Chapter 7

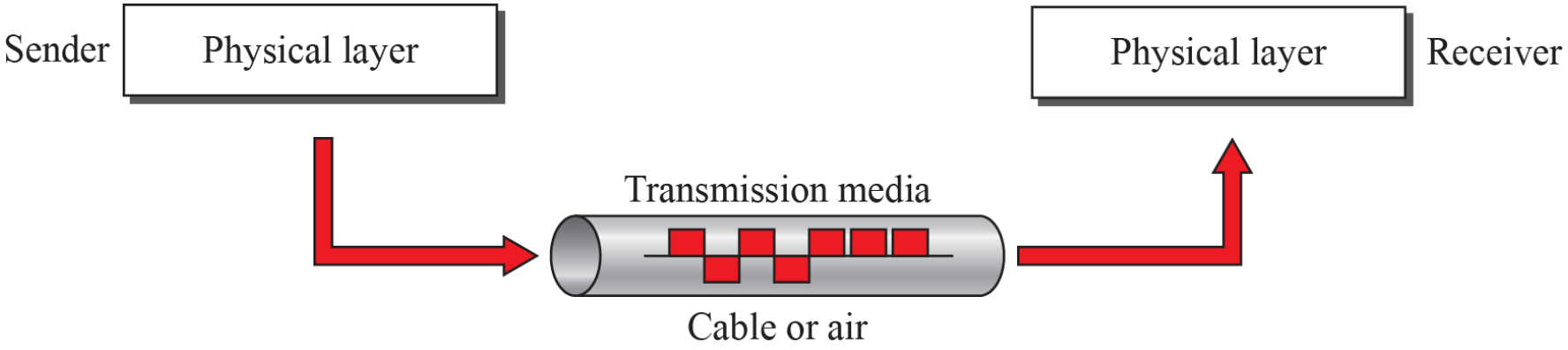
Transmission Media

INTRODUCTION

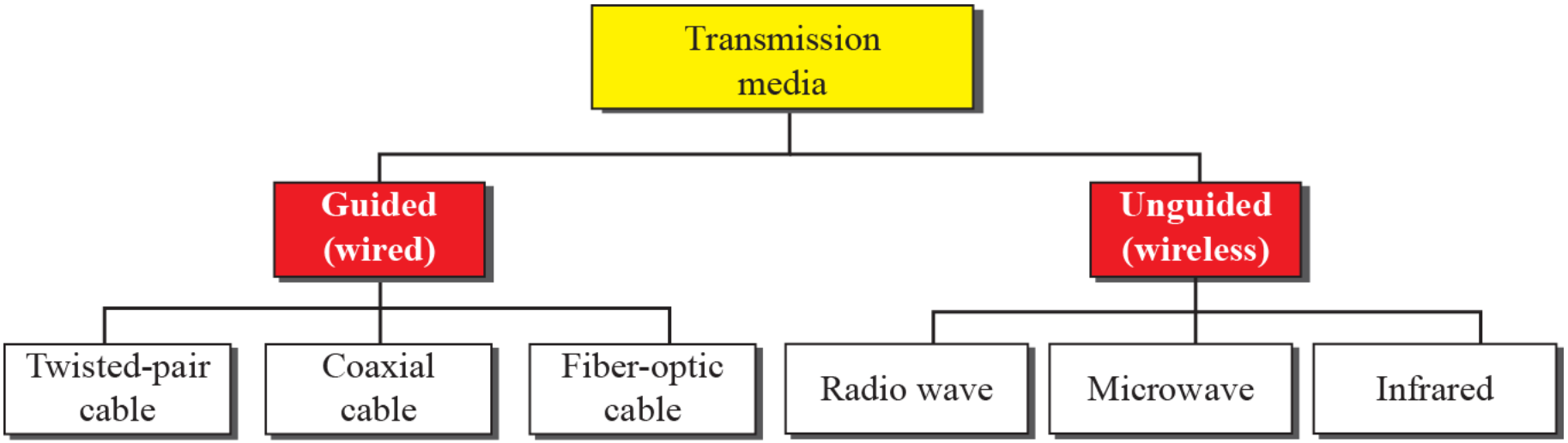
Transmission media are

- ***located below the physical layer***
- ***are directly controlled by the physical layer.***

Transmission media and physical layer



Classes of transmission media



GUIDED MEDIA

- **provide a conduit from one device to another, include twisted-pair cable, coaxial cable, and fiber-optic cable**

- **A signal traveling along any of these media is directed and contained by the physical limits of the medium.**

