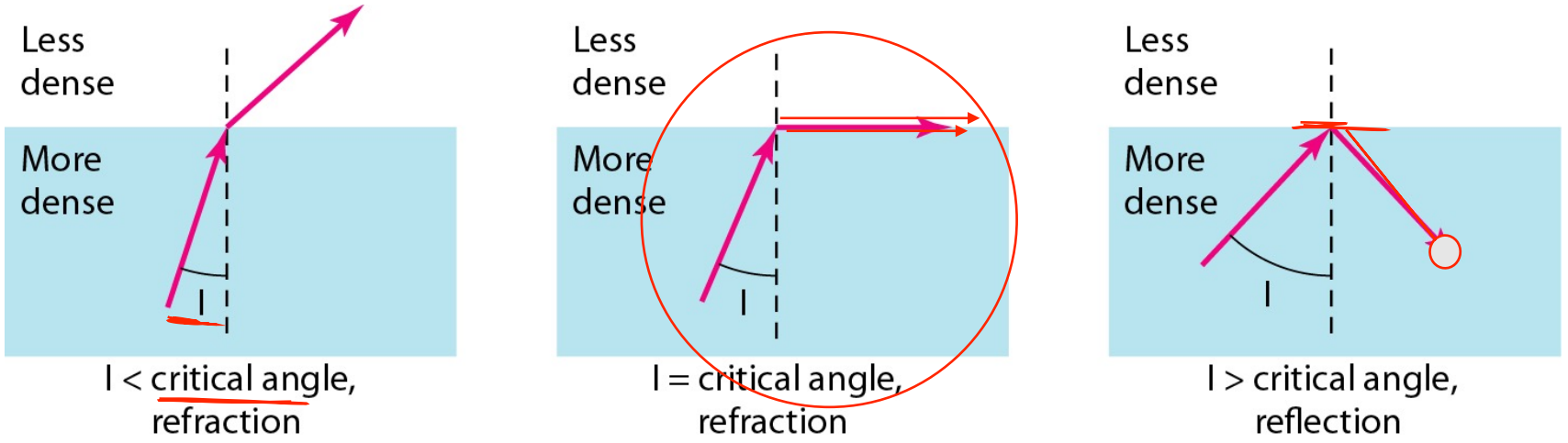
- Cable TV network also uses coaxial cables
- In traditional Ethernet LANs

Optical fiber

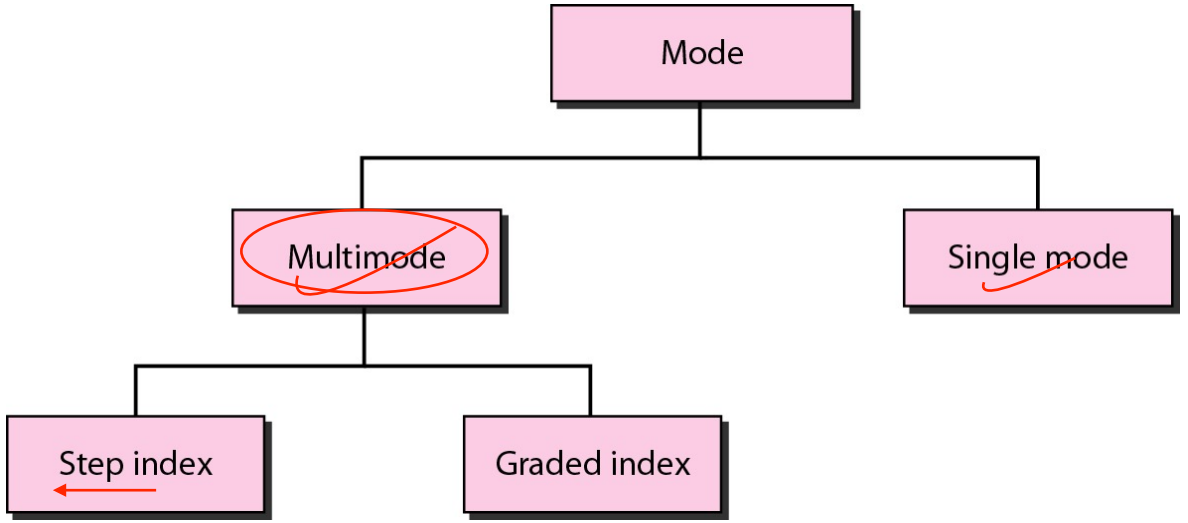


- Light travels in a straight line as long as it is moving through a single uniform substance
- If a light traveling through one substance suddenly enters another substance (of a different density), the changes direction

