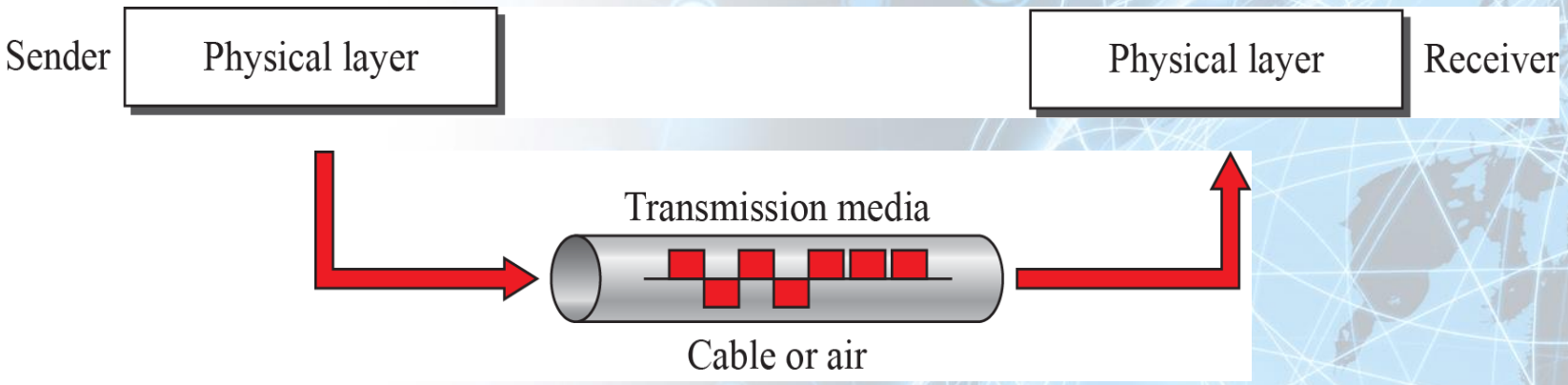
Transmission Media

- Located below the physical layer and are directly controlled by the physical layer
- Belong to layer zero
- Metallic Media i.e. Twisted pair and Coaxial Cable
- Optical Fiber Cable
- Free Space i.e. Air, Vaccum

Transmission Media & Physical Payer



Transmission Media

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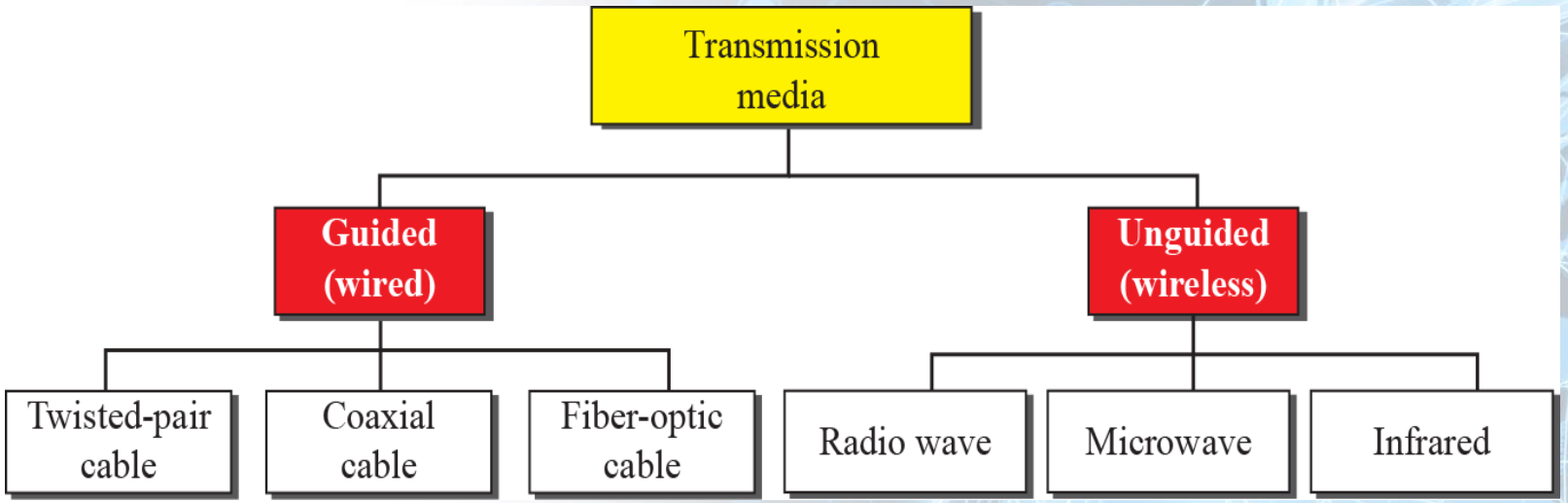
Classes of Transmission Media



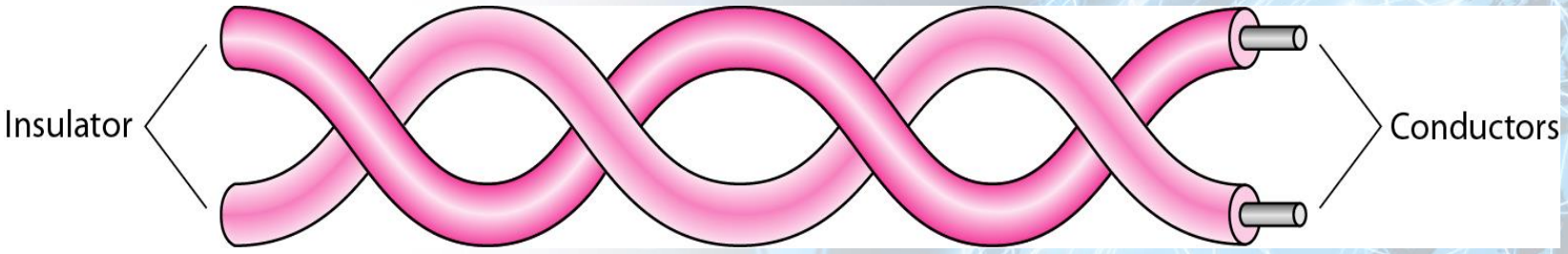
Guided Media

- Media that provides a conduit from one device to another
- Twisted-pair cable, coaxial cable, and fiber-optic cable
- Signal traveling along any of these media is directed and contained by the physical limits of the medium

Twisted-Pair Cable

- Consists of 2 copper conductors, each with its own plastic insulation, twisted together
- One wire carries signals and other is ground reference
- Receiver uses difference between the two
- Interference (Noise) & Crosstalk