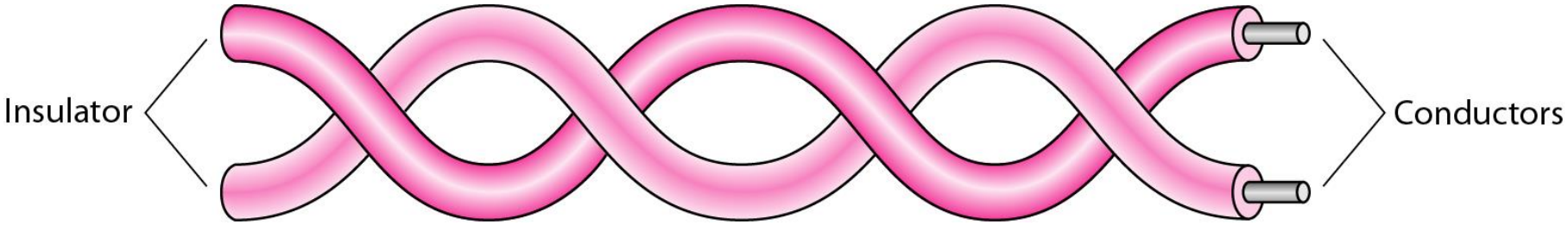
Twisted-Pair Cable

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

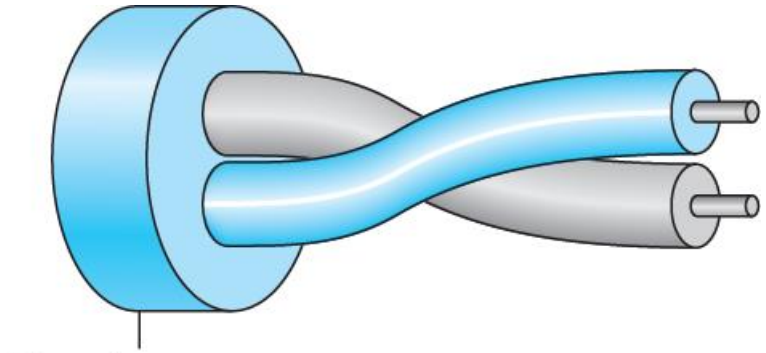
- One of the wires is used to carry signals to the receiver, and the other is used only as a ground reference.

- In addition to the signal sent by the sender on one of the wires, interference (noise) and crosstalk may affect both wires and create unwanted signals