Fiber optics: *Bending of light ray*

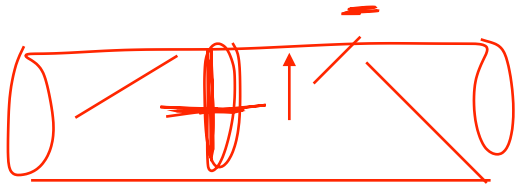


Propagation modes



- Multimode: Multiple beams from a light source move through the core in different paths
- How these beams move within the cable depends on the structure of the core

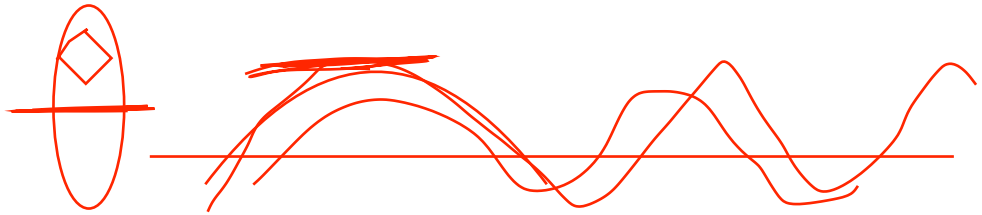
Modes



Multimode Step-Index:

- The density of the core remains constant from the center to the edges
- Light beam moves through the constant density in a straight line until it reaches the interface of the core and cladding
- At the interface the light beam alters the direction due to density difference
- Step-index refers to the suddenness of this change, which contributes to the distortion of the signals it passes through the fiber

Modes



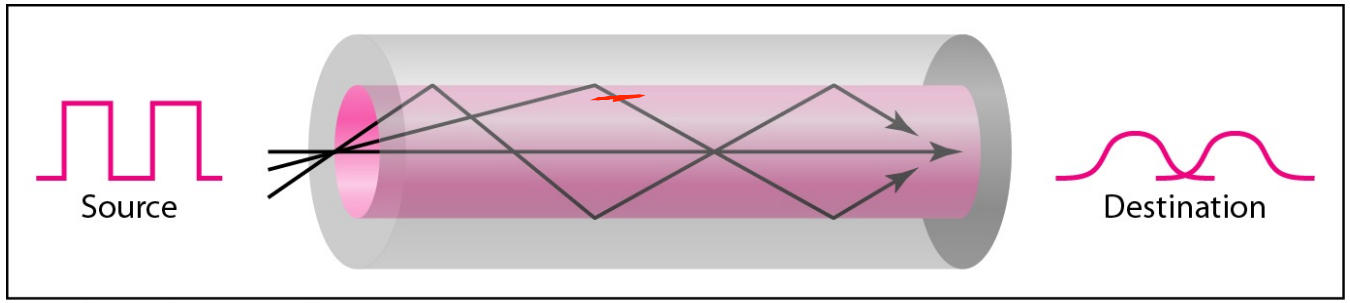
Multimode graded-index:

- A graded index-fiber is of varying density
  - Density is highest at the center of the core and decreases gradually to its lowest at the edge
- Decreases the distortion of the signal through the cable

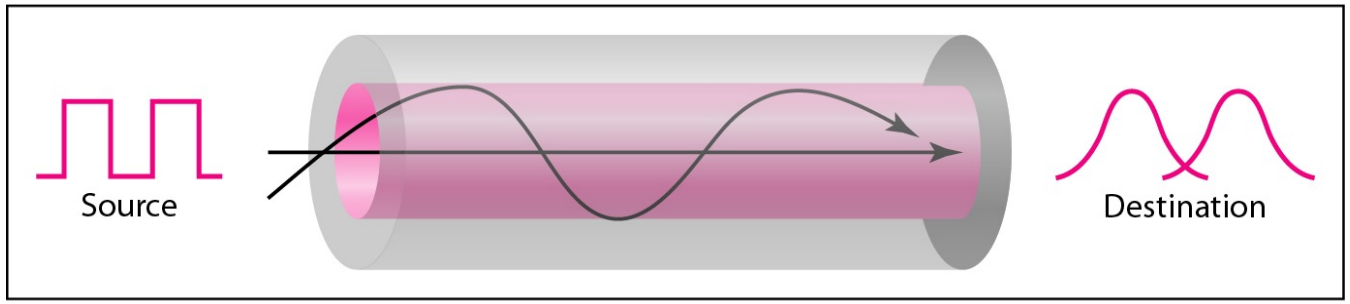
Single mode:

