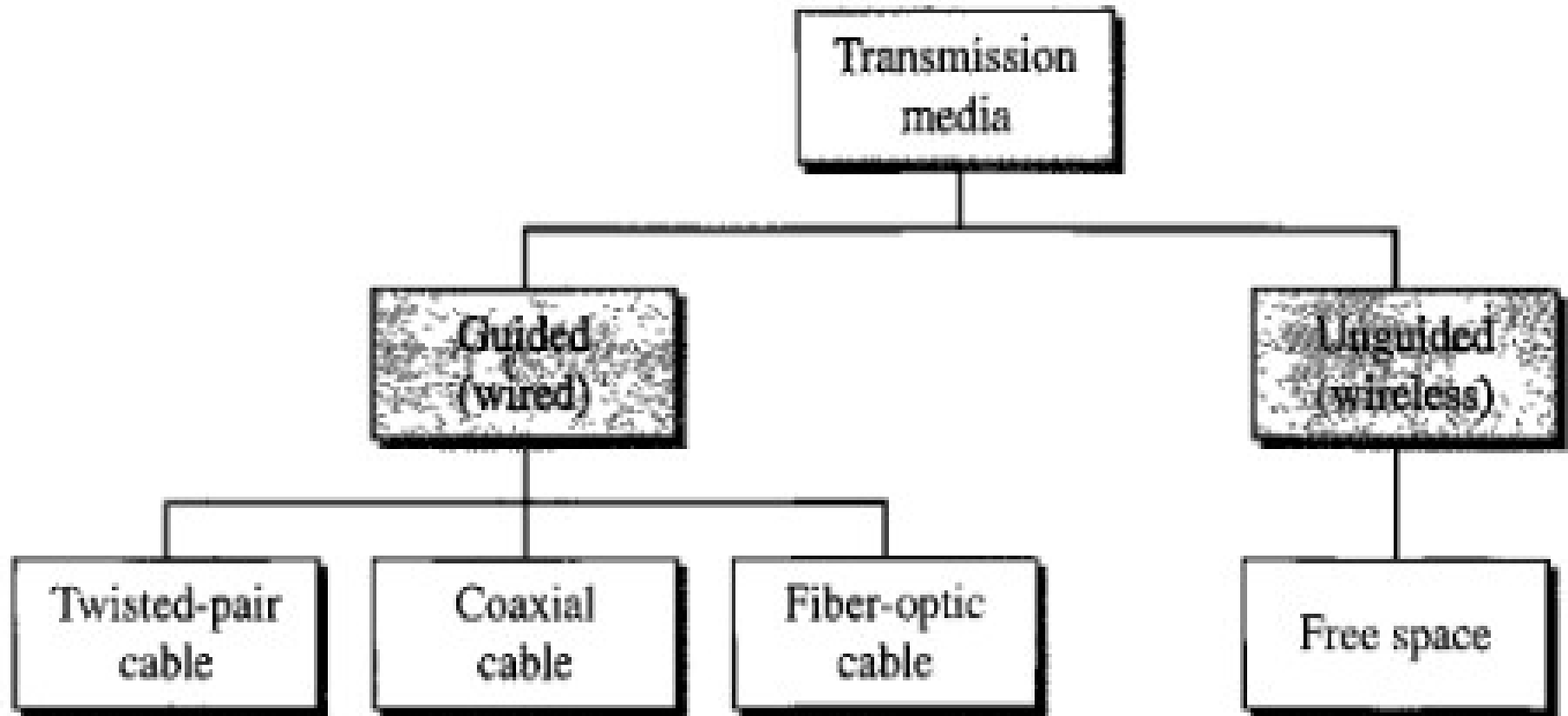


# Chapter 7

# TRANSMISSION MEDIA

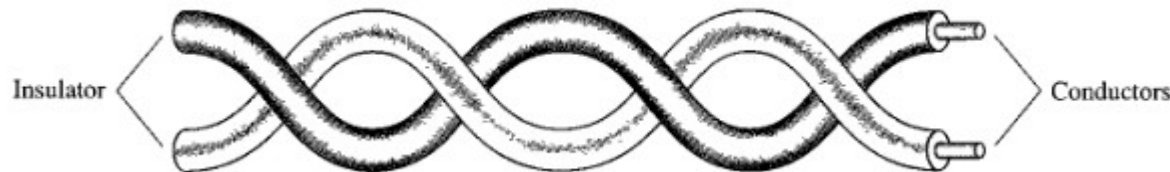
- “Layer 0”
- Anything that can carry information from a source to destination
- **Electromagnetic energy** – a combination of electric and magnetic fields vibrating in relation to each other: power, radio waves, infrared light, etc.
- Portions of **electromagnetic spectrum**