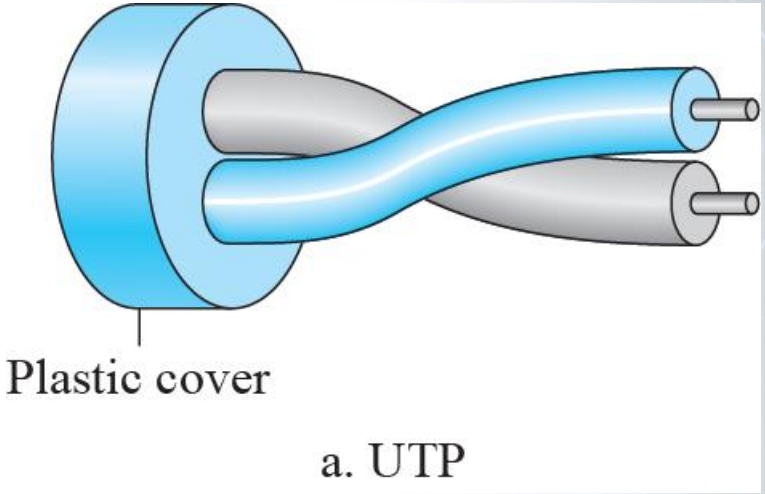
Twisted-Pair Cable

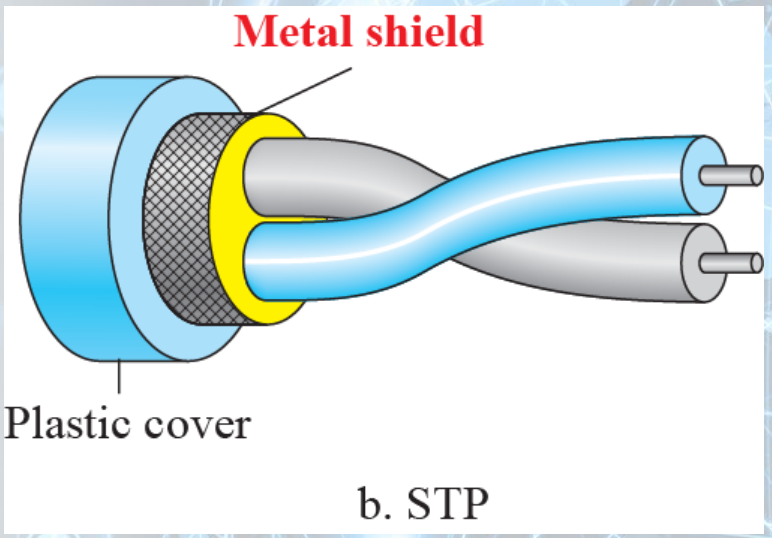


Twisted-Pair Cable

- UTP
- STP

Unshielded vs. Shielded Twisted Pair Cable

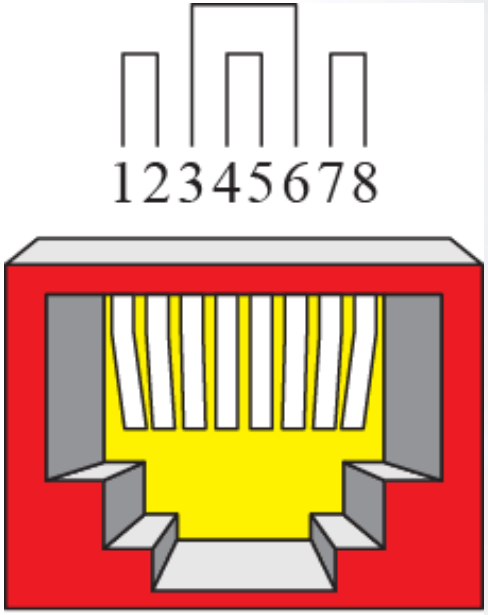




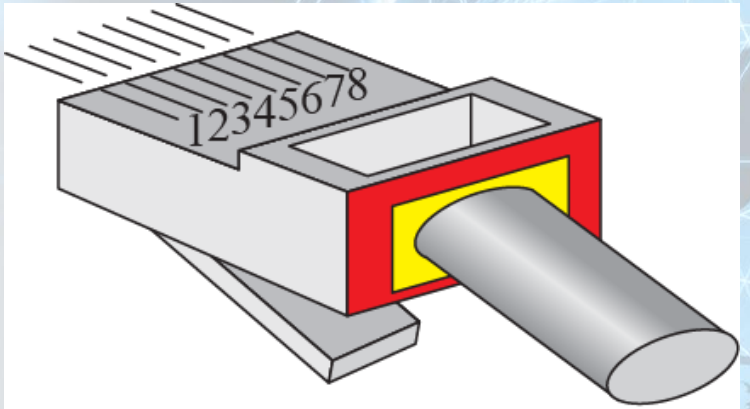
Categories of Unshielded Twisted-Pair Cables