- Limits the beam to a small range of angles, all close the horizontal
- Manufactured with a much *smaller diameter and lower density* than multimode fiber
- *Critical angle close to 90 degree*
  - Propagation of beams almost horizontal and hence delays are negligible.
  - Distortion is very little

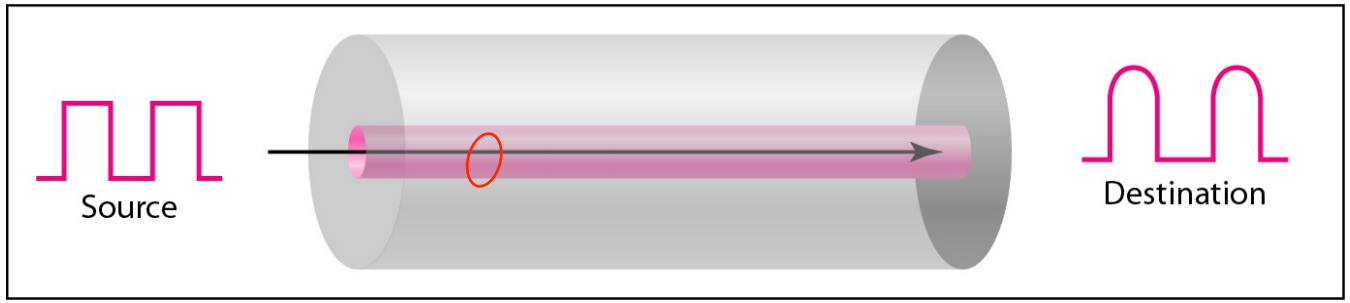
Modes



a. Multimode, step index



b. Multimode, graded index

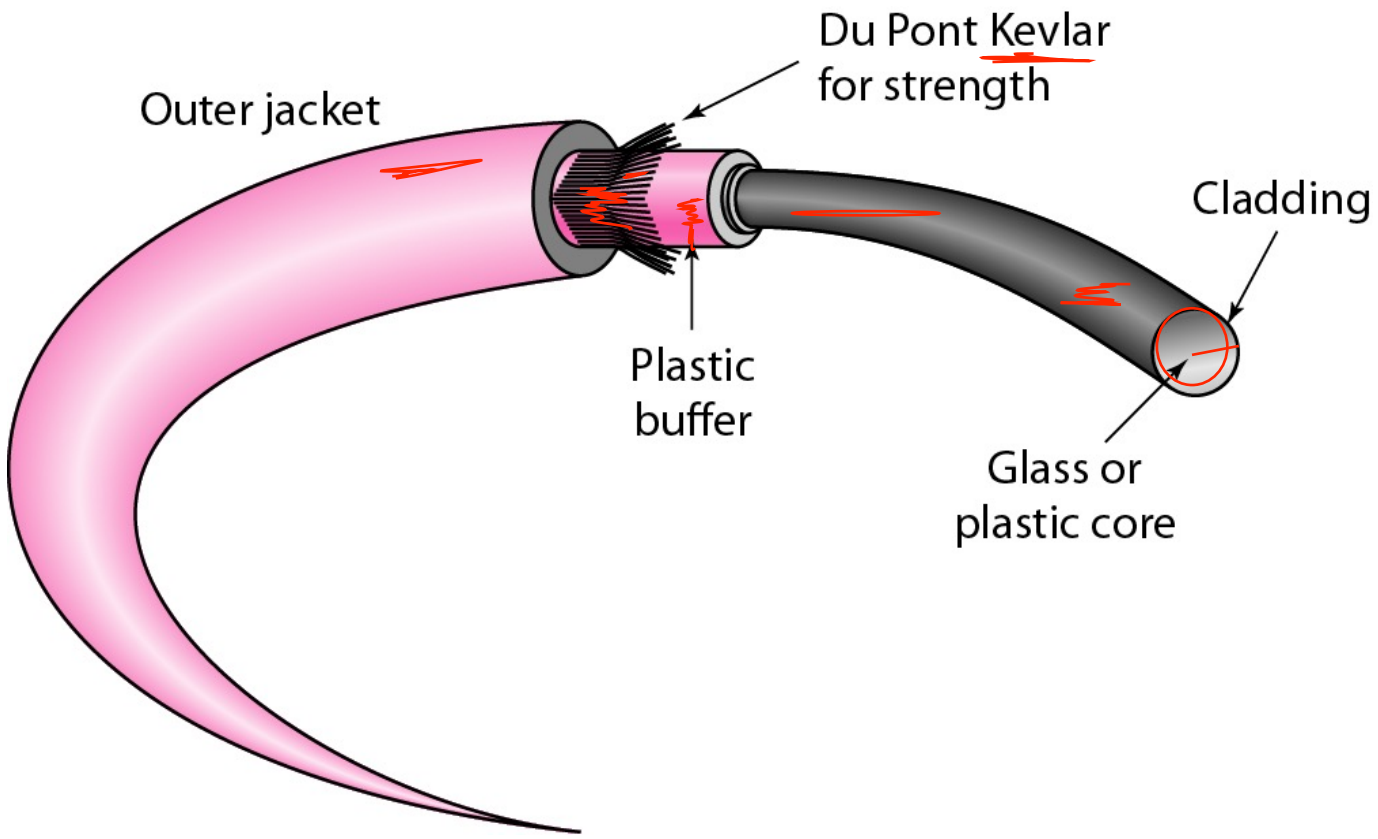


c. Single mode

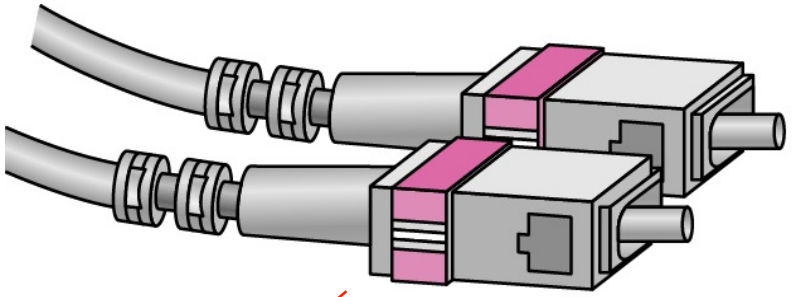
