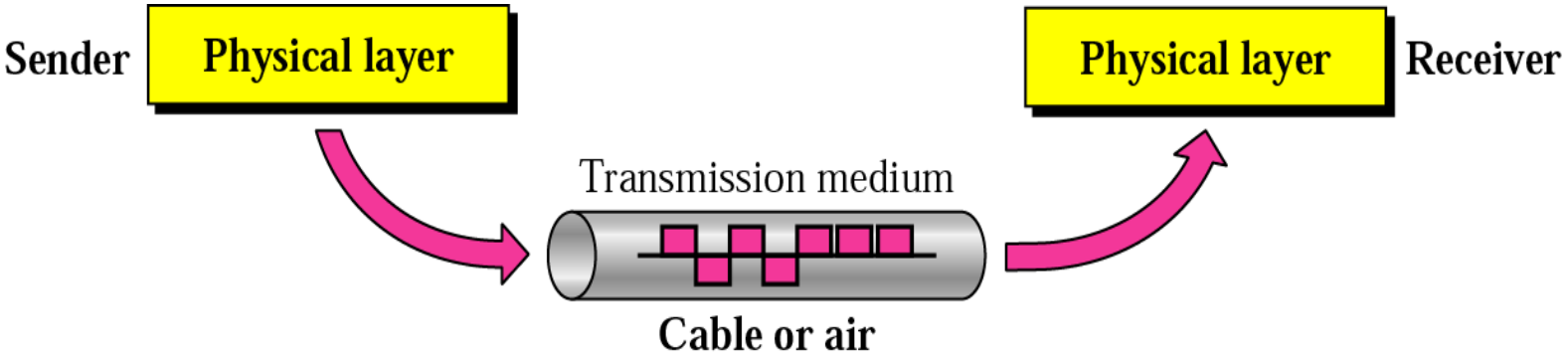
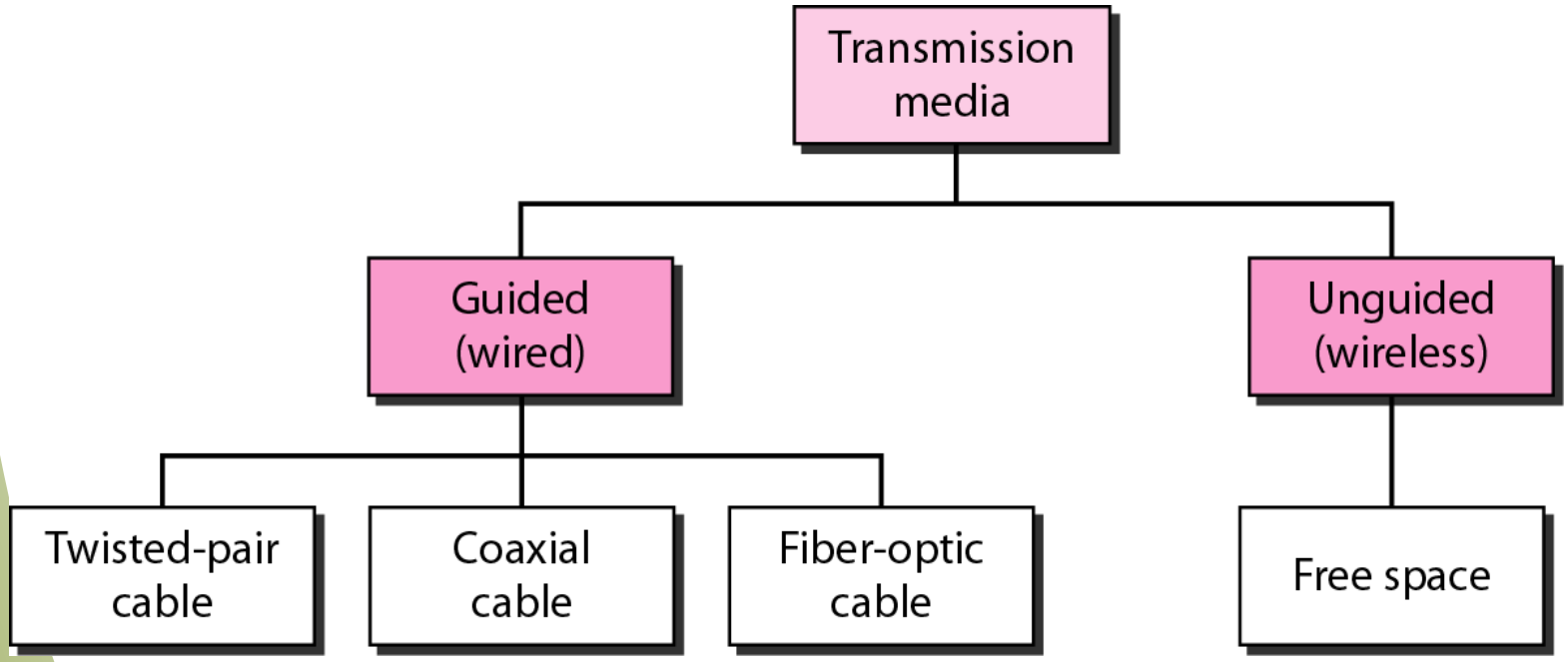
Chapter 7. Transmission Media