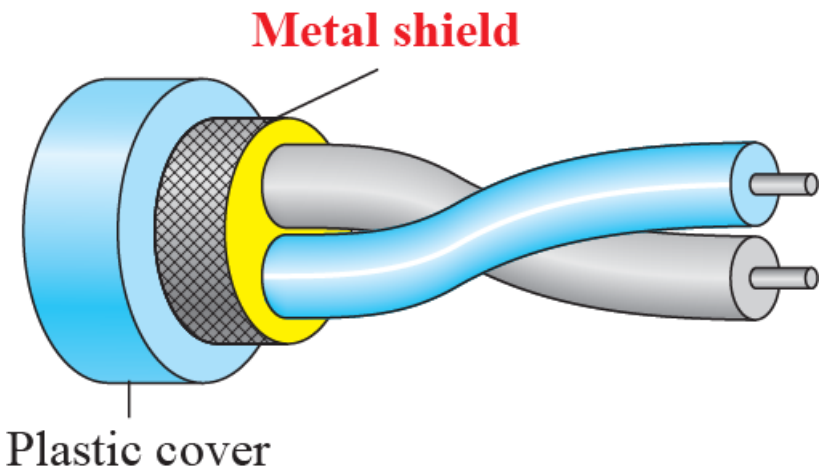
Twisted-pair cable



UTP and STP cables



a. UTP

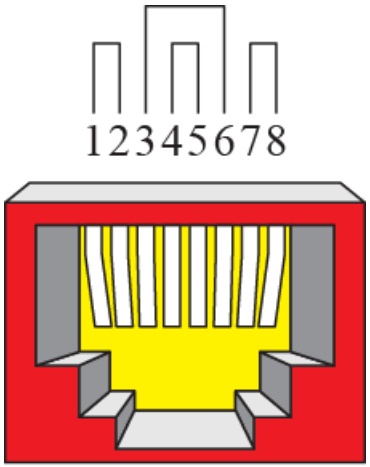


b. STP

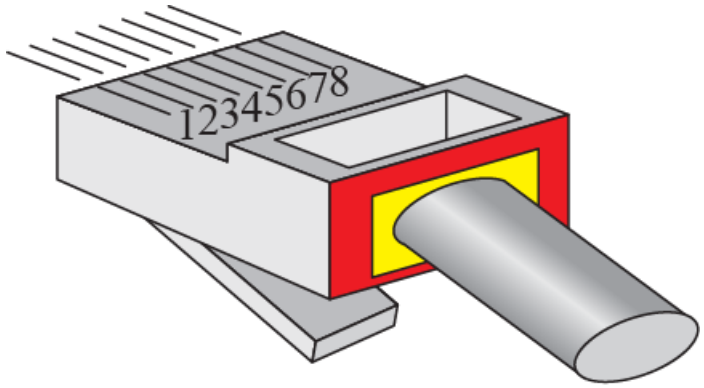
Unshielded twisted-pair cables

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

UTP Connectors



RJ-45 Female

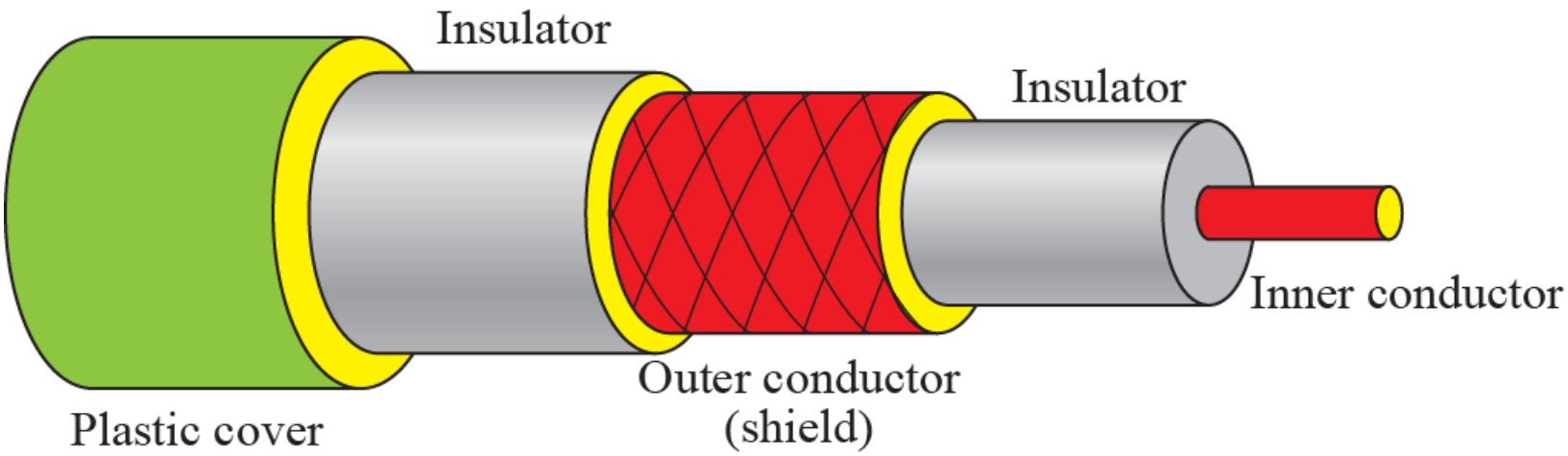


RJ-45 Male

Coaxial Cable

- carries signals of higher frequency ranges than those in twisted pair cable, in part because the two media are constructed quite differently.
- 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.