# Transmission Media

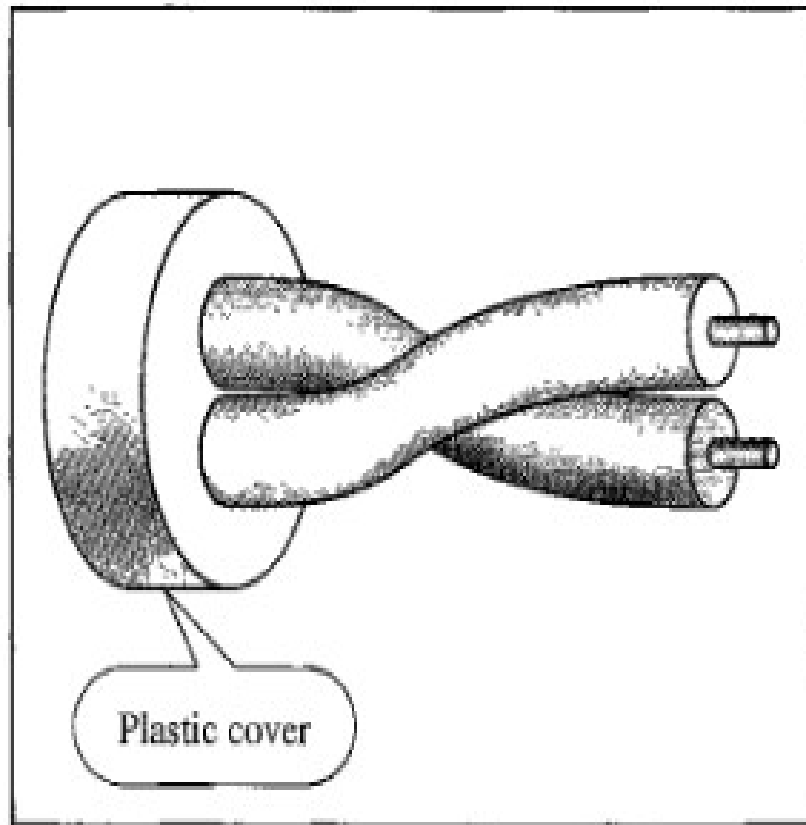


# Twisted-Pair Cable

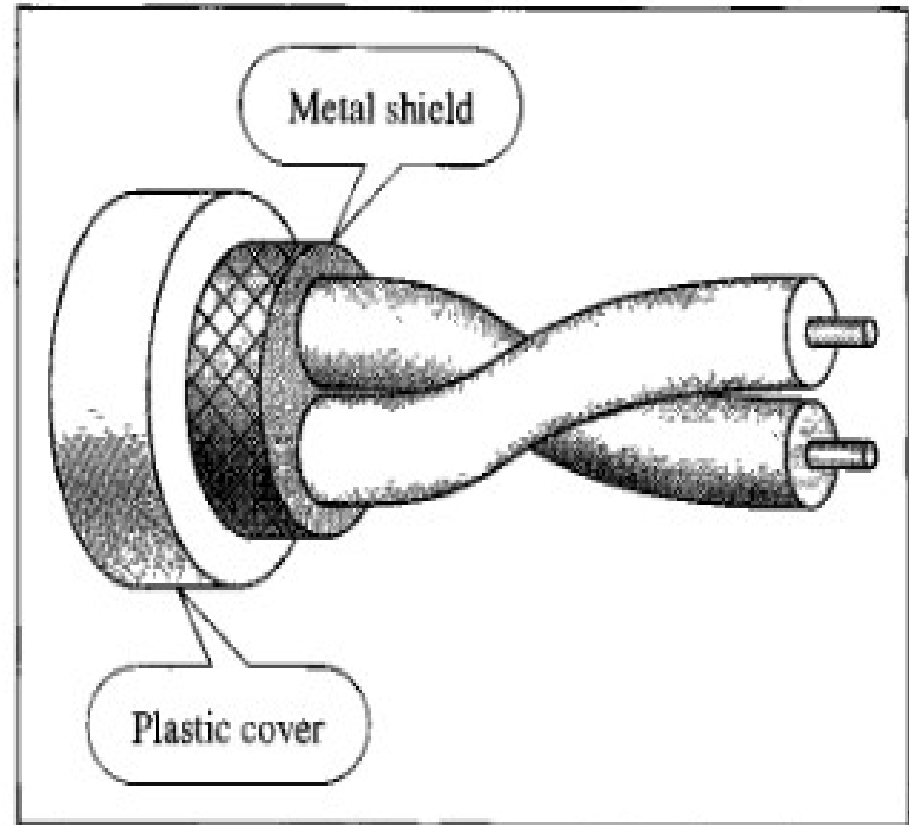
- One wire is used to carry signals to the receiver, another is for ground reference
- If the two wires are parallel, effect of unwanted signals is not the same since they are located at different distance relative to the noise
- Applications: telephone lines, DSL, LANs