1. Guided Media
2. Unguided Media: Wireless

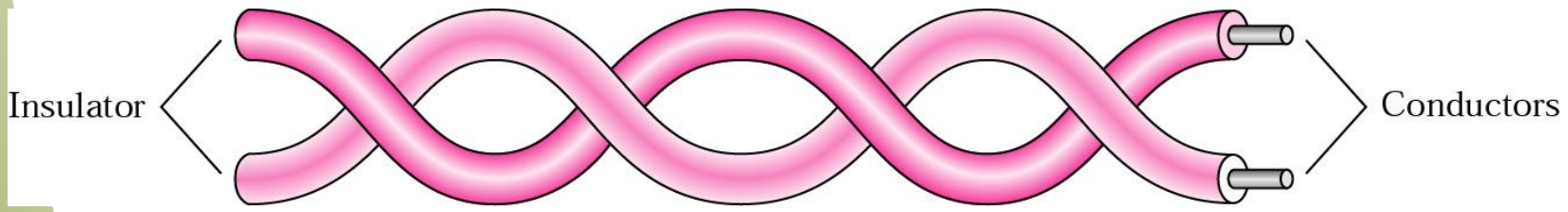
Transmission Medium & Physical Layer



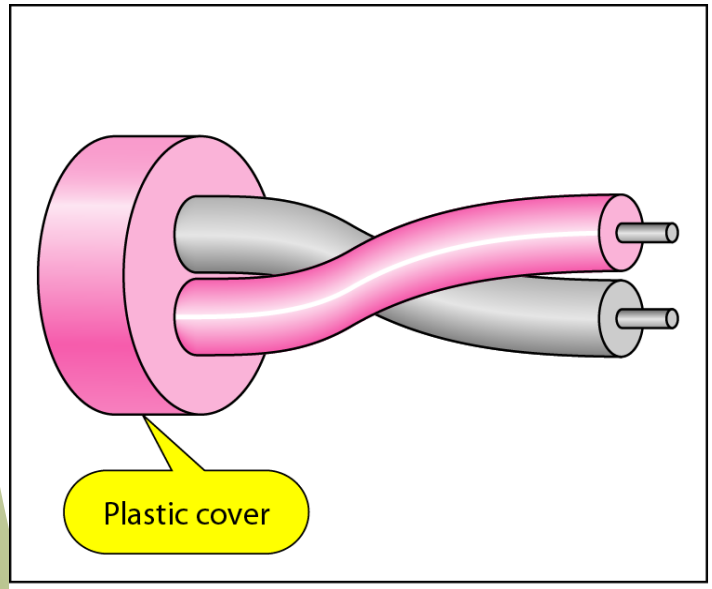
Classes of Transmission Media



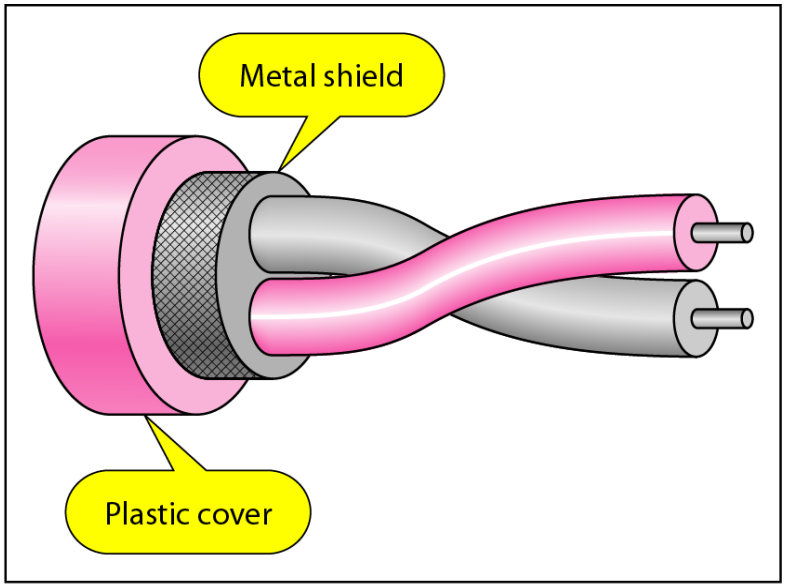
Twisted-pair Cable



UTP and STP Cables



a. UTP



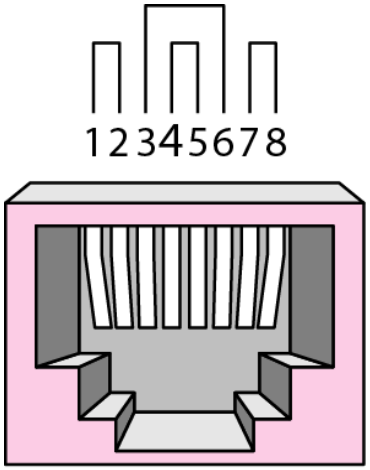
b. STP

Categories of UTP Cables

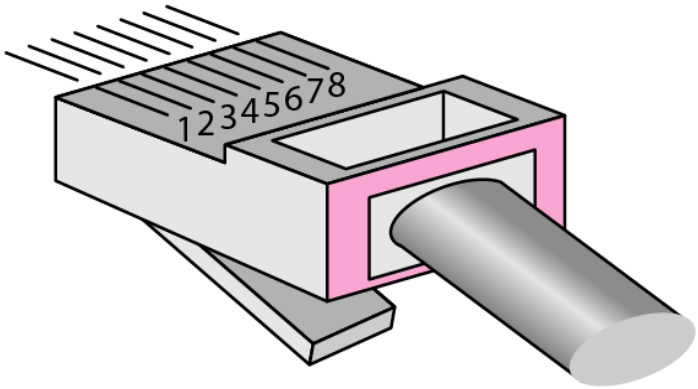
Category	*Specification*	*Data Rate (Mbps)*	*Use*
1	Unshielded twisted-pair used in telephone	< 0.1	Telephone
2	Unshielded twisted-pair originally used in T-lines	2	T-1 lines
3	Improved CAT 2 used in LANs	10	LANs
4	Improved CAT 3 used in Token Ring networks	20	LANs
5	Cable wire is normally 24 AWG with 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

UTP Connector

- RJ45 (RJ stands for registered jack)