Fiber types

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

Fiber construction

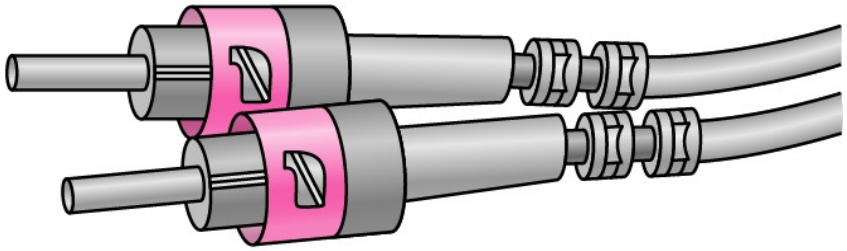


Fiber-optic cable connectors



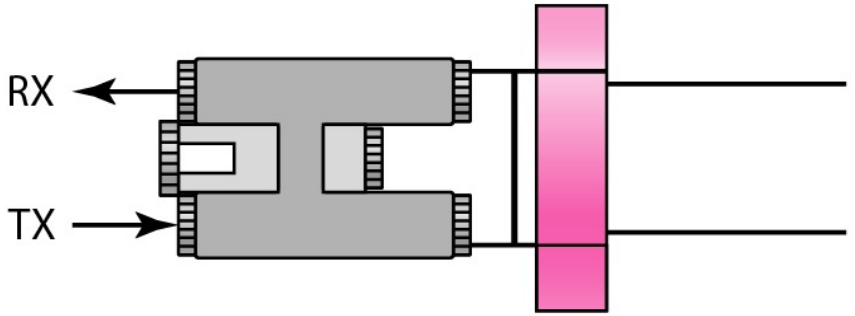
SC connector

Subscriber channel (SC) connector



ST connector

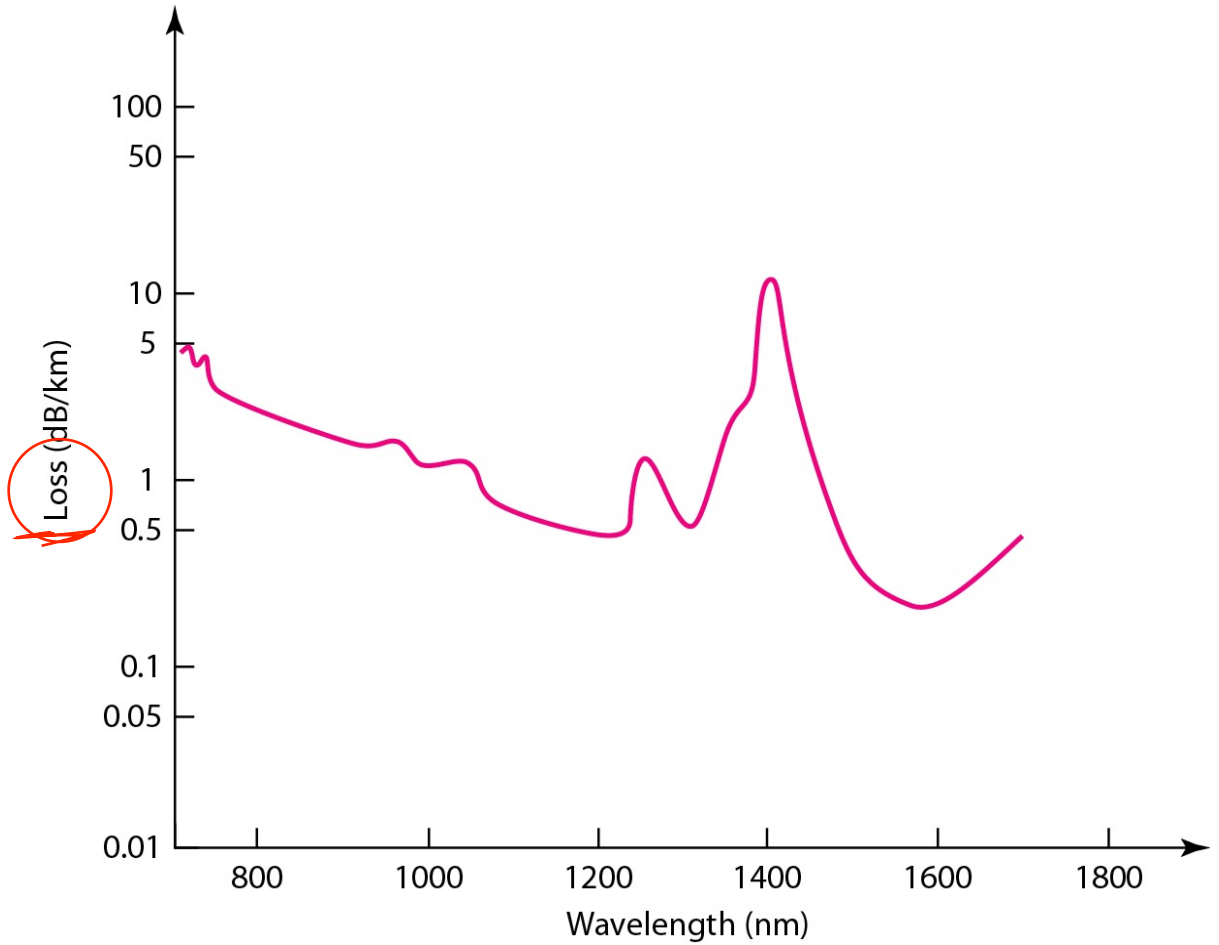
Straight-tip (ST) connector



MT-RJ connector

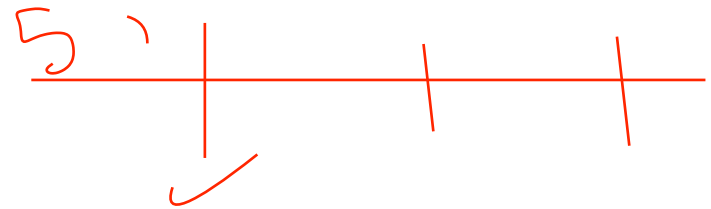
Mechanical Transfer registered Jack

Optical fiber performance



With wavelength division Multiplexing (WDM) we can transfer data at a rate of 1600Gbps

Advantages and Disadvantages



Advantages:

- **Higher bandwidth**
  - can transfer data up to 1600Gbps using wavelength division multiplexing
- **Less signal strength**
  - can run up to 50Km without regeneration compared to 5Km in case of coaxial cable
- **Immunity to electromagnetic interference**
  - Electromagnetic noise can not effect
- **Resistance to corrosive materials**
- **Light weight**
- **Greater immunity to tapping**

Disadvantages:

- Installation and Maintenance
- Unidirectional light propagation
- Cost

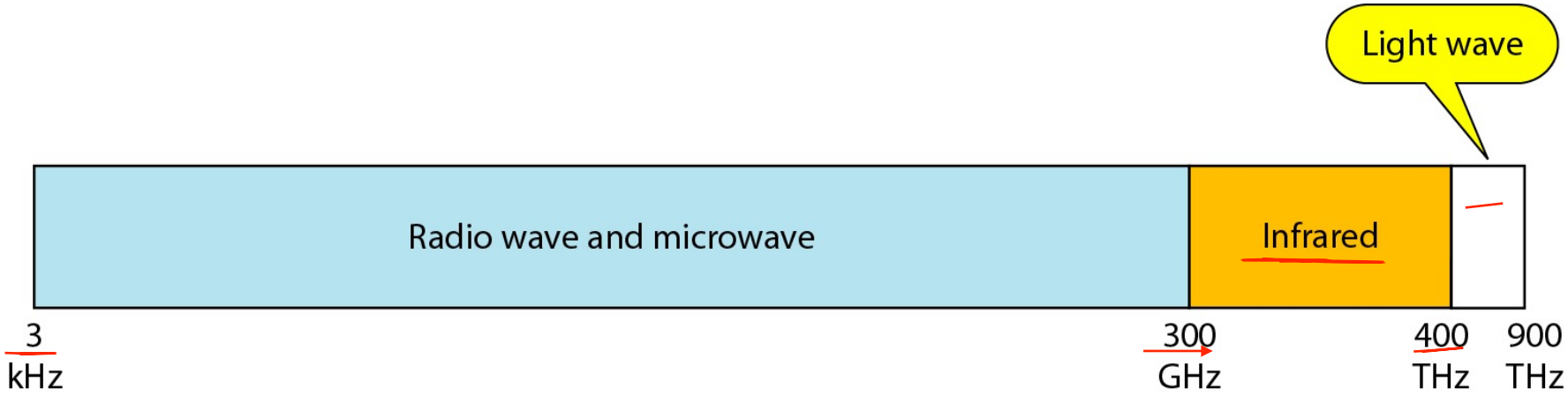
Unguided Media: Wireless

- Unguided media transport electromagnetic waves without using a physical conductor.

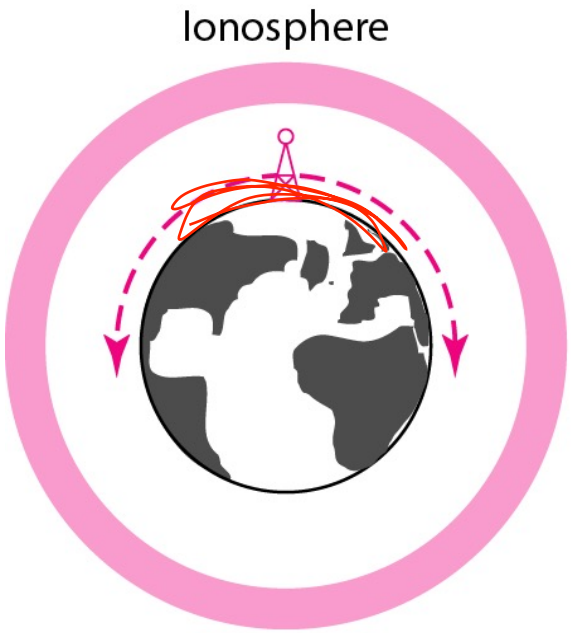
- This type of communication is often referred to as wireless communication.

  - Example:
    Radio Waves
    Microwaves
    Infrared

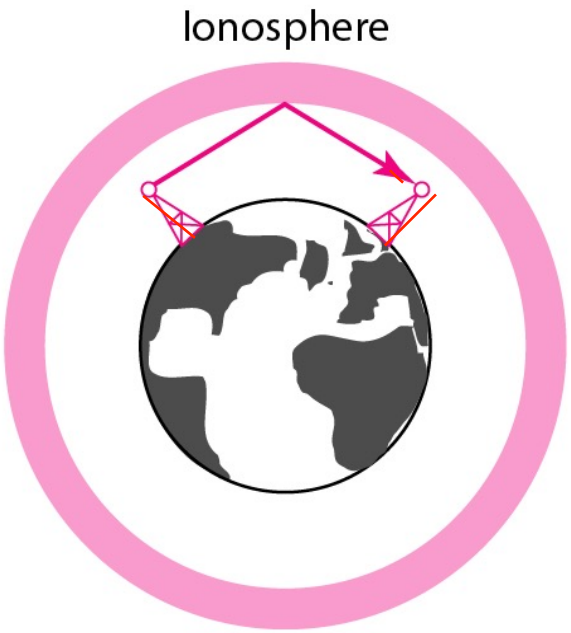
Electromagnetic spectrum for wireless communication