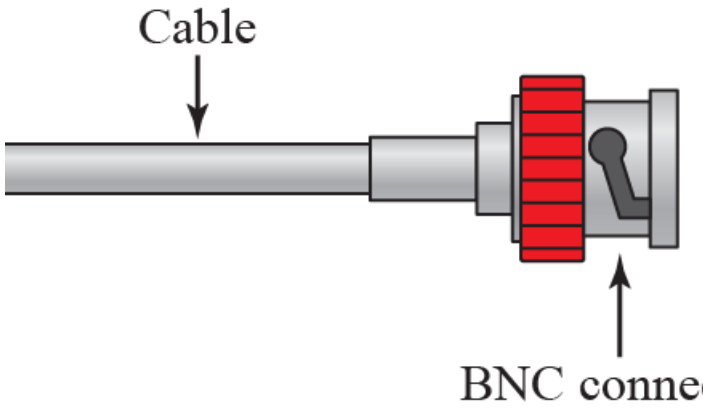
Coaxial cable

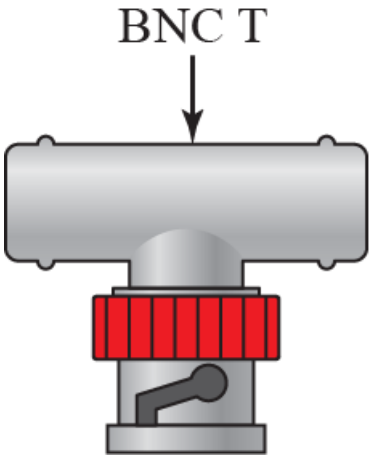


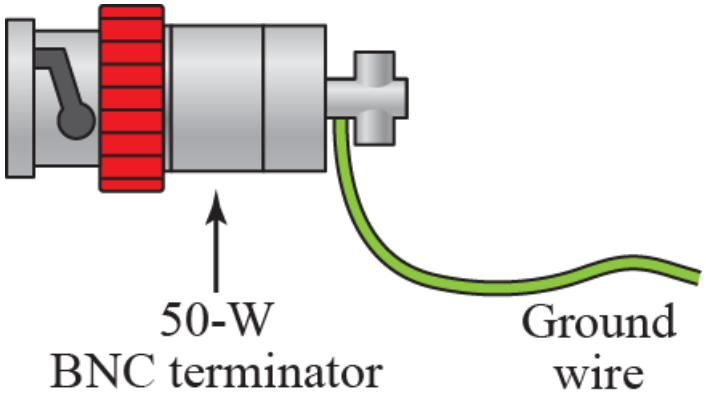
coaxial cables

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

BNC connectors







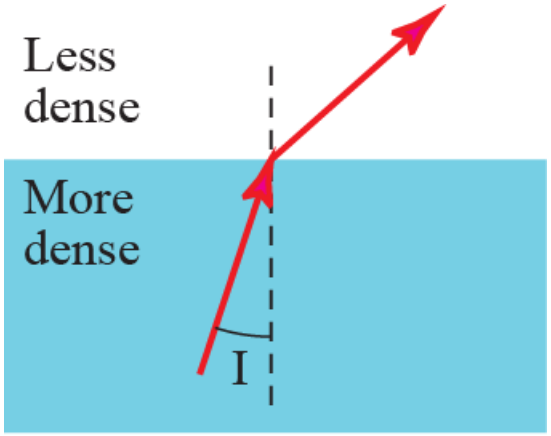
Fiber-Optic Cable

- **is made of glass or plastic and transmits signals in the form of light**

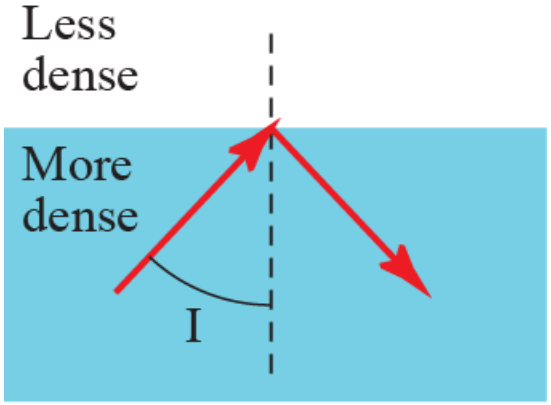
- **Light travels in a straight line as long as it is moving through a single uniform substance.**

- **If a ray of light traveling through one substance suddenly enters another substance (of a different density), the ray changes direction.**