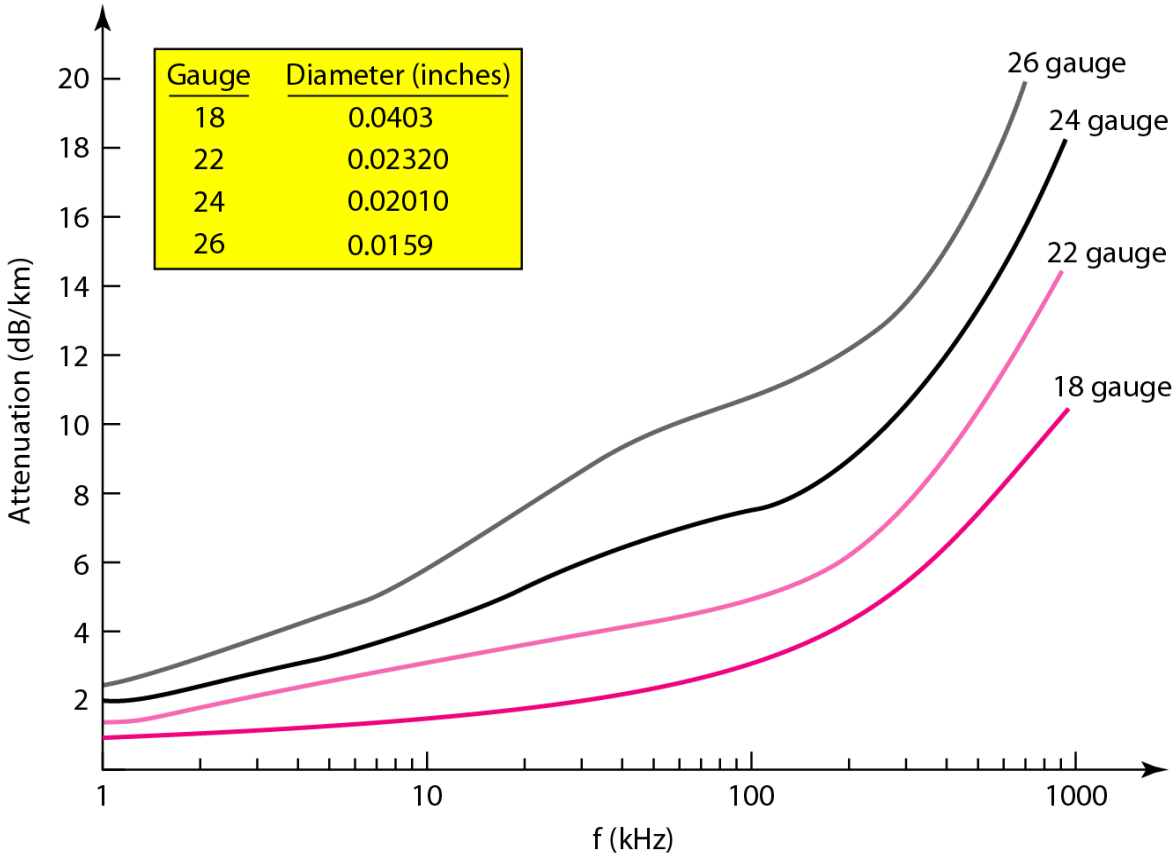


RJ-45 Female



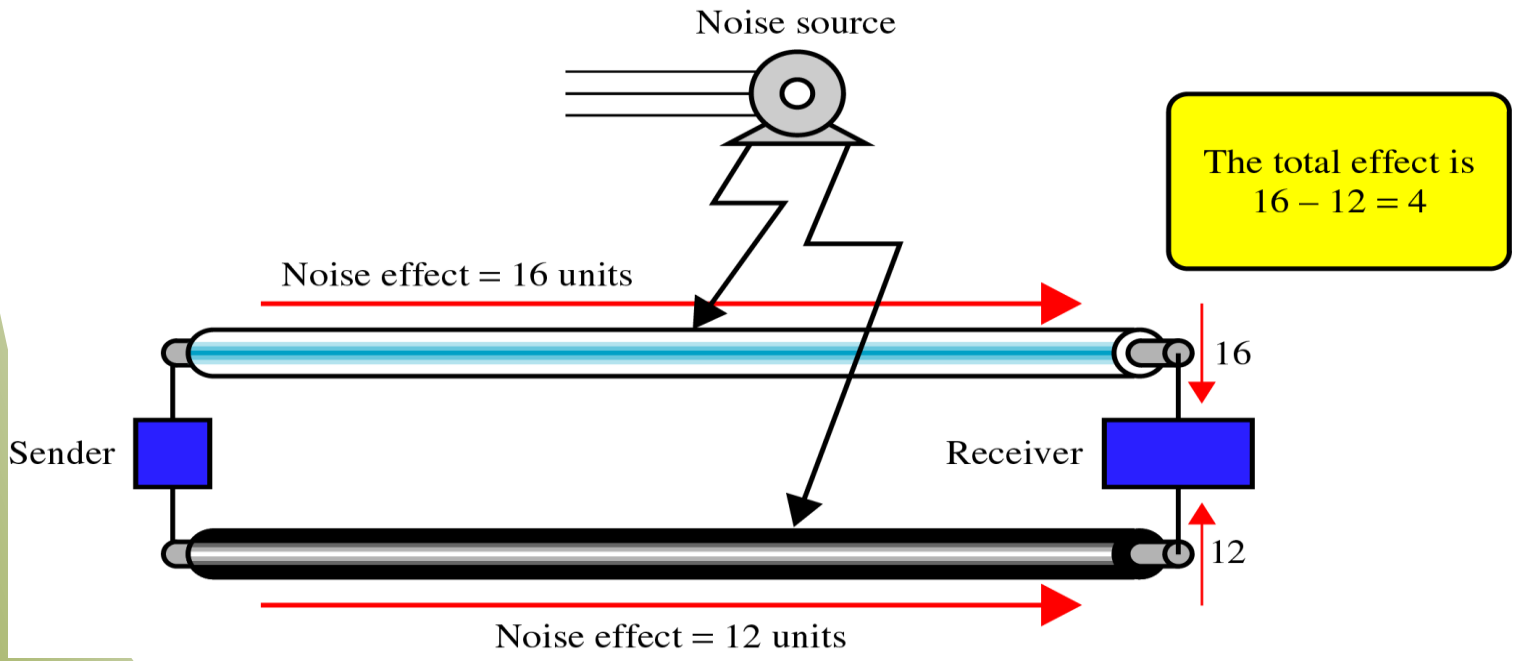
RJ-45 Male

UTP Performance



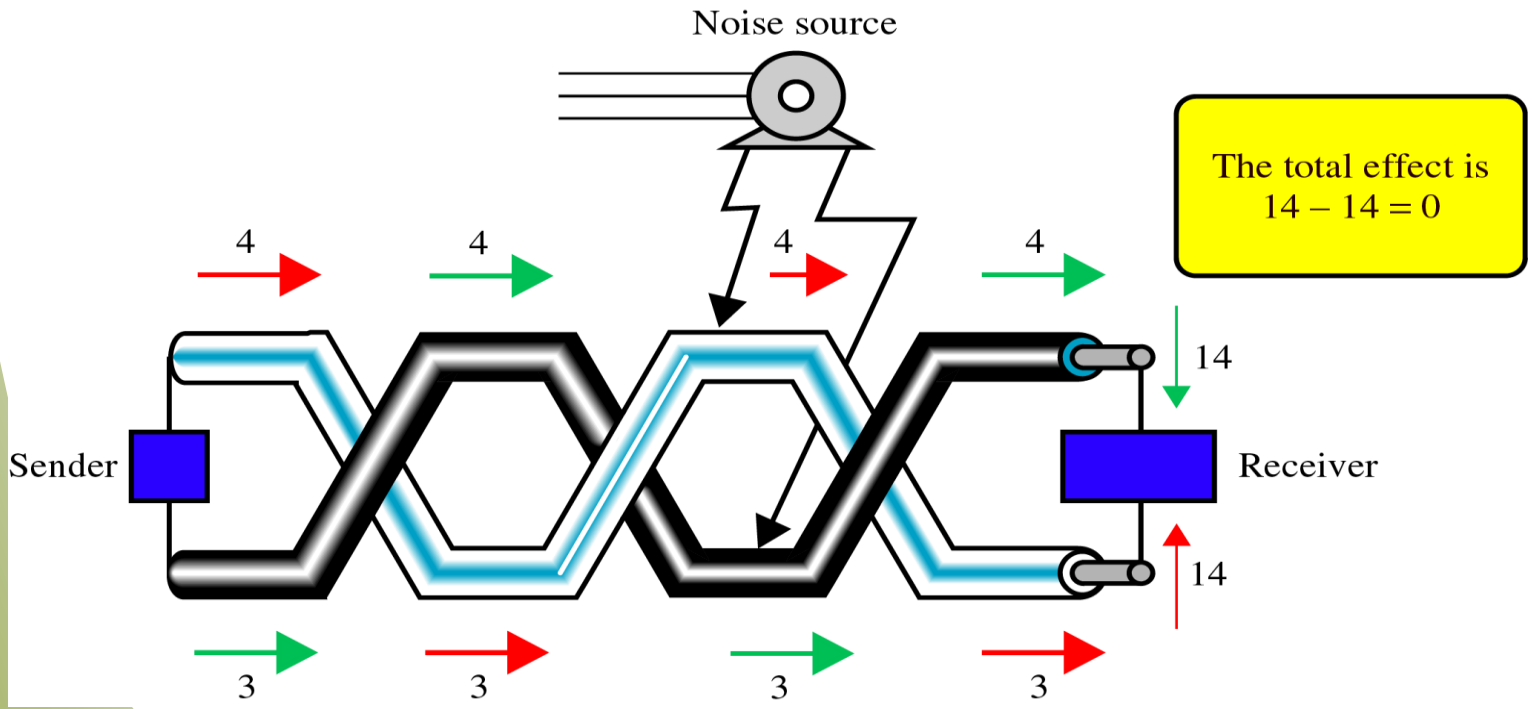
Parallel Flat Wire

- Electromagnetic interference can create noise
- The noise over parallel wires results in an uneven load and a damaged signal