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

UTP Connectors

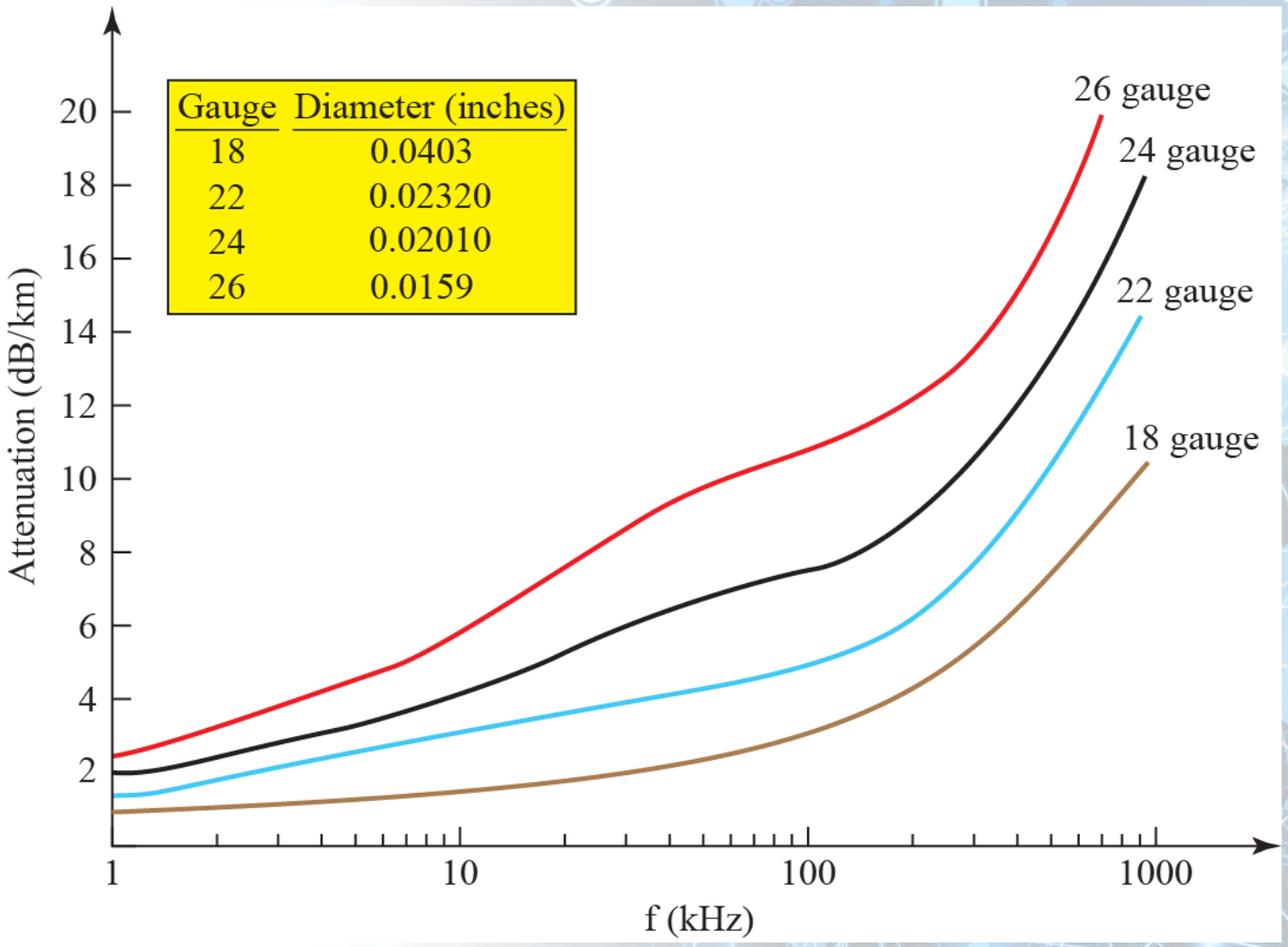


RJ-45 Female



RJ-45 Male

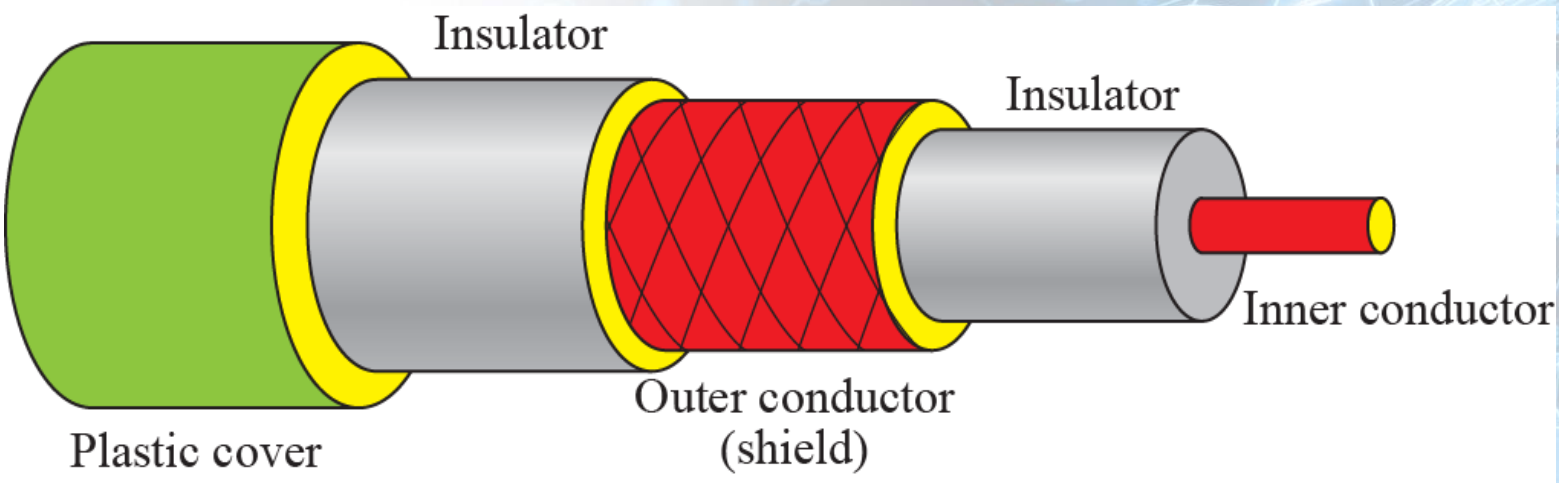
UTP Performance



Coaxial Cable

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

Coaxial Cable



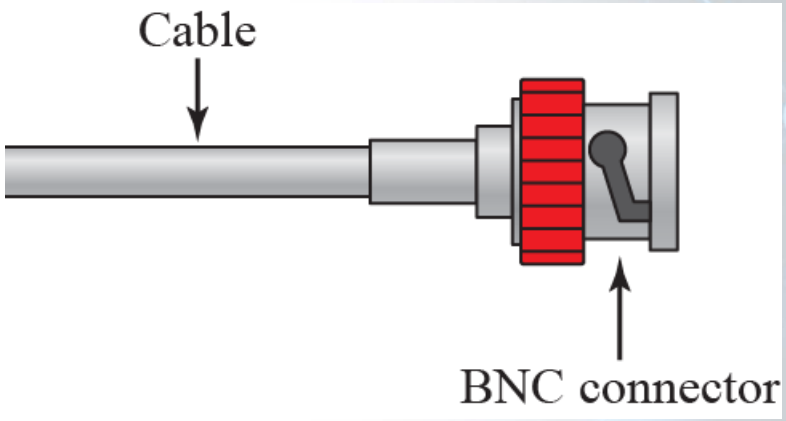
Categories of Coaxial Cables

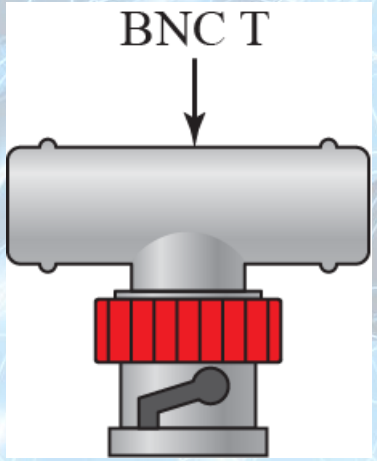
Category	*Impedance*	*Use*
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet
RG-11	50 Ω	Thick Ethernet