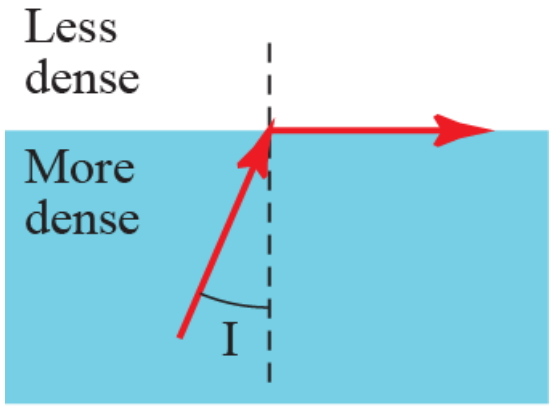
Bending of light ray



I < critical angle,
refraction

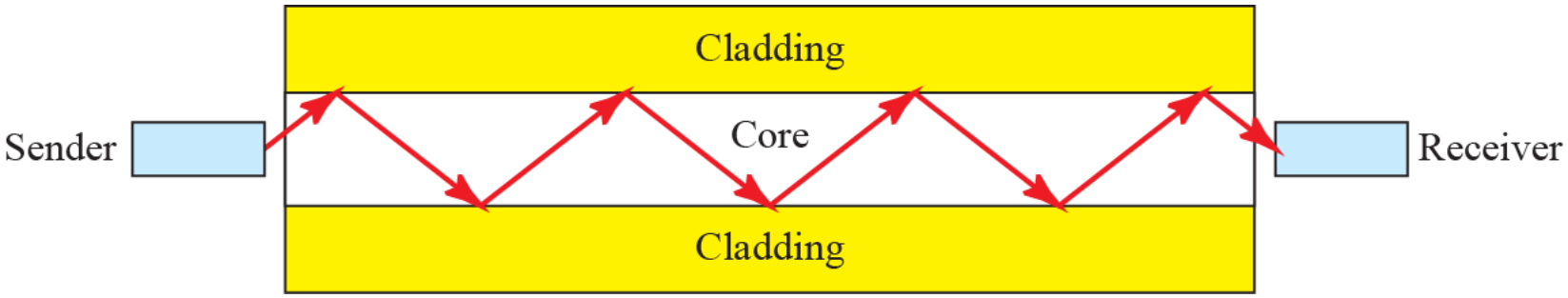


I > critical angle,
reflection

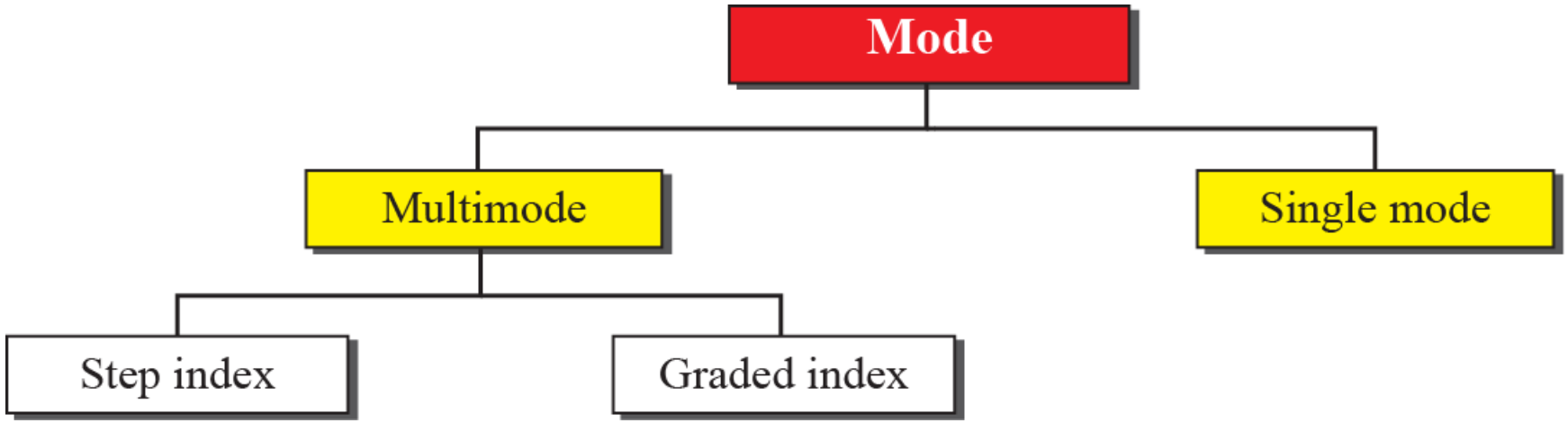


I = critical angle,
refraction

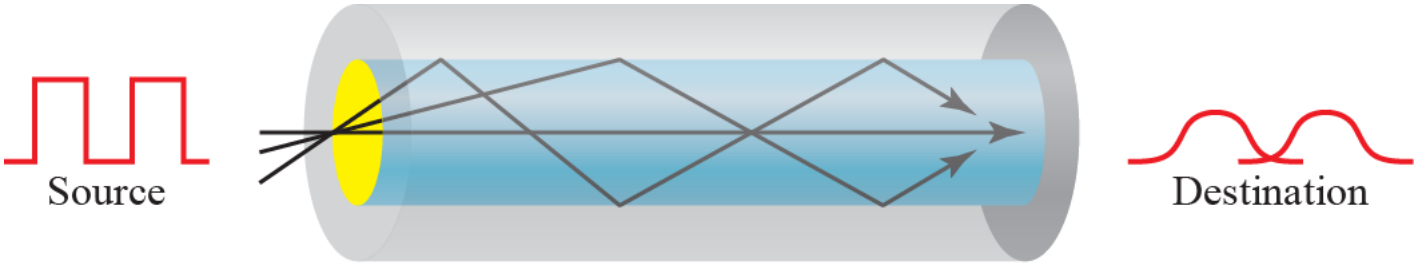
Optical fiber



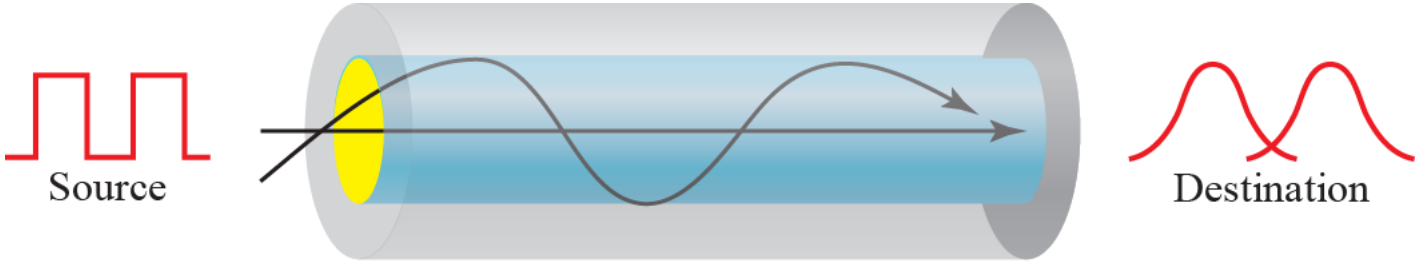
Propagation modes



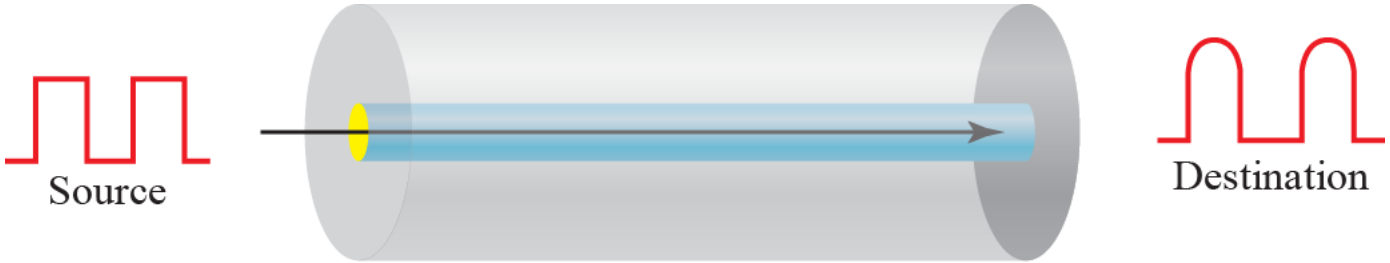
Modes



a. Multimode, step index



b. Multimode, graded index