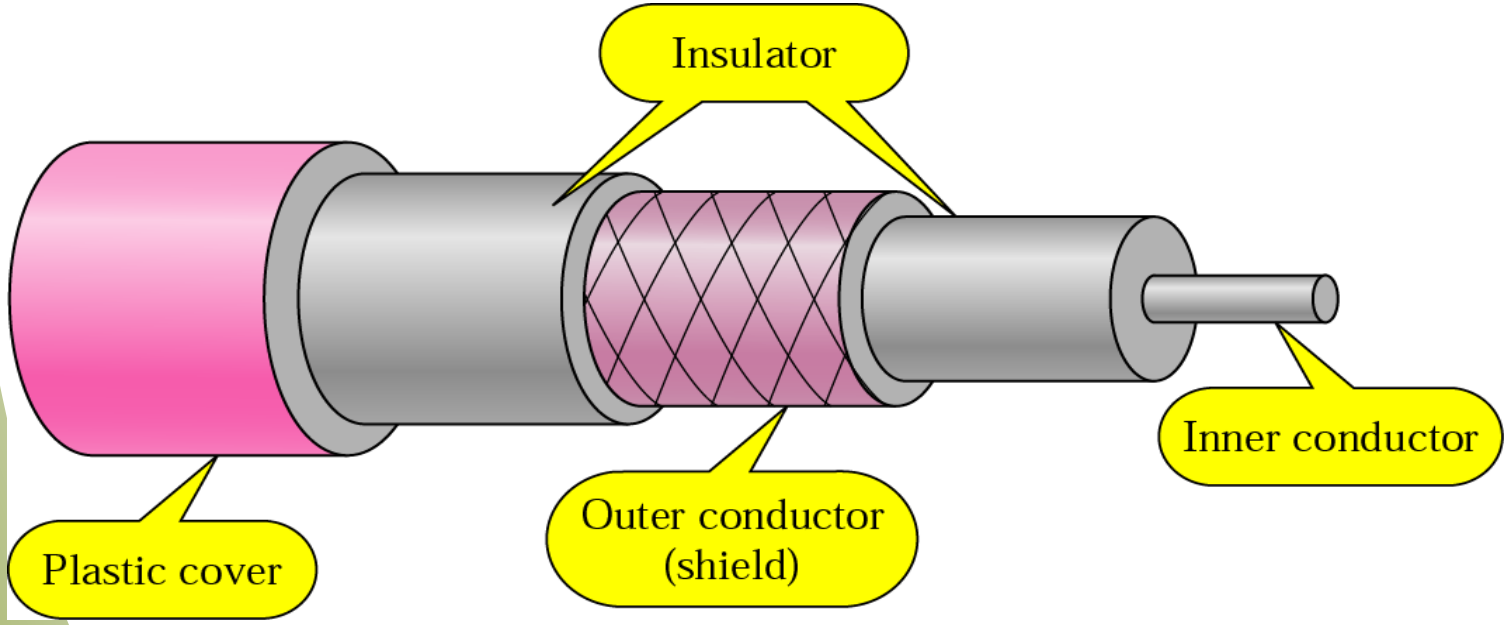
Noise Effect on Twisted-Pair

- Cumulative effect of noise is equal on both sides
- Twisting does not always eliminate the noise, but does significantly reduce it



Coaxial Cable

- Carries signals of higher frequency ranges than those in twisted-pair cable

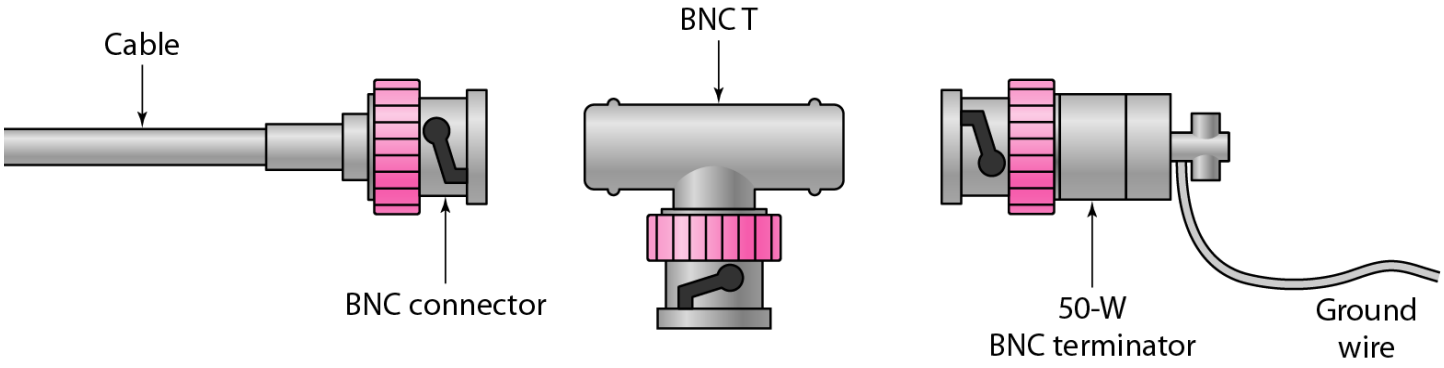


Categories of Coaxial Cables

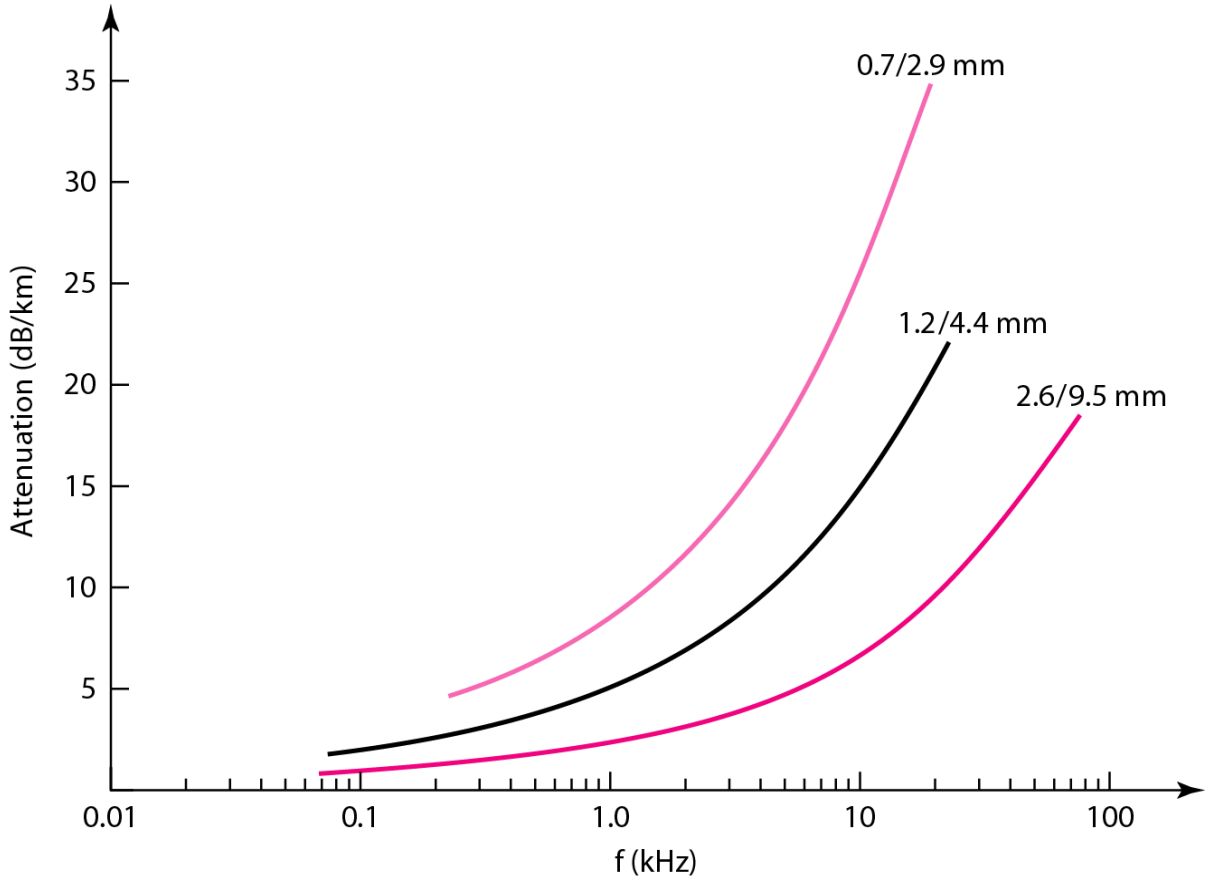
Category	*Impedance*	*Use*
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet
RG-11	50 Ω	Thick Ethernet