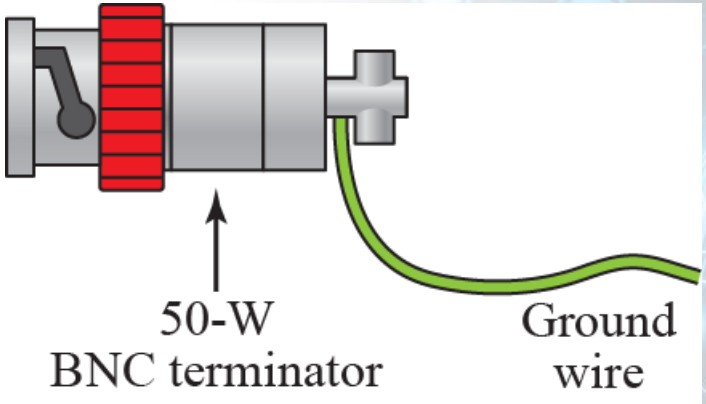
Coaxial Cable

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

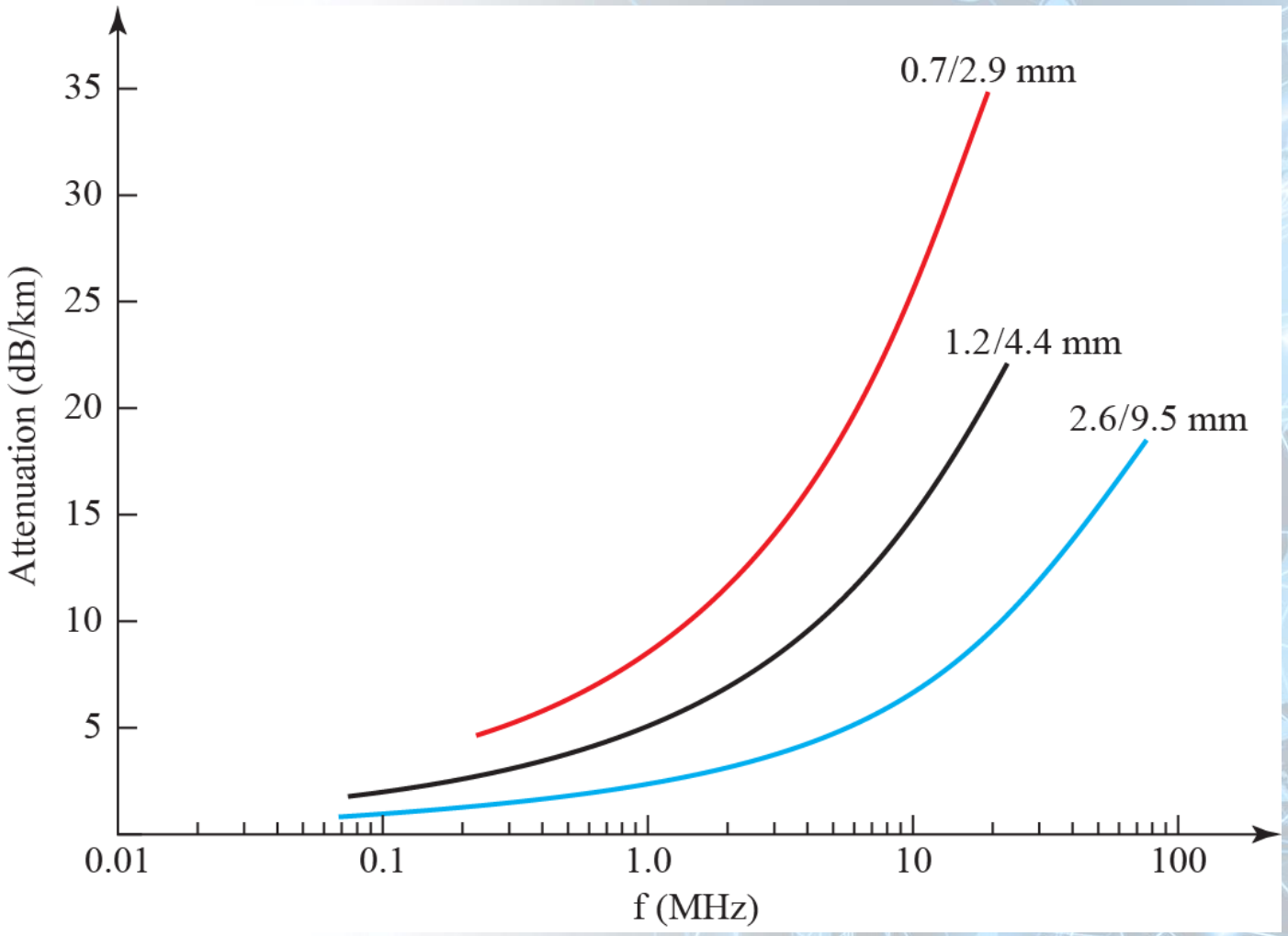
BNC Connectors







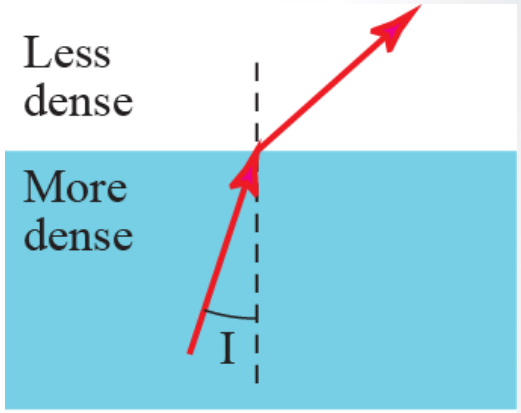
Coaxial Cable Performance



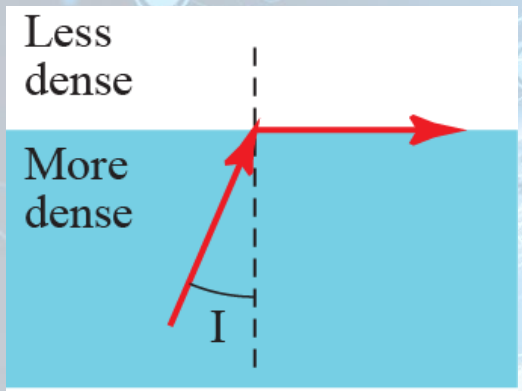
Fiber-Optic Cable

- Made of glass or plastic and transmits signals in the form of light
- Light travels in a straight line as long as it is moving through a single uniform substance
- If a ray of light traveling through one substance suddenly enters another substance (of a different density), the ray changes direction