# Twisted-Pair Cable



**a. UTP**

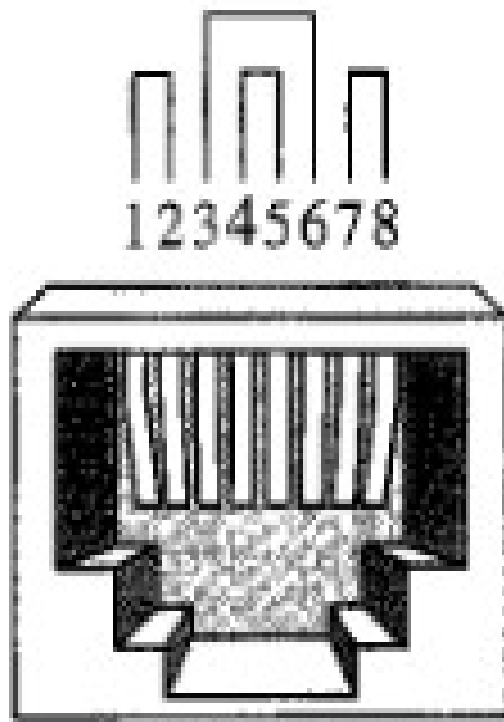


**b. STP**

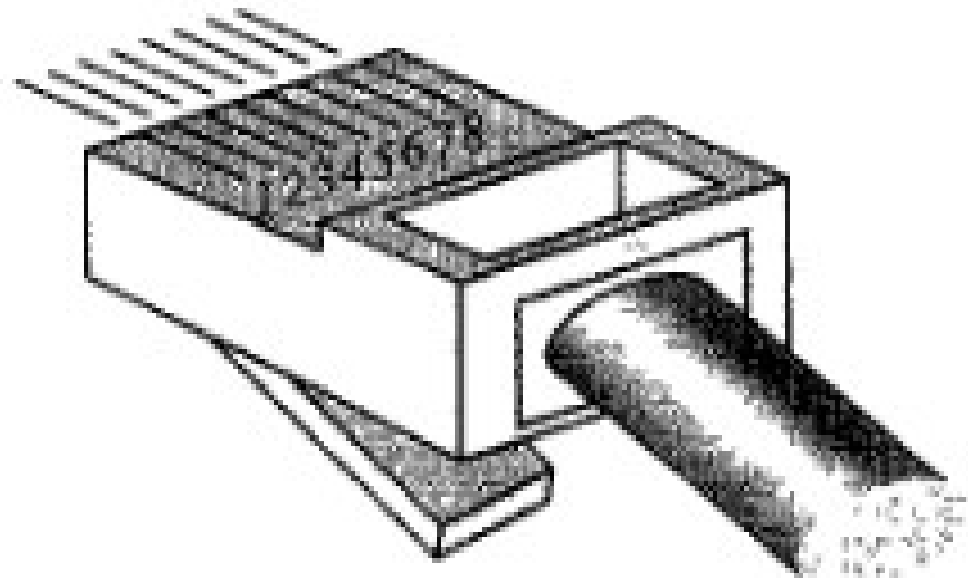
# Twisted-Pair Cable