BNC Connectors

- Bayone-Neil-Concelman (BNC) connector



Coaxial Cable Performance



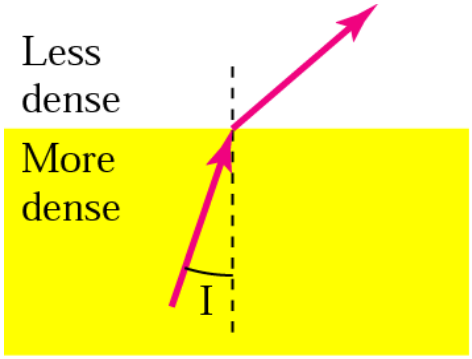
Optical Fiber

- Optical fiber is made of glass or plastic
- It transmits signals in the form of *light*

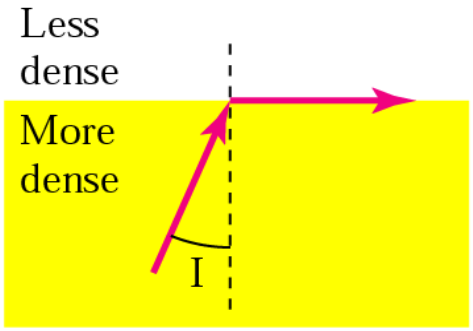
The Nature of Light

- The speed of light
  - 300,000 Km/sec in a vacuum
  - Depends on the density of the medium through which it is traveling
- Other properties of light
  - Refraction, Critical angle, Reflection