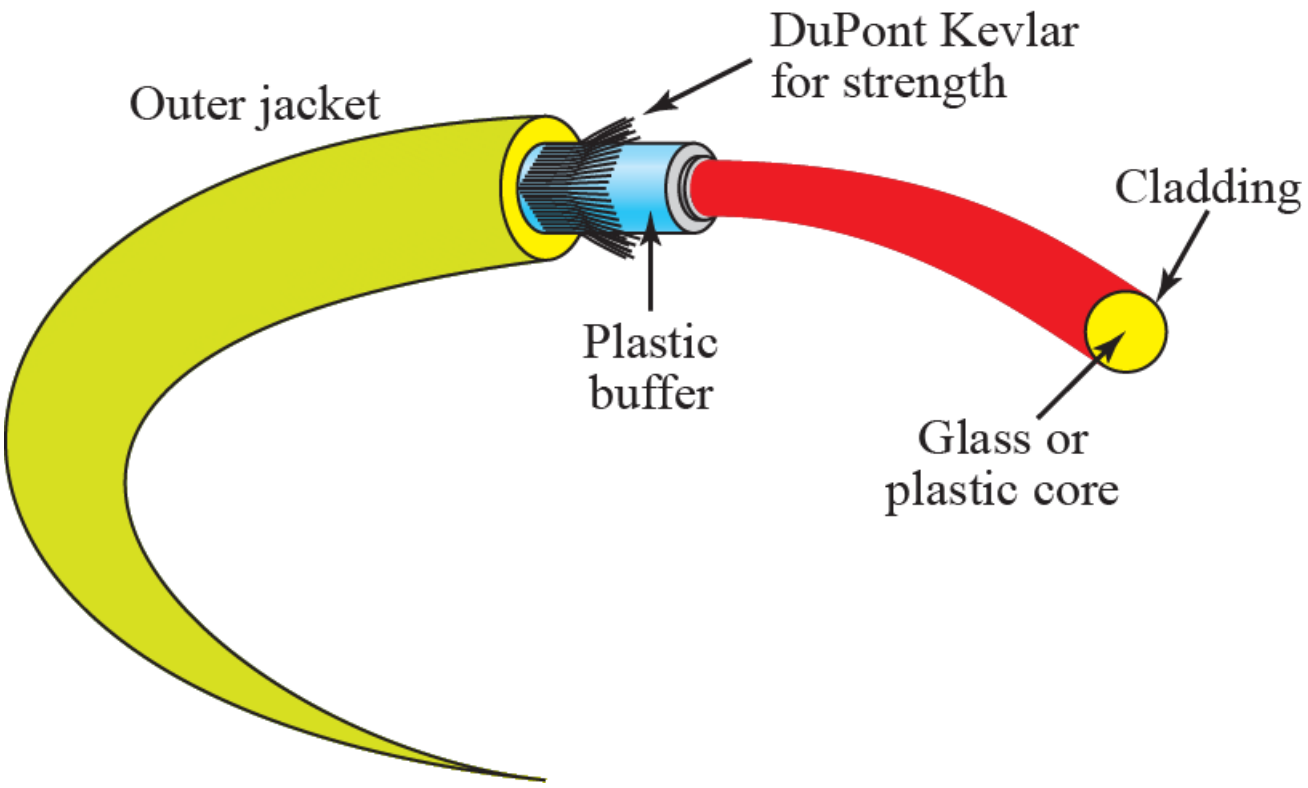


c. Single mode

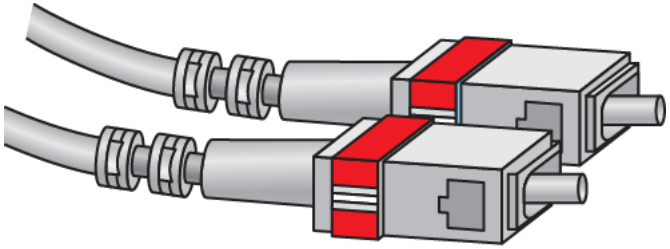
Fiber types

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

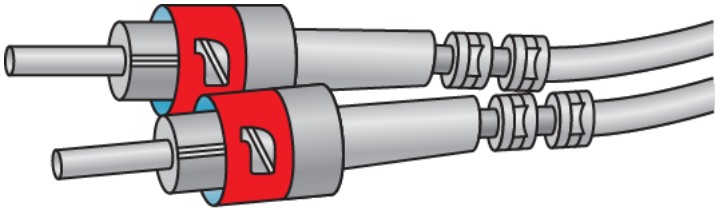
Fiber connection



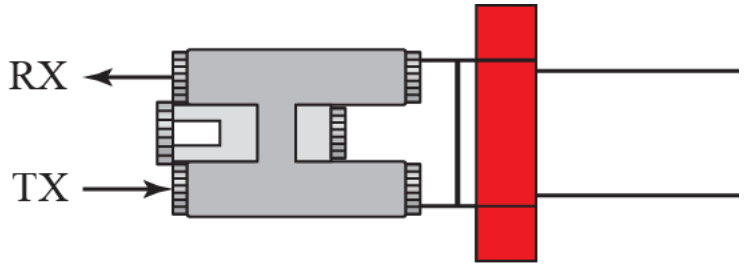
Fiber-optic cable connector



SC connector



ST connector



MT-RJ connector

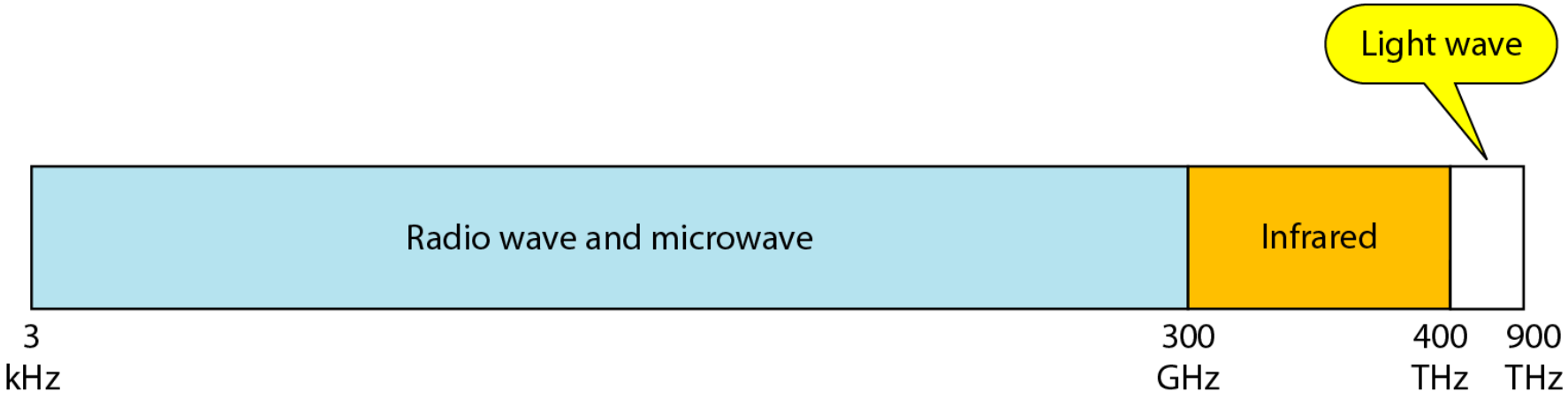
UNGUIDED MEDIA

- transport waves without using a physical conductor

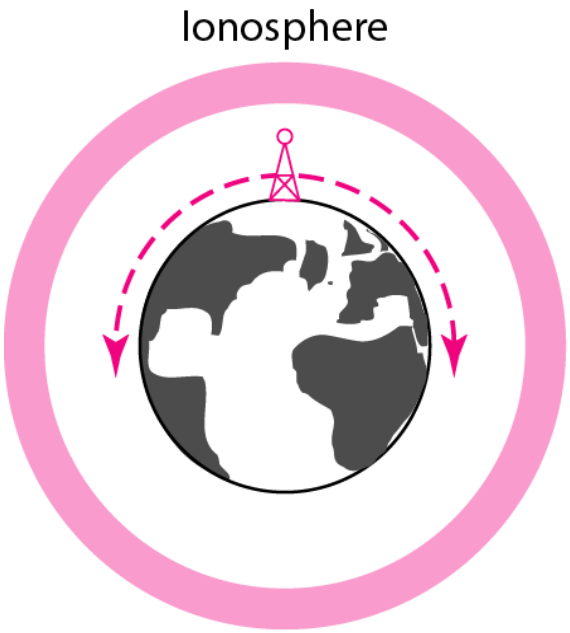