<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

# Twisted-Pair Cable

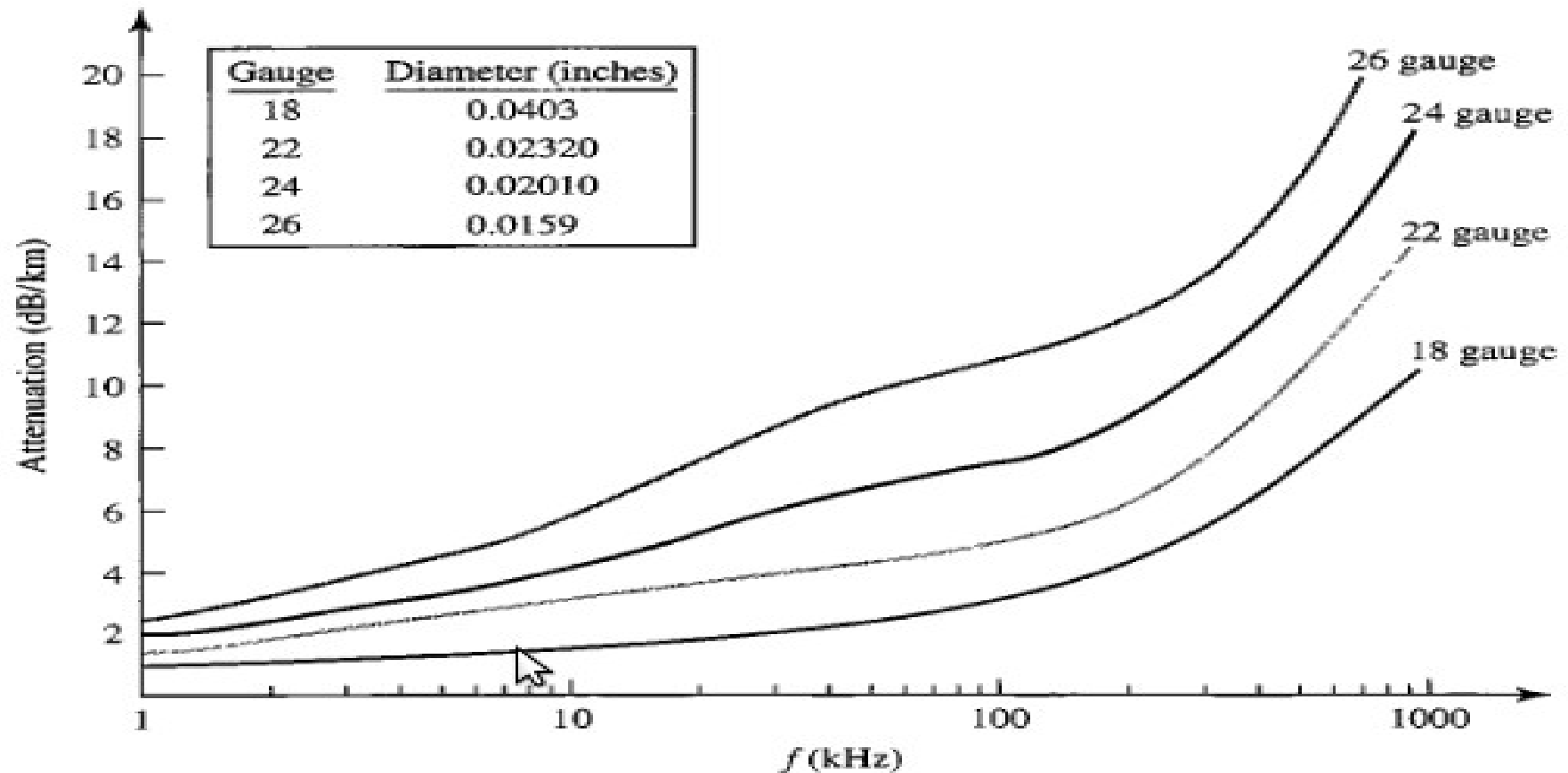


RJ-45 Female



RJ-45 Male

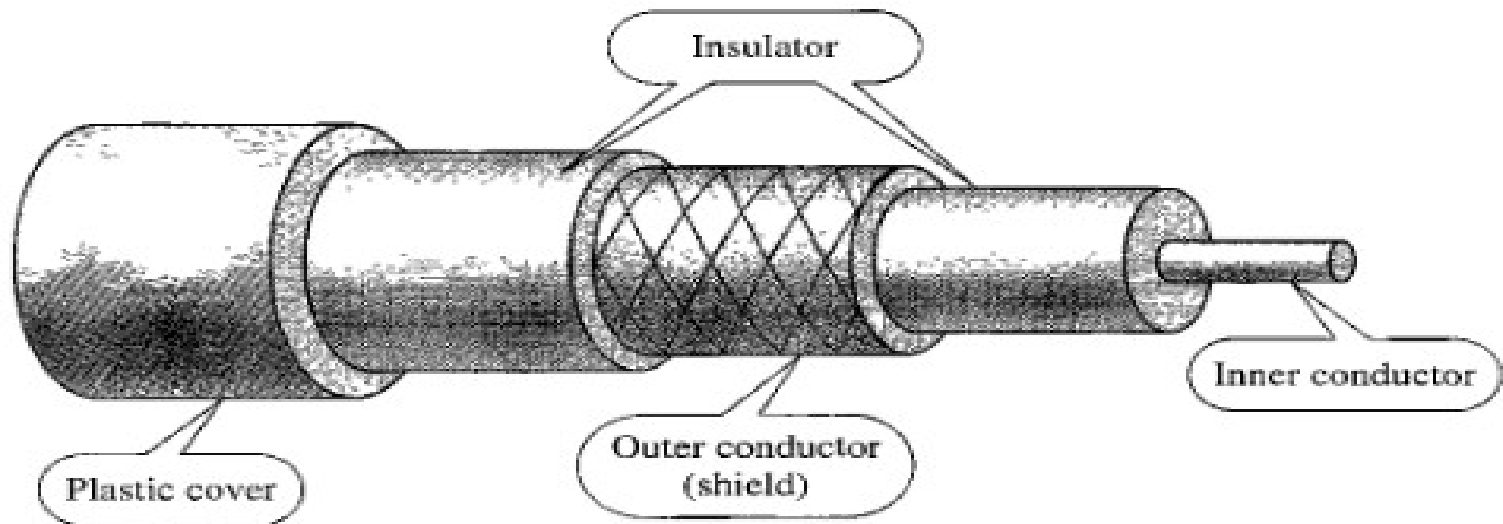