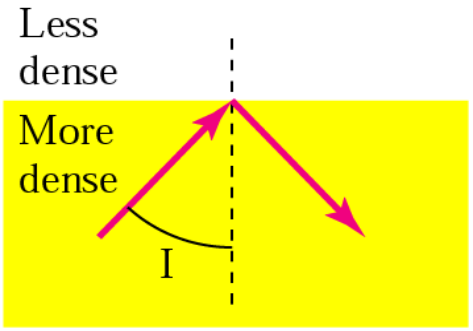
Bending of Light Ray



I < critical angle,
refraction

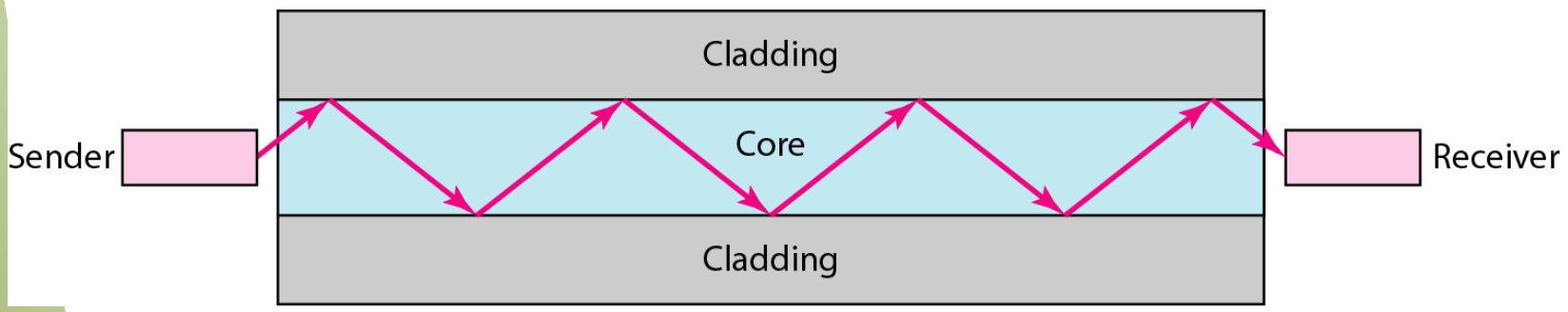


I = critical angle,
refraction

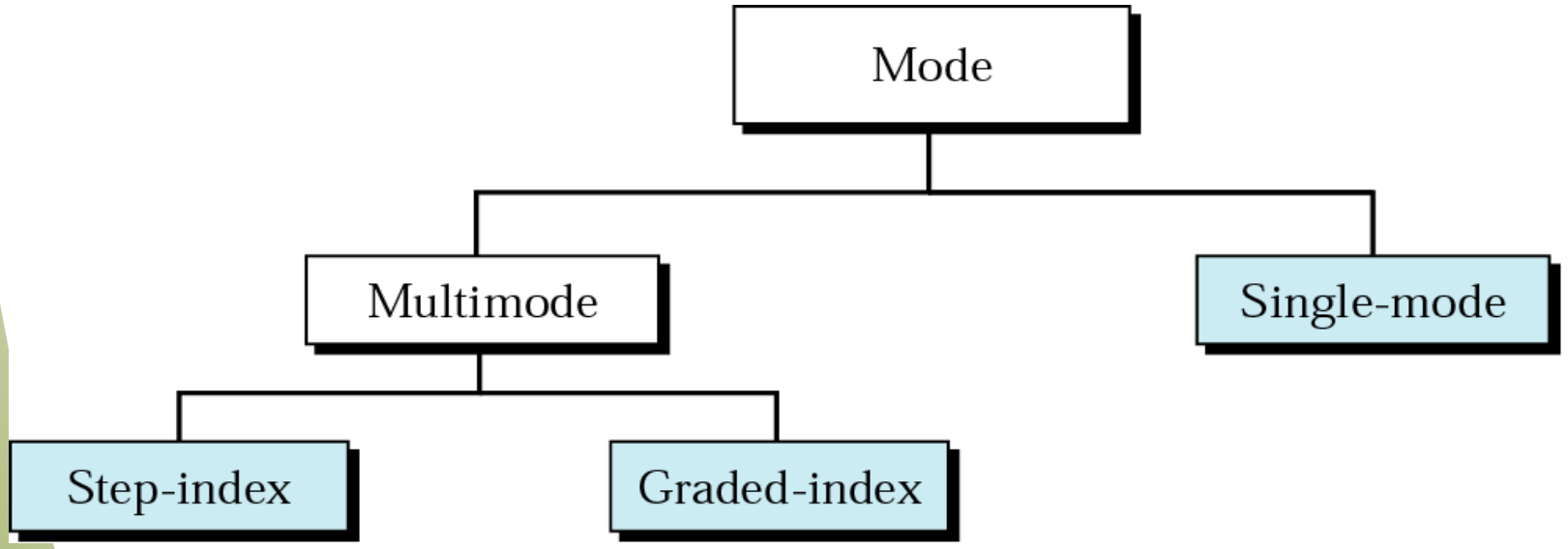


I > critical angle,
reflection

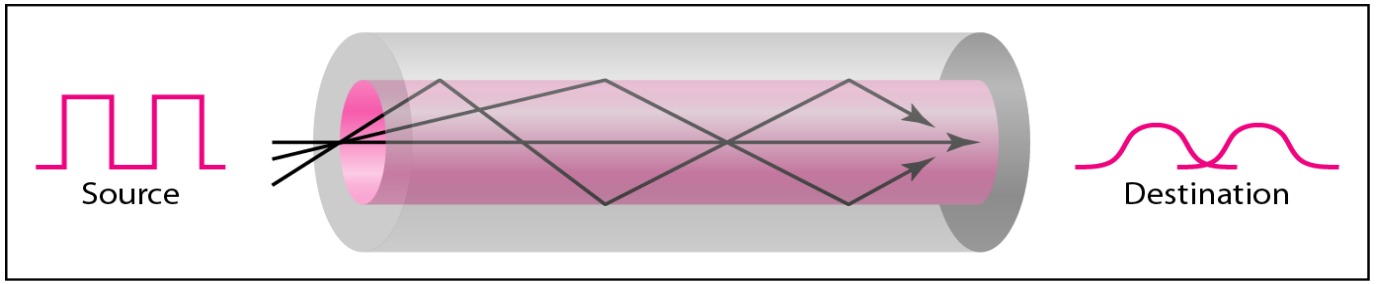
Optical Fiber



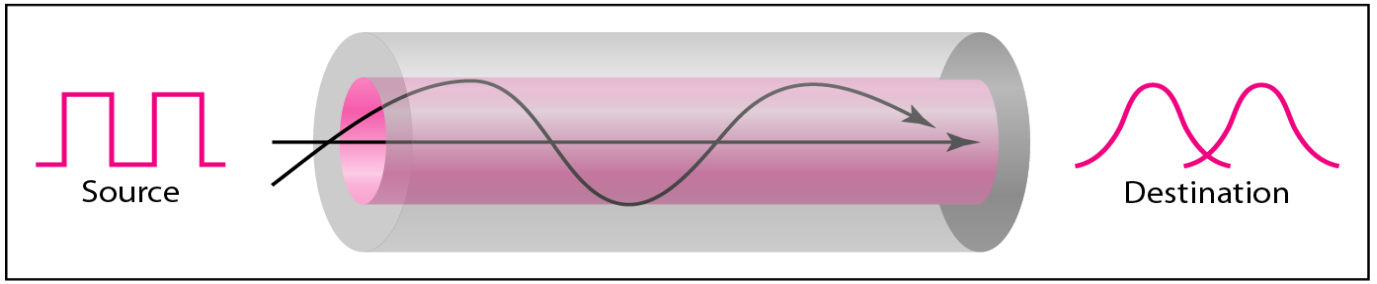
Propagation Modes



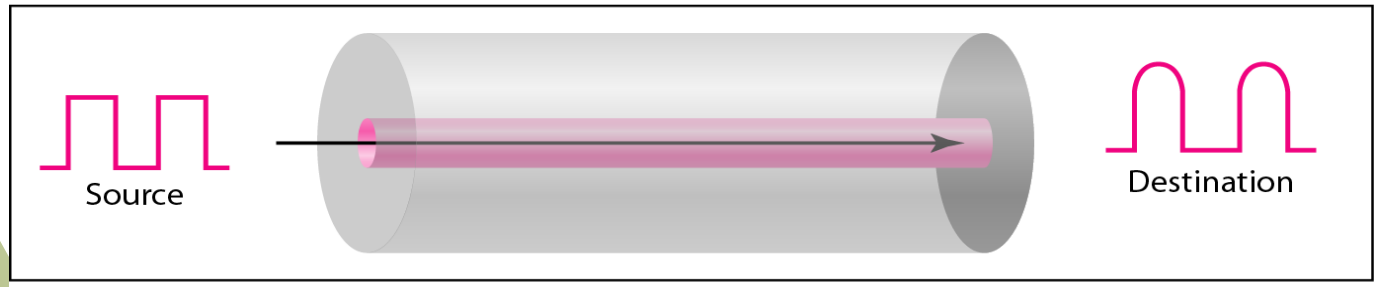
Modes



a. Multimode, step index



b. Multimode, graded index

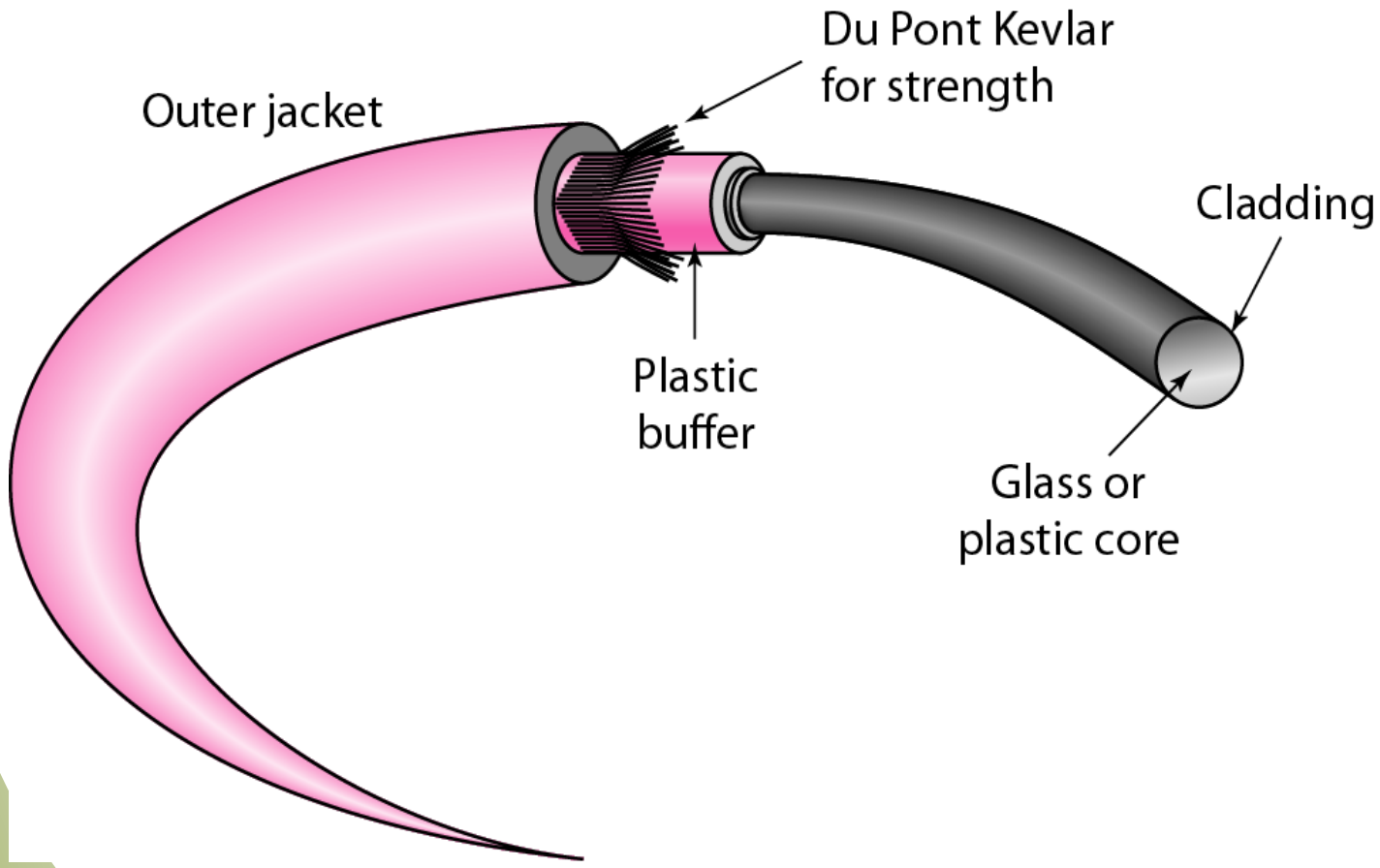


c. Single mode

Fiber Types

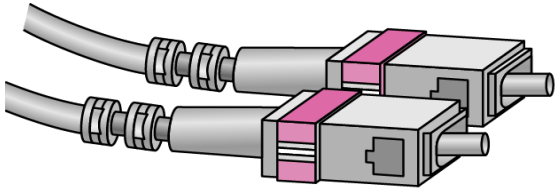
Type	*Core (μm)*	*Cladding (μm)*	*Mode*
50/125	50.0	125	Multimode, graded index
62.5/125	62.5	125	Multimode, graded index
100/125	100.0	125	Multimode, graded index
7/125	7.0	125	Single mode