- This type of communication is often referred to as wireless communication.

- Signals are normally broadcast through free space and thus are available to anyone who has a device capable of receiving them.

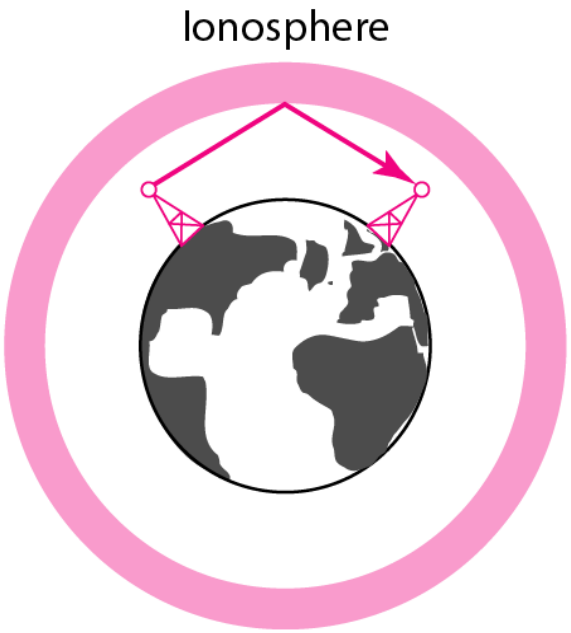
Electromagnetic spectrum for wireless communication



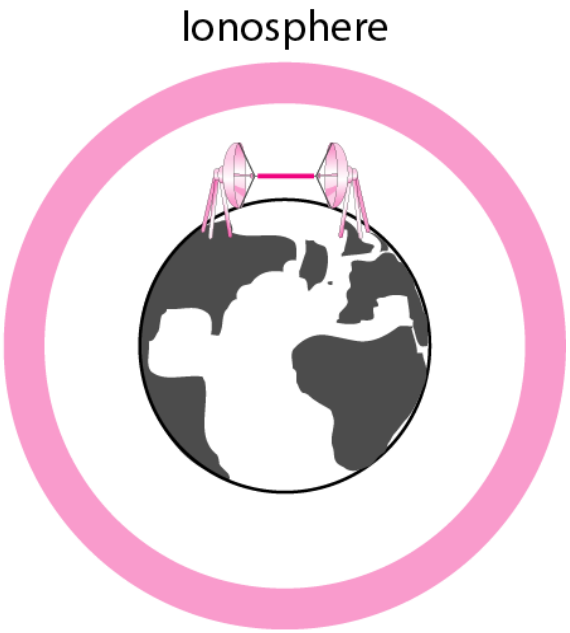
Propagation methods



Ground propagation
(below 2 MHz)



Sky propagation
(2–30 MHz)



Line-of-sight propagation
(above 30 MHz)