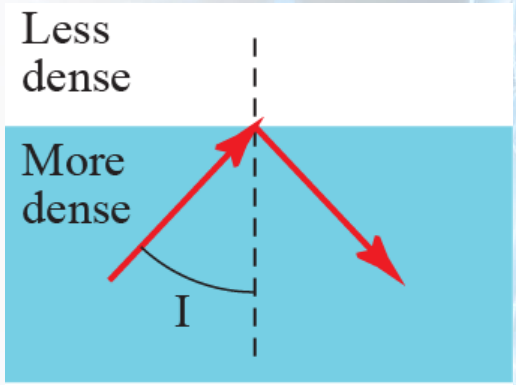
Bending of Light Ray



I < critical angle,
refraction



I = critical angle,
refraction

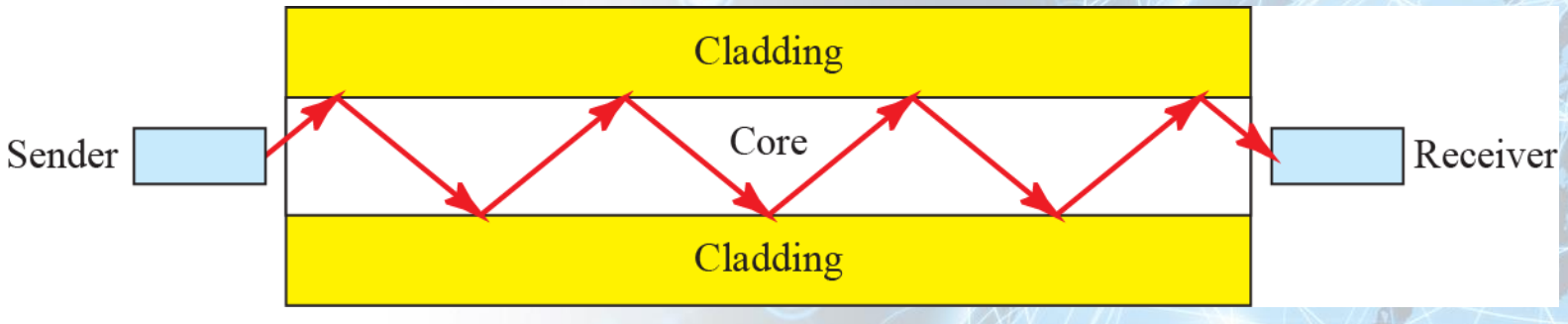


I > critical angle,
reflection

Fiber-Optic Cable

- Made of glass or plastic and transmits signals in the form of light

Optical Fiber



Fiber-Optic Cable

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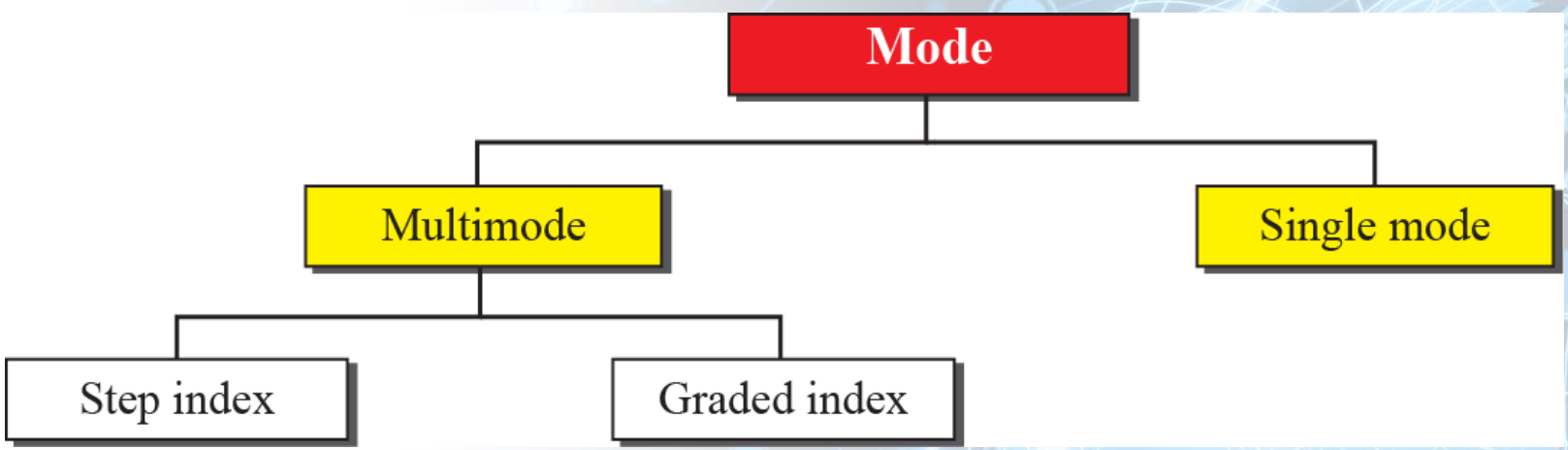
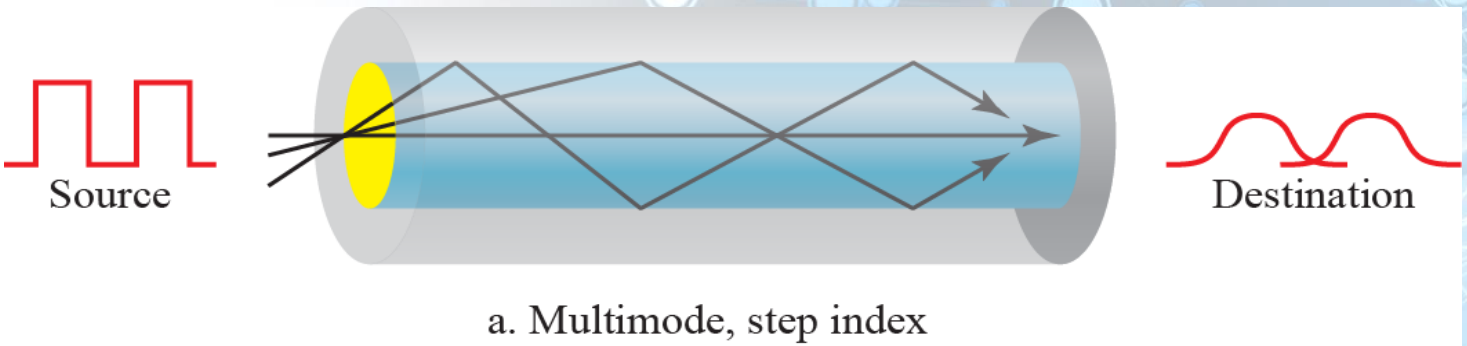
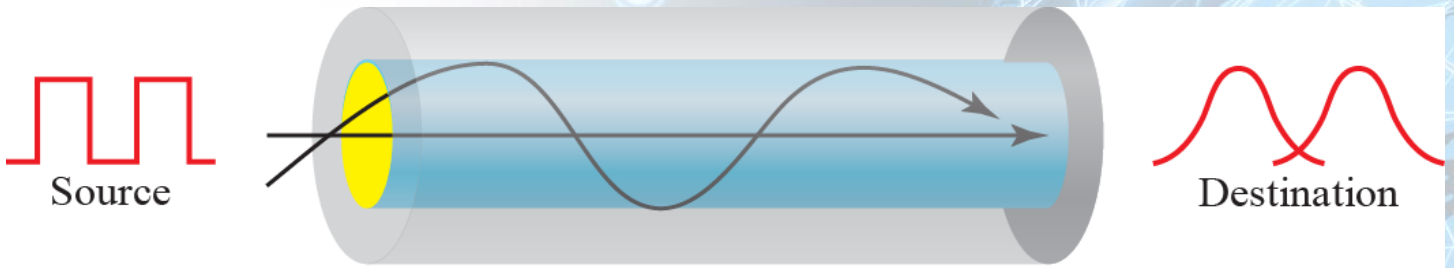
Propagation Modes