Fiber Construction

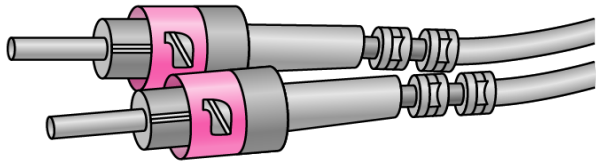


Fiber-optic Cable Connectors

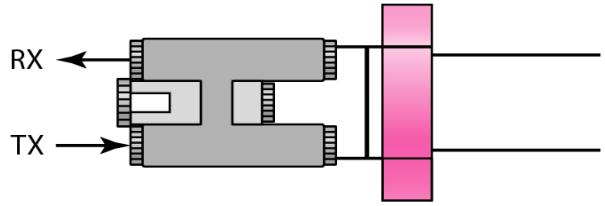
- SC (subscriber channel) connector used for cable TV. It uses push/pull locking system
- ST (straight-tip) connector used for connecting cable to networking device. It uses a reliable bayonet locking system
- MT-RJ is the same size as RJ45



SC connector

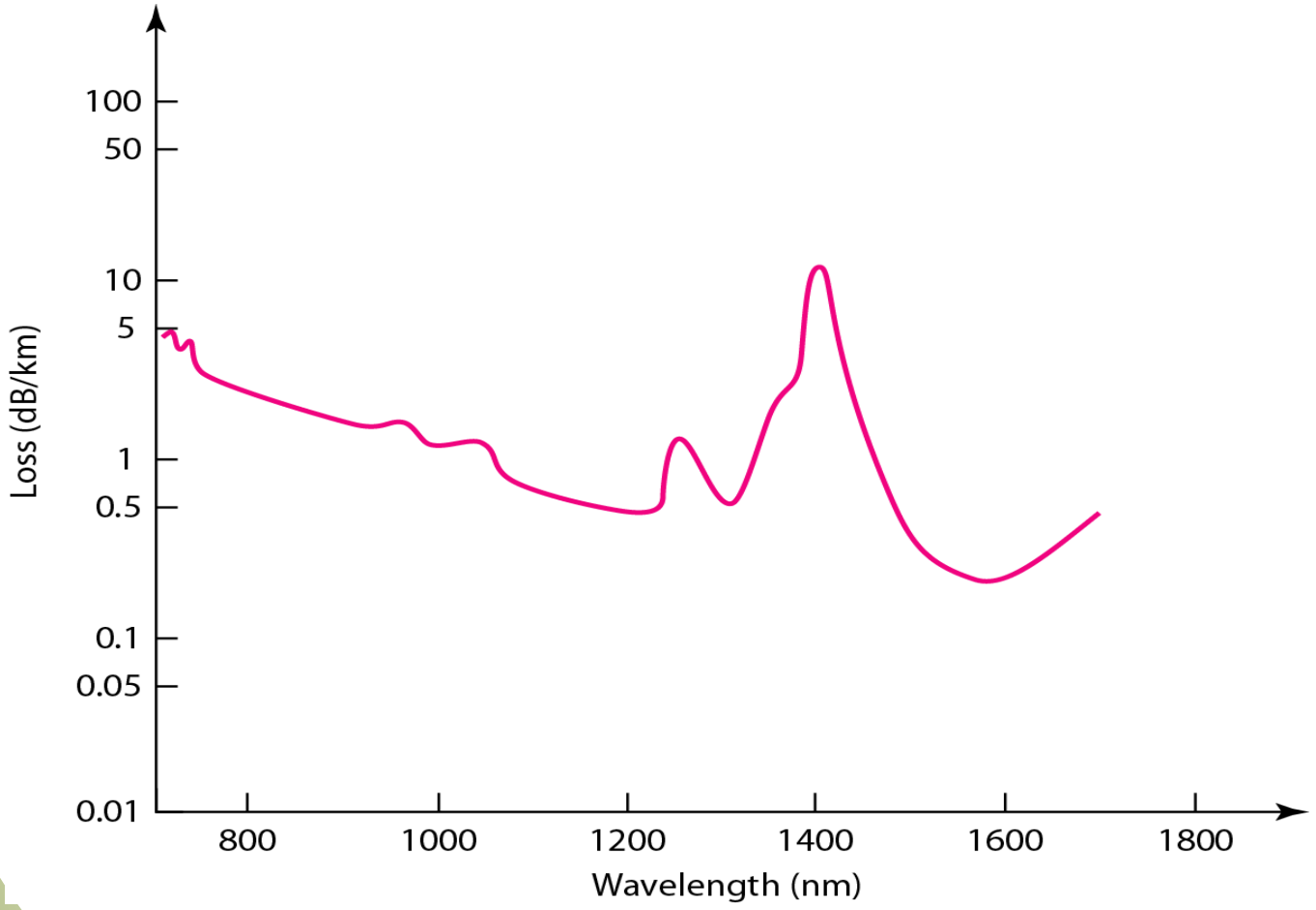


ST connector



MT-RJ connector

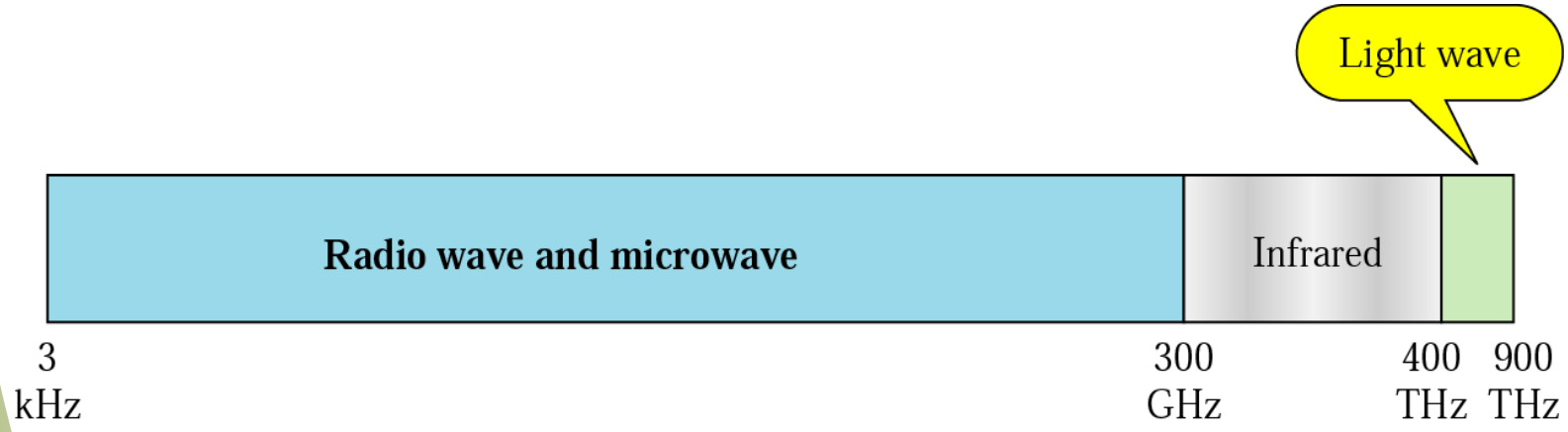
Optical Fiber Performance



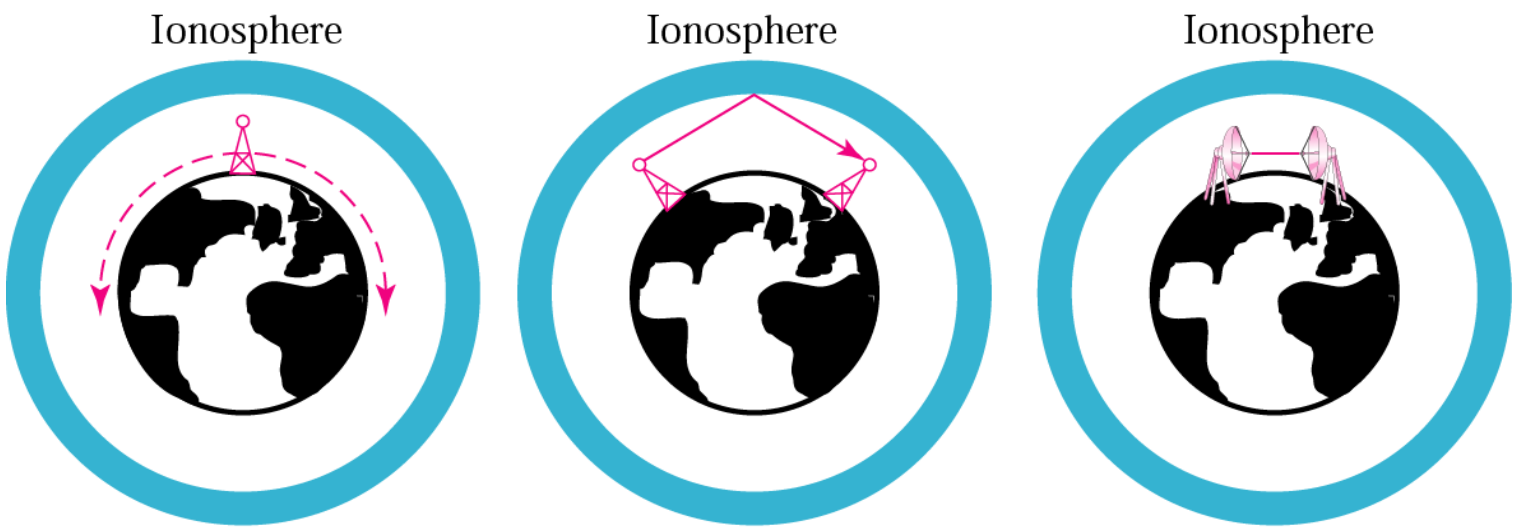
Advantages/Disadvantages of Optical Fiber

- Advantages
  - Higher bandwidth
  - Less signal attenuation
  - Immunity to electromagnetic interference
  - Resistance to corrosive materials
  - Light weight
  - Greater immunity to tapping
- Disadvantages
  - Installation and maintenance
  - Unidirectional light propagation
  - Cost

Electromagnetic Spectrum for wireless



Propagation Methods



Ground propagation
(below 2 MHz)

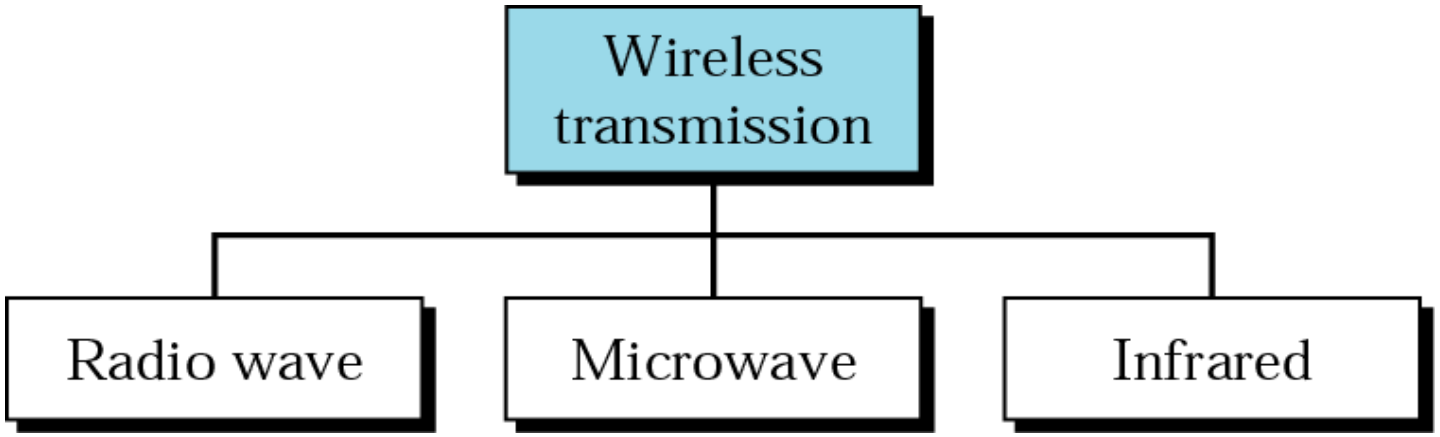
Sky propagation