Bands

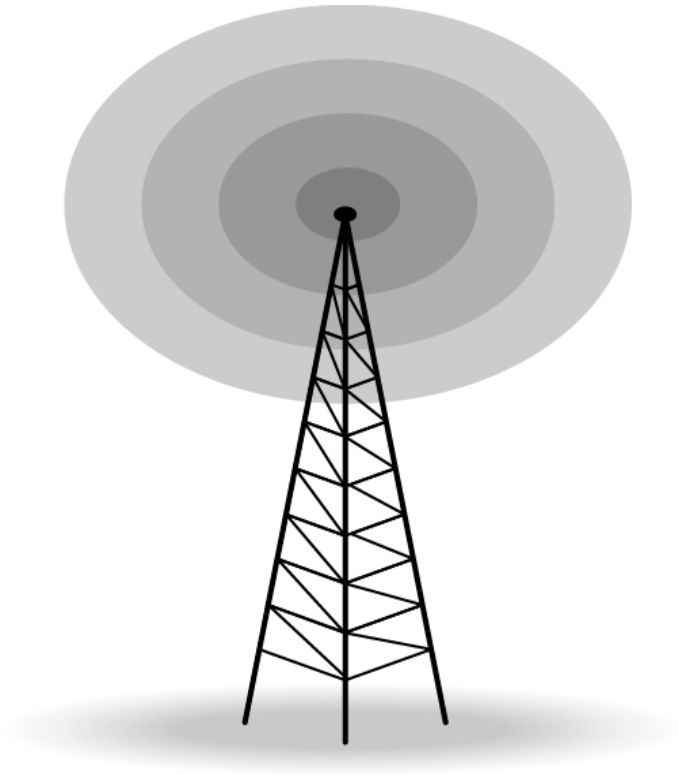
Band	*Range*	*Propagation*	*Application*
very low frequency (VLF)	3–30 kHz	Ground	Long-range radio navigation
low frequency (LF)	30–300 kHz	Ground	Radio beacons and navigational locators
middle frequency (MF)	300 kHz–3 MHz	Sky	AM radio
high frequency (HF)	3–30 MHz	Sky	Citizens band (CB), ship/aircraft
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**

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

Omnidirectional antenna



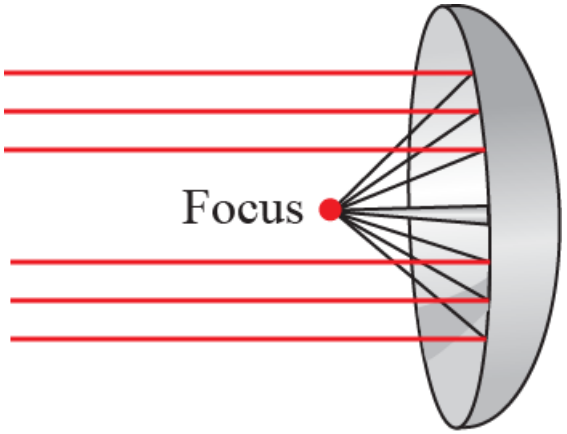
Microwaves

- **having frequencies between 1 and 300 GHz**

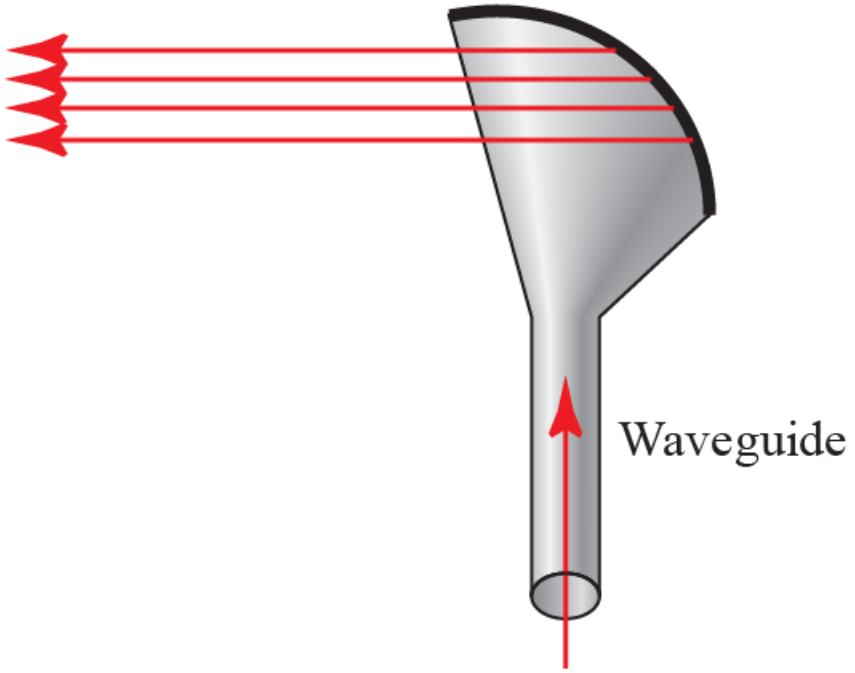
- **unidirectional. When an antenna transmits microwaves**

- **the sending and receiving antennas need to be aligned.**

Unidirectional antenna



a. Parabolic dish antenna



b. Horn antenna

Infrared

- **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.**