# Twisted-Pair Cable





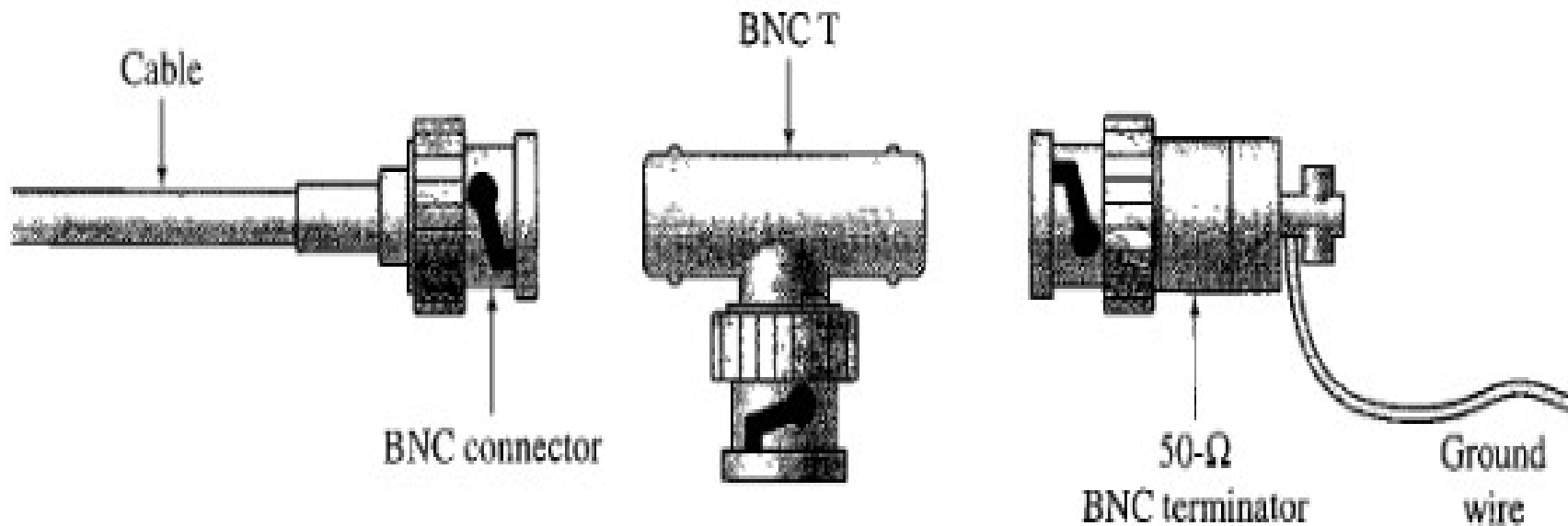
# Coaxial Cable

- Can carry signals of higher frequencies than twisted pair
- Applications: telephone lines, cable, LANs