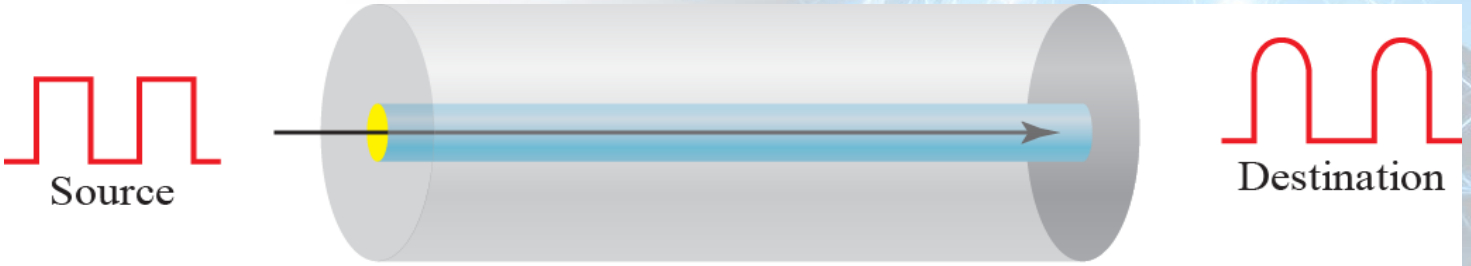
Modes



a. Multimode, step index



b. Multimode, graded index



c. Single mode

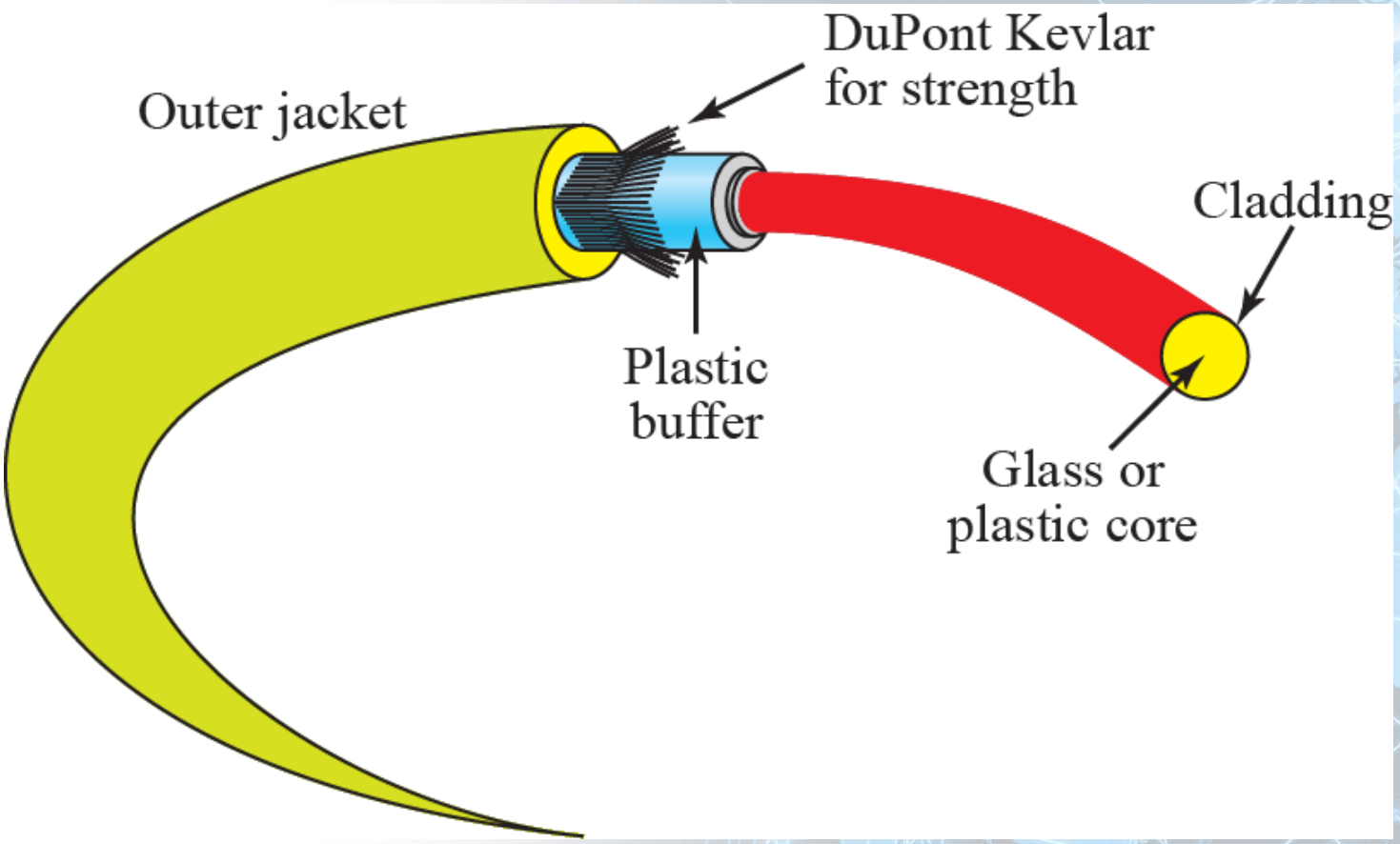
Fiber-Optic Cable

- Made of glass or plastic and transmits signals in the form of light

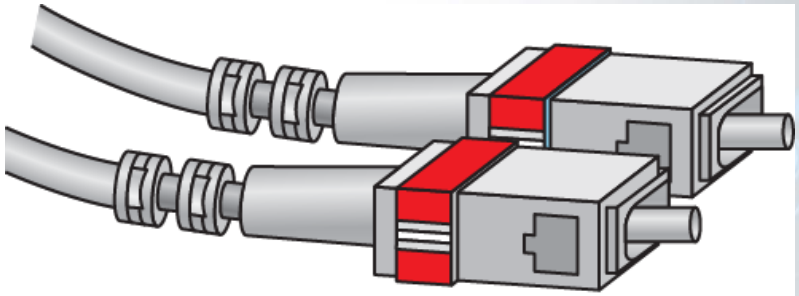
Fiber Types

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

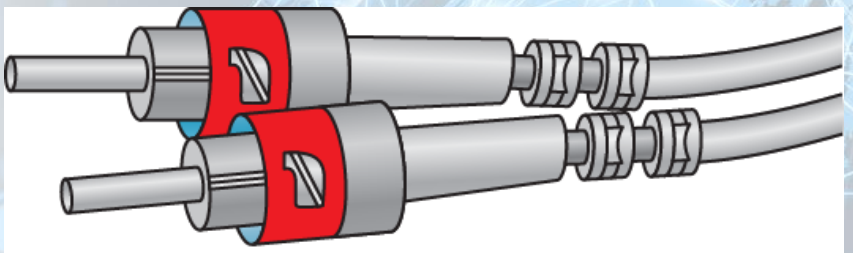
Fiber Composition



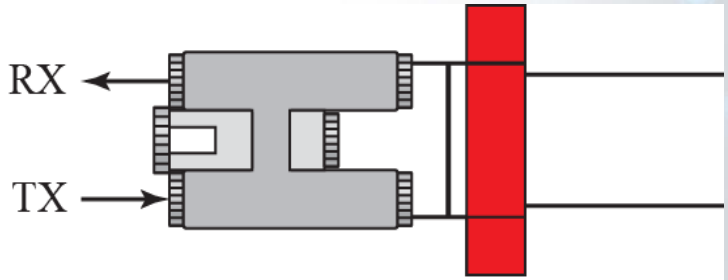
Fiber-Optic Cable Connector



SC connector

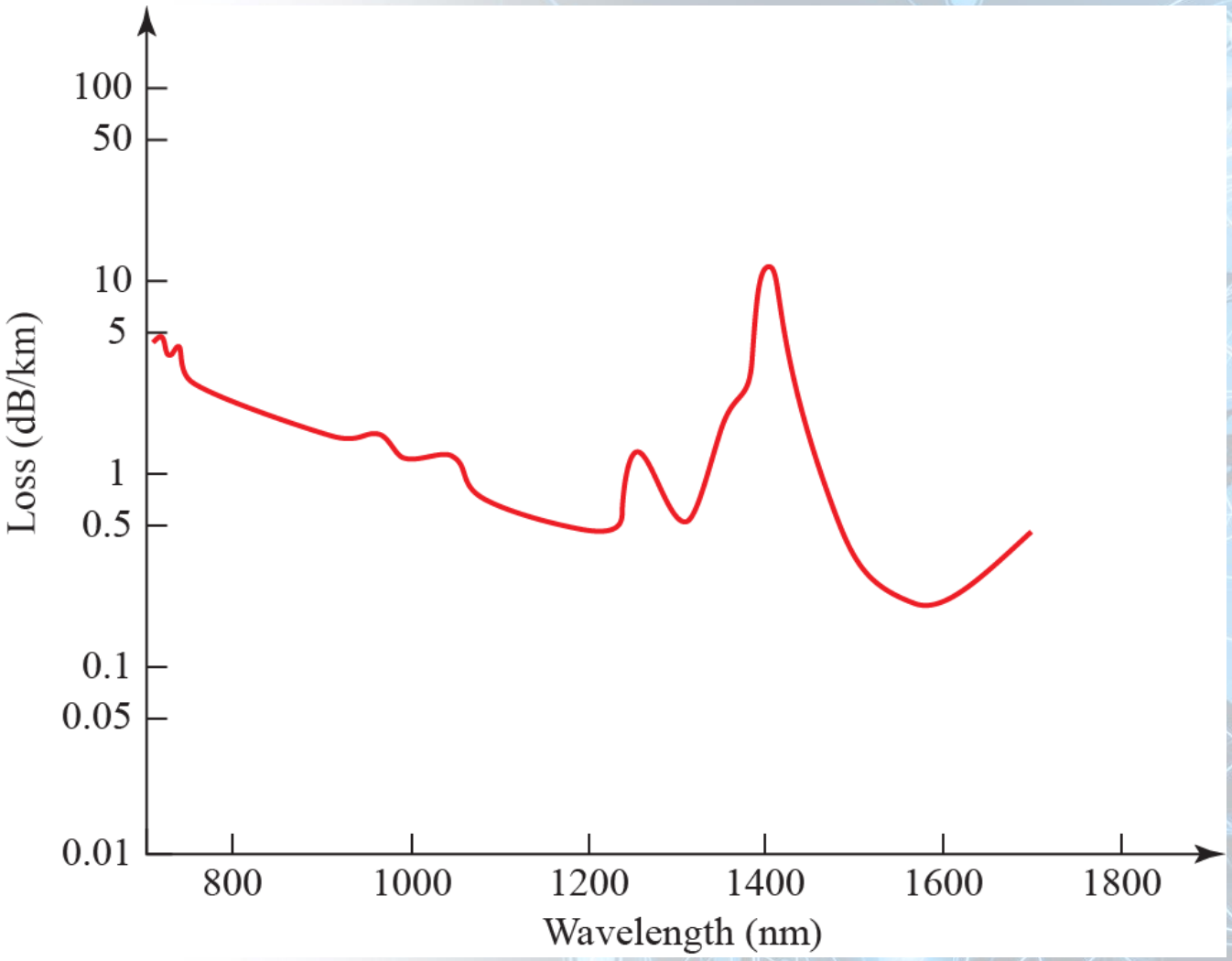


ST connector



MT-RJ connector

Optical Fiber Performance



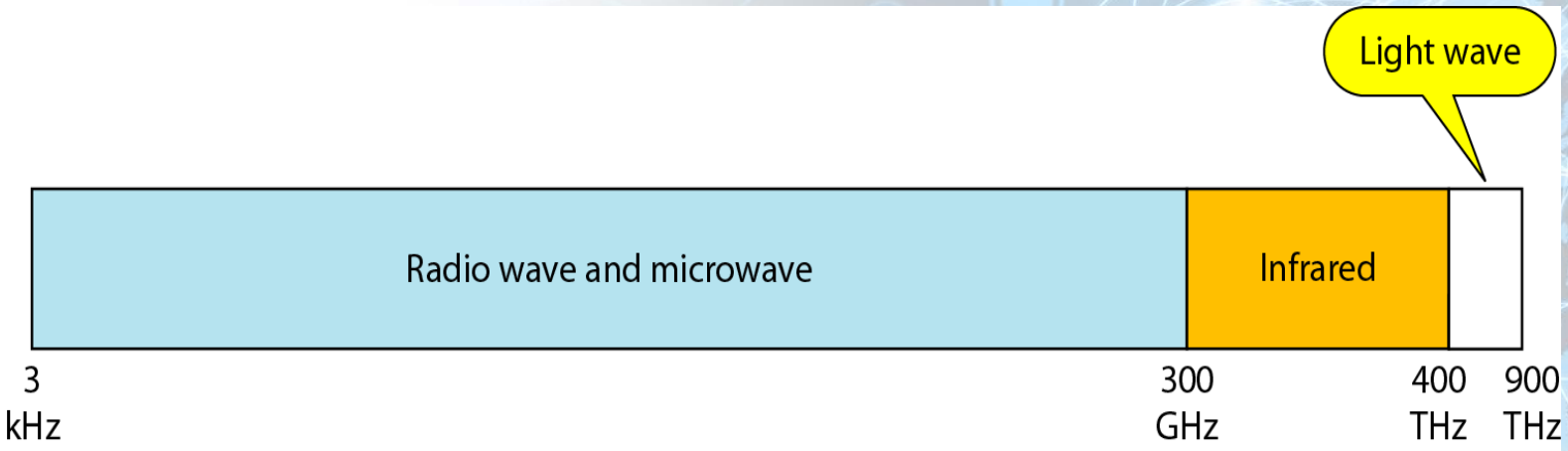
Advantages & Disadvantages

- Higher Bandwidth
- Less Attenuation
- Less EM Interference
- Light Weight
- Less corrosive than copper