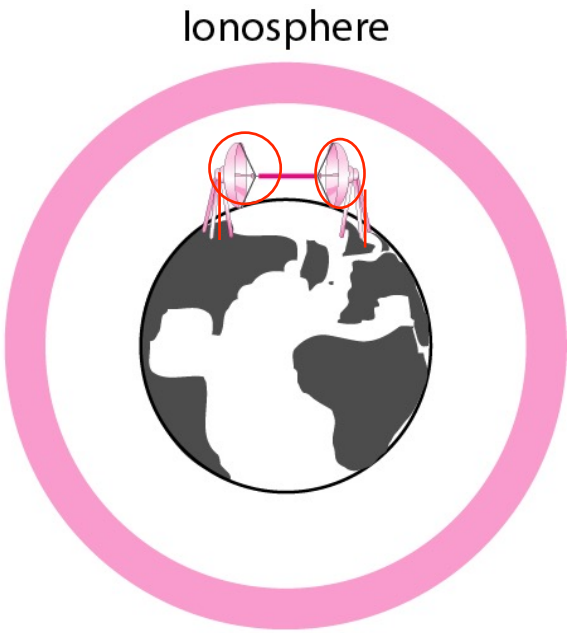
Propagation methods



Ground propagation
(below 2 MHz)



Sky propagation
(2–30 MHz)

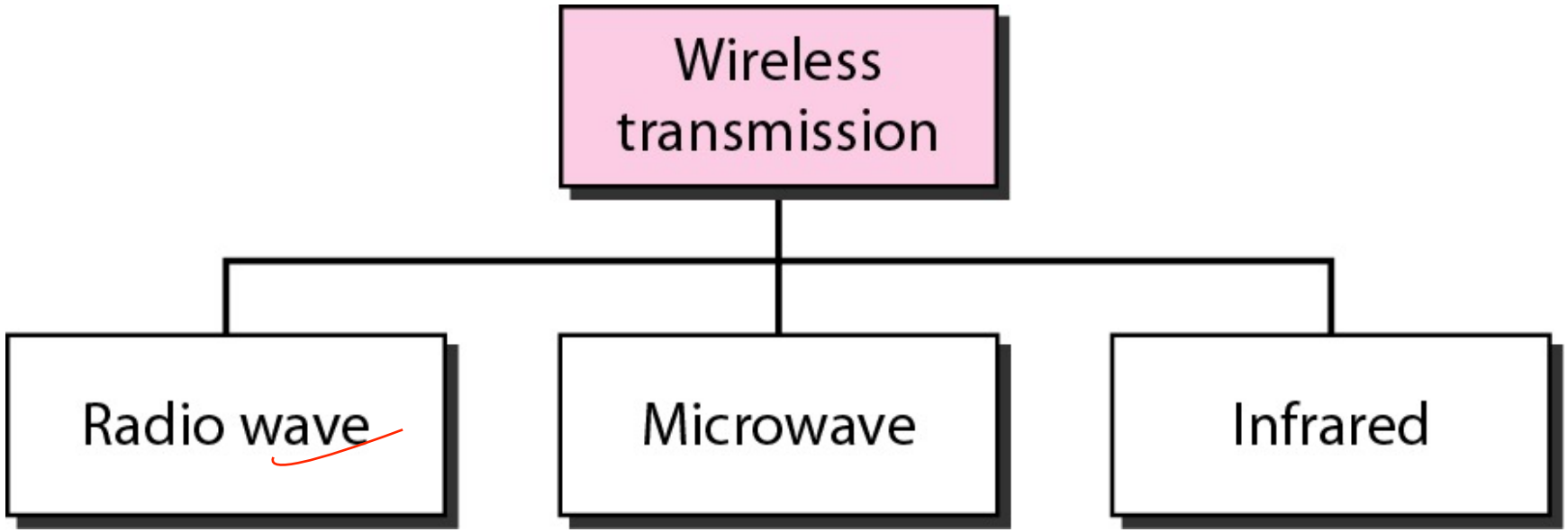


Line-of-sight propagation
(above 30 MHz)