(2 - 30 MHz)

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

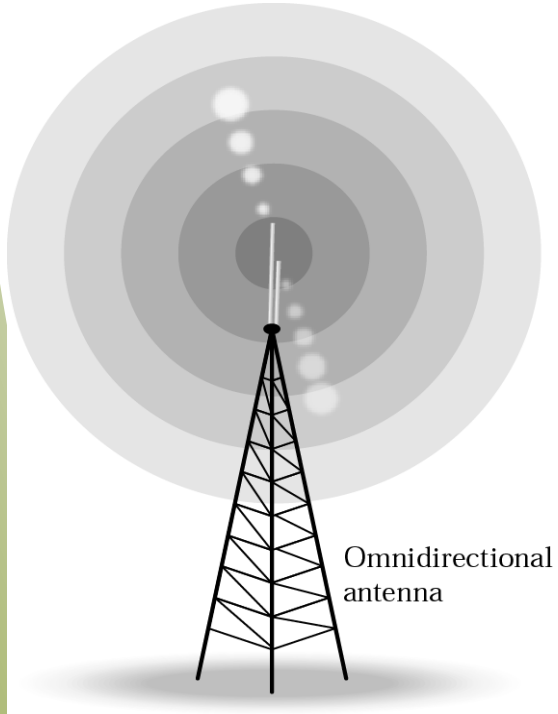
Wireless Transmission Waves

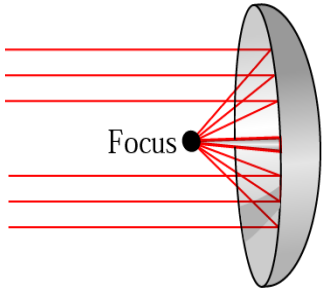


Wireless Transmission Waves

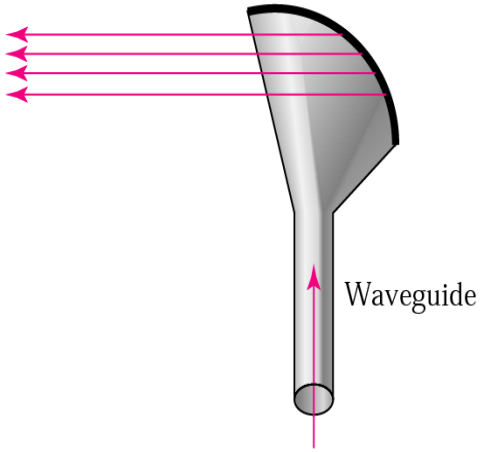
- Radio waves are used for multicast communications, such as radio and television, and paging systems
- Microwaves are used for unicast communication such as cellular telephones, satellite networks, and wireless LANs
- Infrared signals can be used for short-range communication in a closed area using line-of-sight propagation

Omnidirectional & Unidirectional Antennas





a. Dish antenna



b. Horn antenna

Infrared

- Infrared waves with frequencies from 300 GHz to 400 THz for short-range communication in a closed area using line-of-sight propagation
- Having high frequencies, it cannot penetrate walls
- IrDA (Infrared Data Association) for standards
- Example: IrDA port for wireless keyboard
  - Originally defined a data rate of 75 kbps for a distance up to 8 m
  - Recent standard for a data rate of 4 Mbps