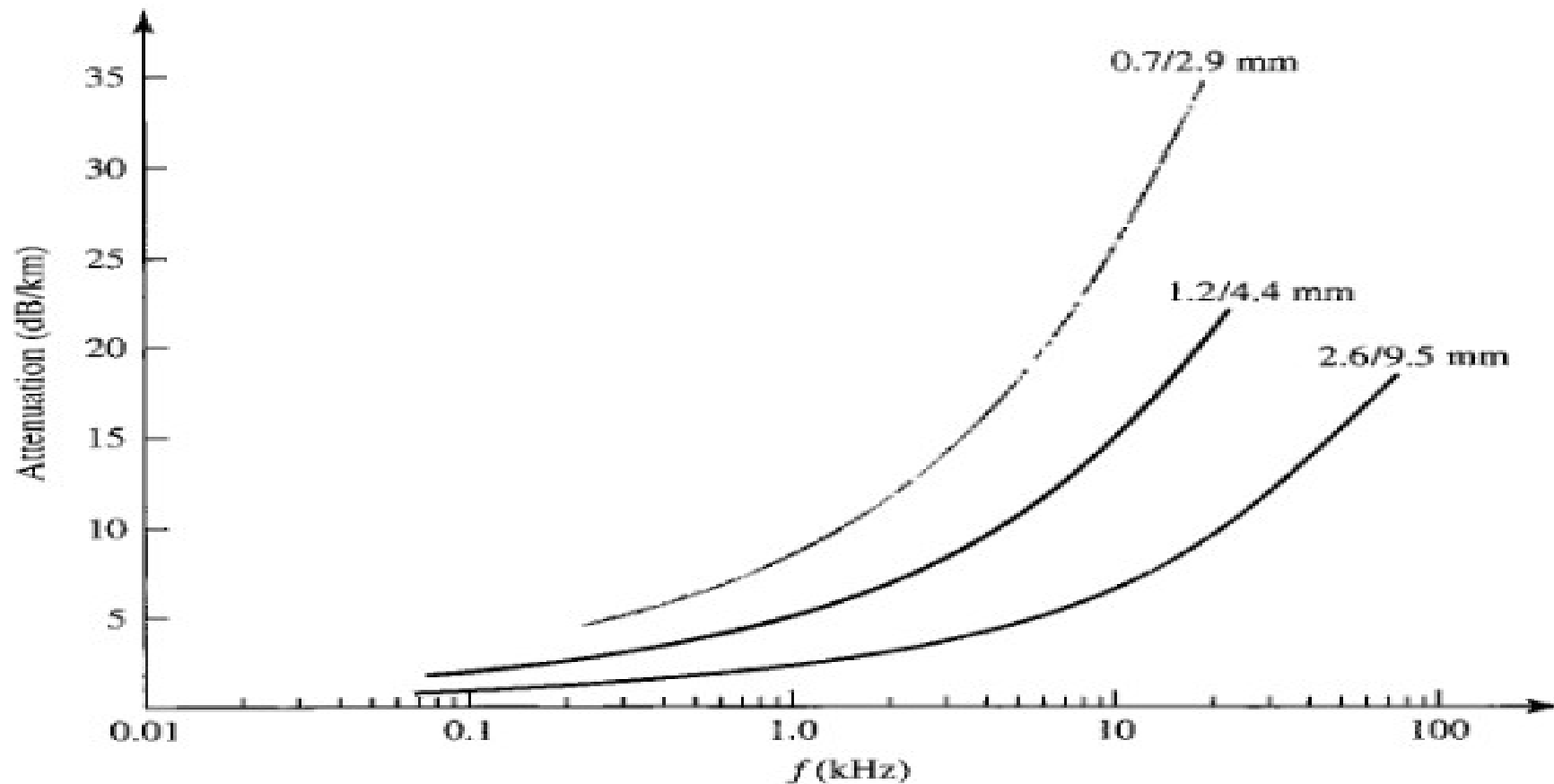


# Coaxial Cable

- Bayone-Neill-Concelman (BNC)