- Installation/Maintenance
- Unidirectional
- Cost

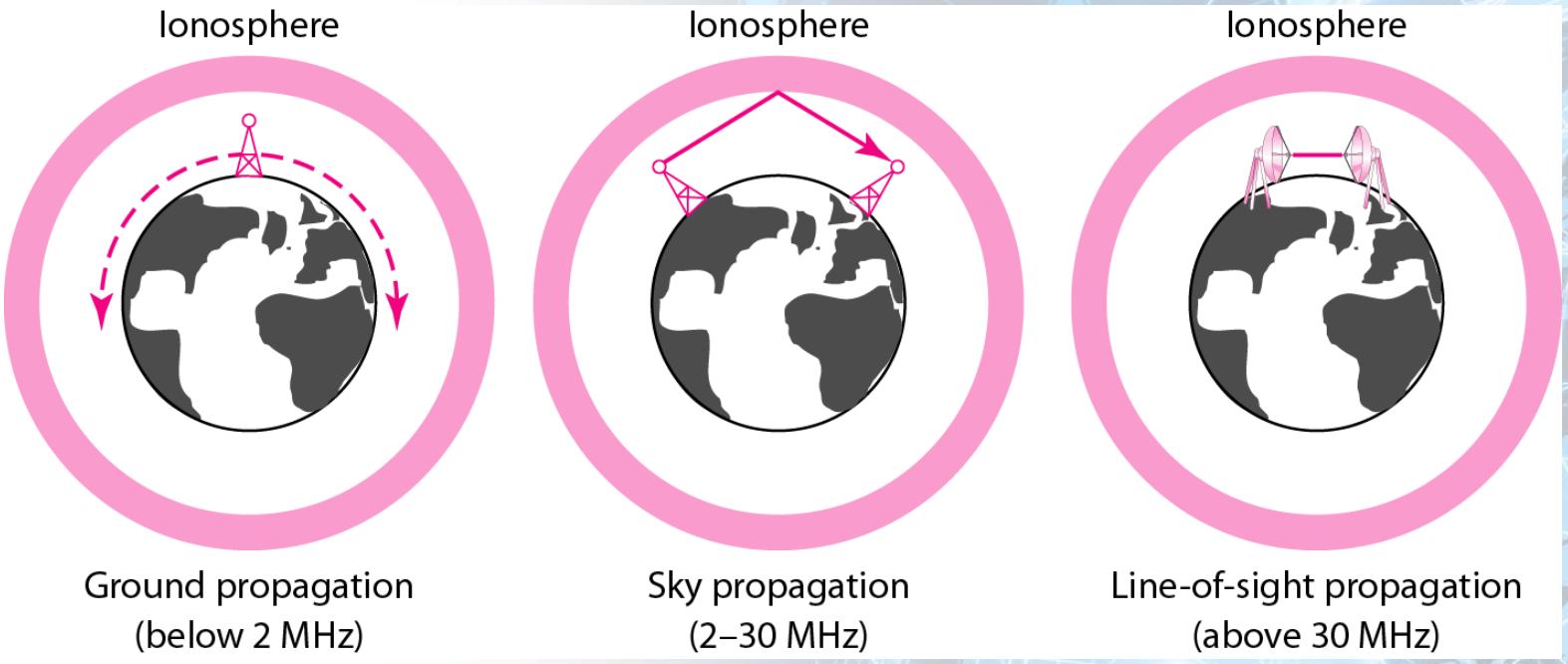
Unguided Media

- Unguided medium transport waves without using a physical conductor
- Often referred to wireless communication
- Signals are normally broadcast through free space and thus are available to anyone who has a device capable of receiving them

Electromagnetic Spectrum



Propagation Methods



Bands

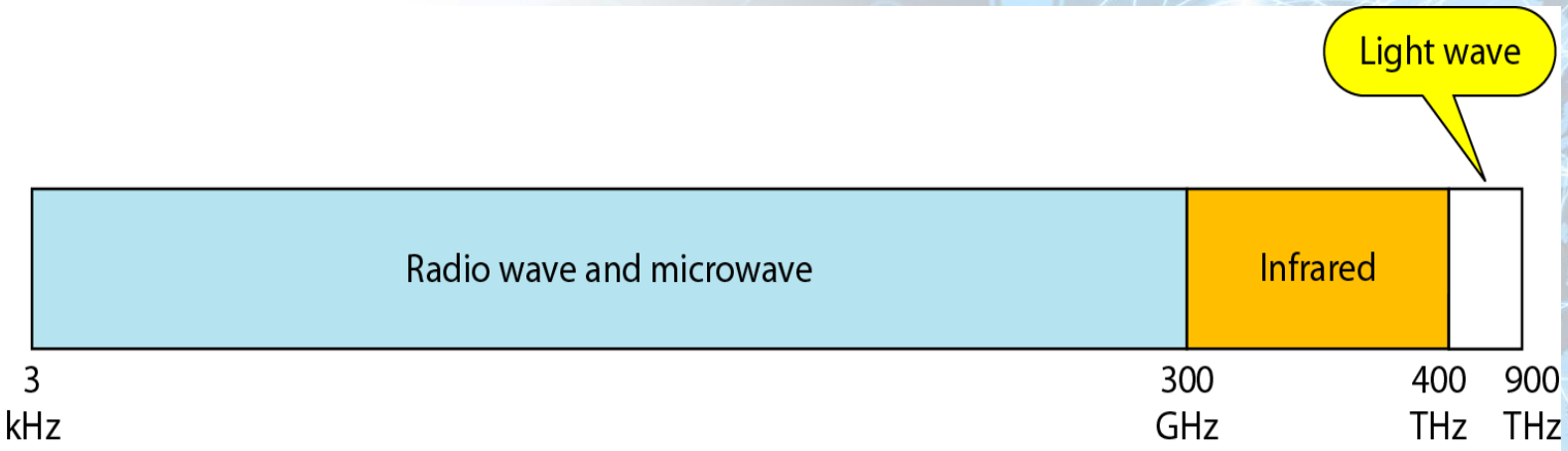
Band	*Range*	*Propagation*	*Application*
very low frequency (VLF)	3–30 kHz	Ground	Long-range radio navigation
low frequency (LF)	30–300 kHz	Ground	Radio beacons and navigational locators
middle frequency (MF)	300 kHz–3 MHz	Sky	AM radio
high frequency (HF)	3–30 MHz	Sky	Citizens band (CB), ship/aircraft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