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

Wireless transmission waves

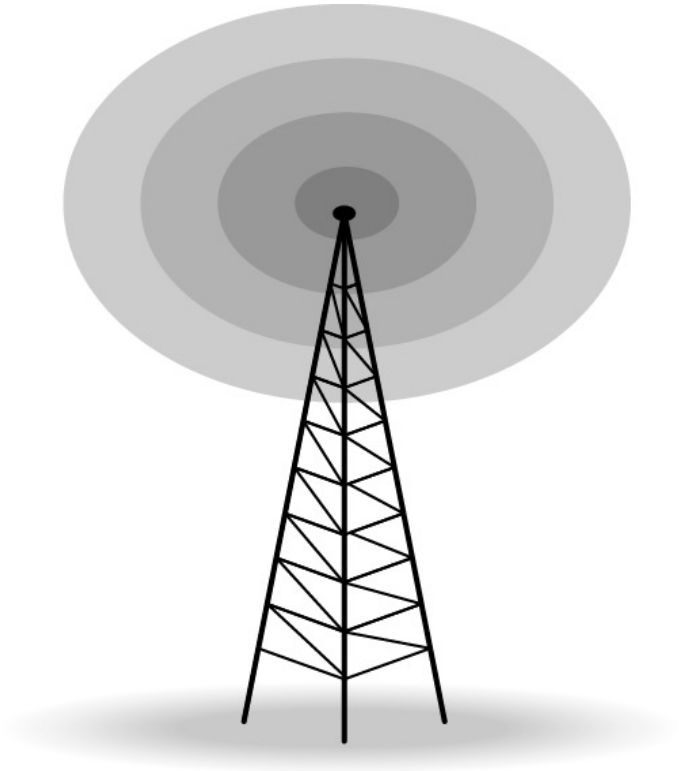


Note

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.

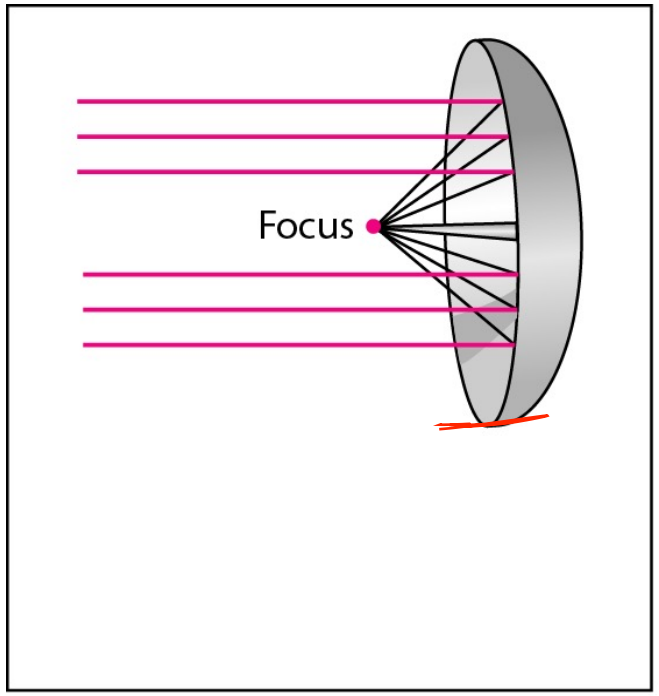
Omnidirectional antenna



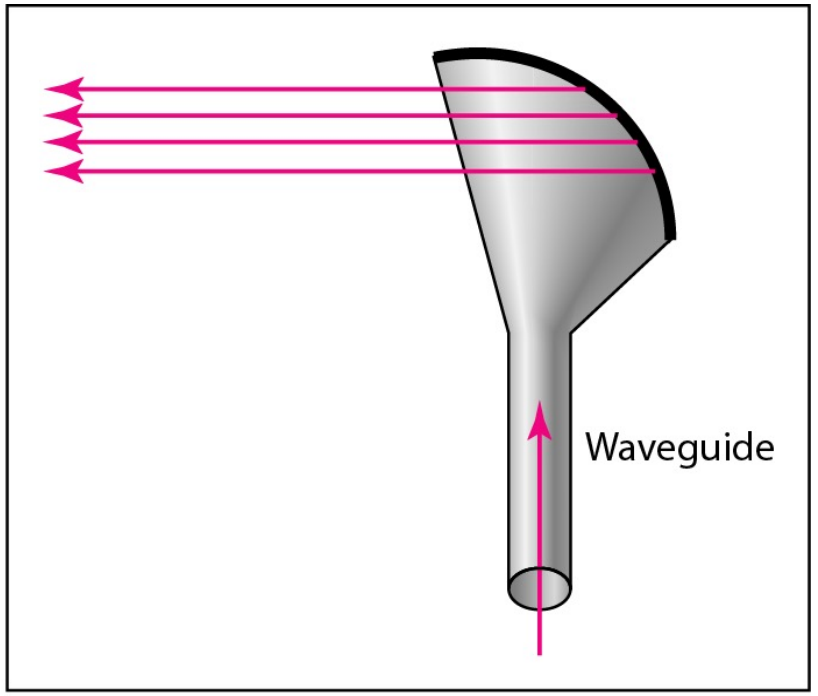
Note

- 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.

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.

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.