Radio Waves

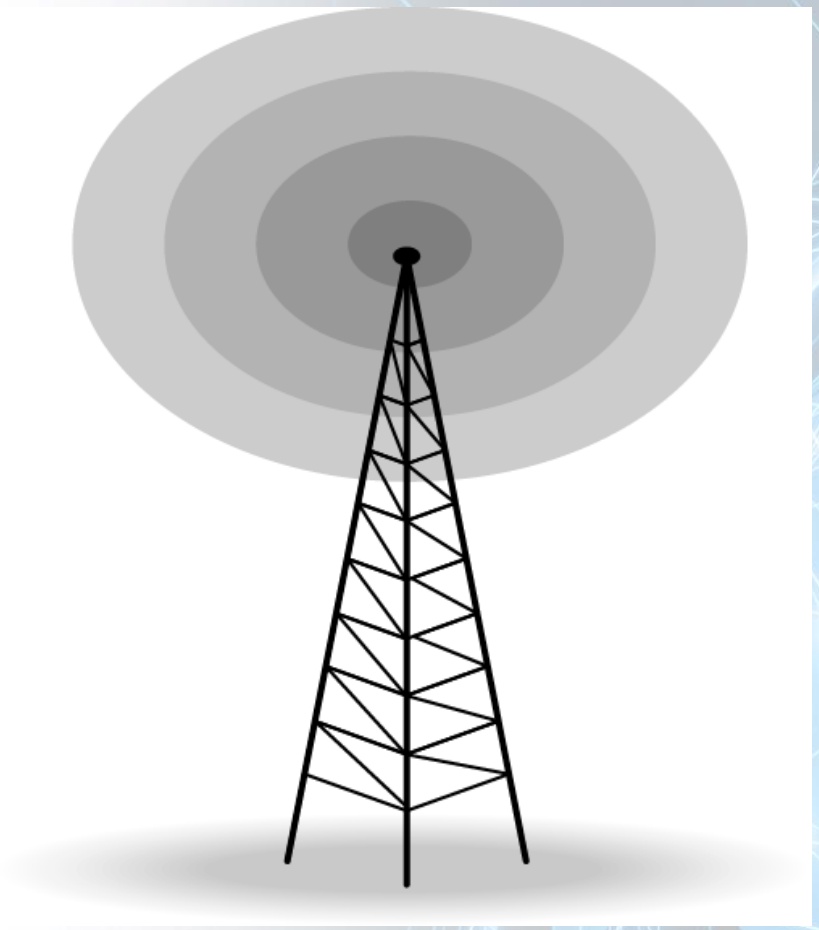
- Electromagnetic waves ranging in frequencies between 3 kHz and 1 GHz are normally called radio waves

- Electromagnetic waves ranging in frequencies between 1 and 300 GHz are called microwaves

Electromagnetic Spectrum



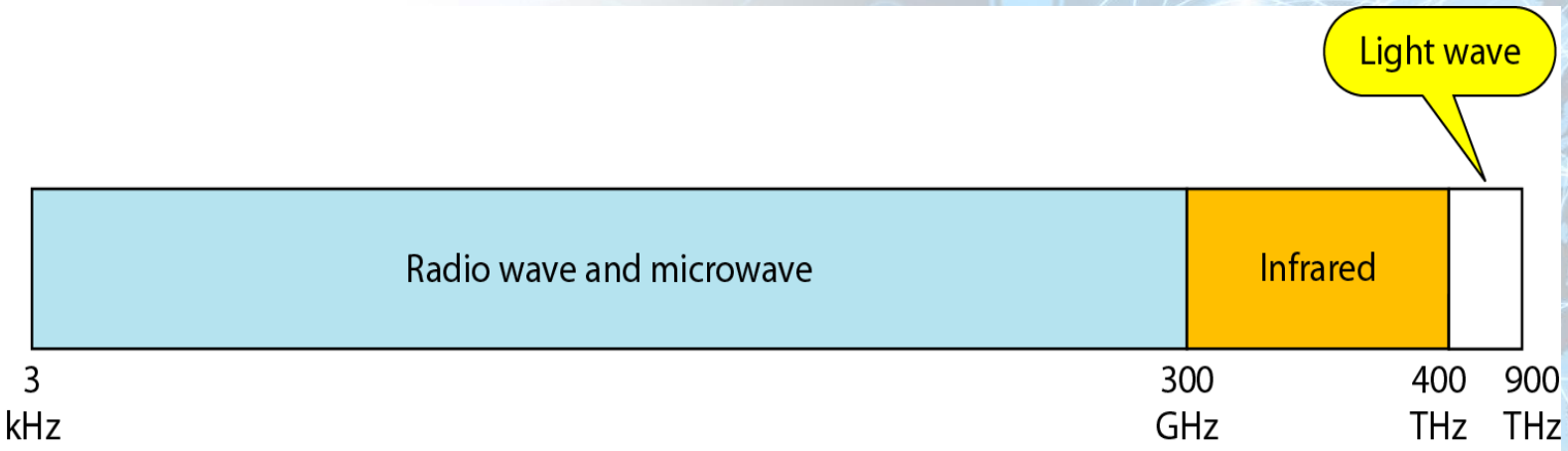
Omnidirectional Antenna



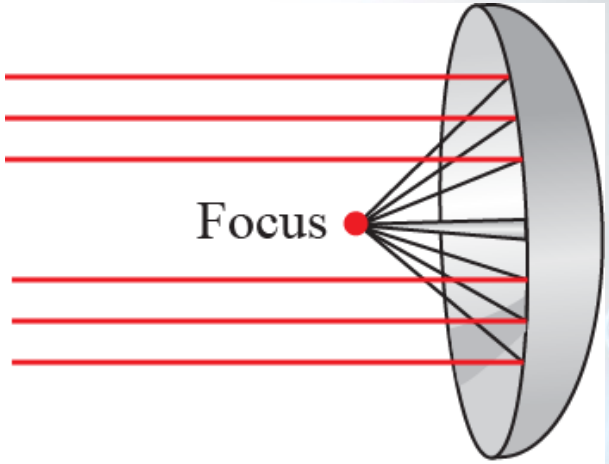
Microwaves

- Electromagnetic waves having frequencies between 1 and 300 GHz are called microwaves
- Microwaves are unidirectional
- When an antenna transmits microwaves, they can be narrowly focused

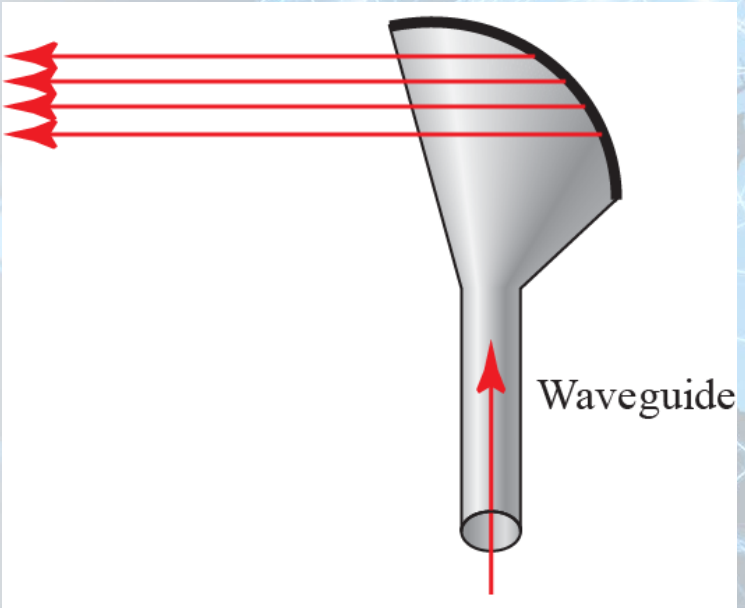
Electromagnetic Spectrum



Unidirectional Antennas



a. Parabolic dish antenna



b. Horn antenna

Infrared

- Infrared waves, with frequencies from 300 GHz to 400 THz (wavelengths from 1 mm to 770 nm), can be used for short-range communication
- Infrared waves, having high frequencies, cannot penetrate walls
- Prevents interference between one system and another