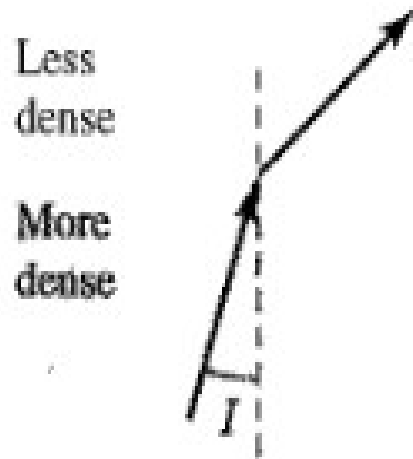


# Coaxial Cable

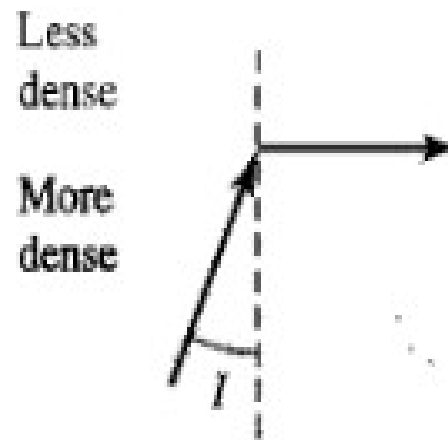


# Fiber Optics

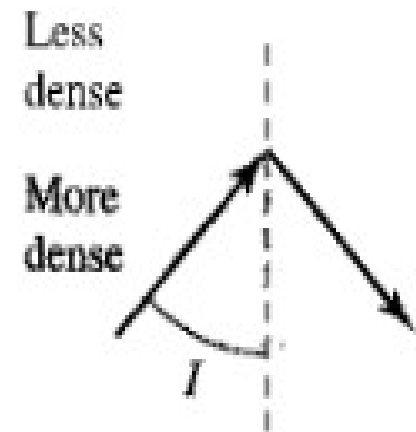
- Made of glass or plastic, uses light



$I < \text{critical angle,}$   
refraction



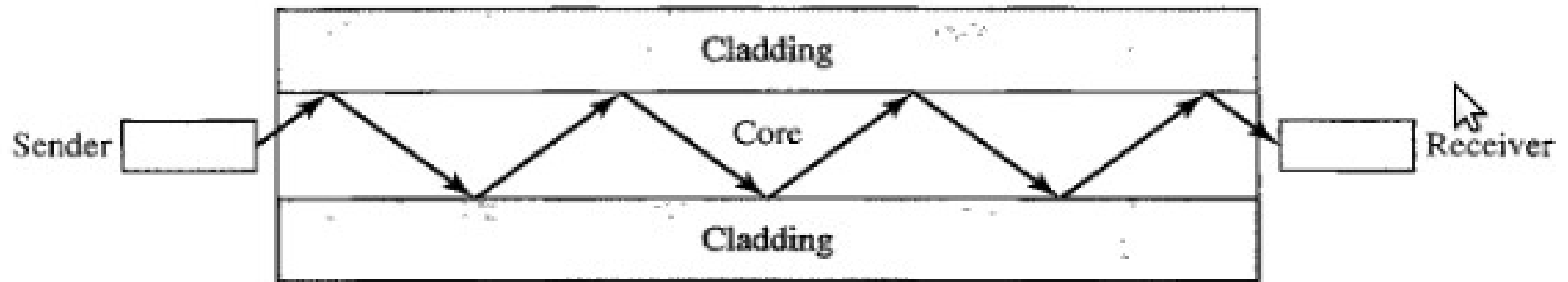
$I = \text{critical angle,}$   
refraction



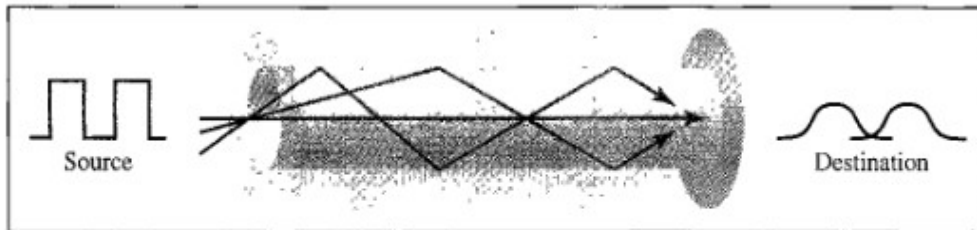
$I > \text{critical angle,}$   
reflection

# Fiber Optics

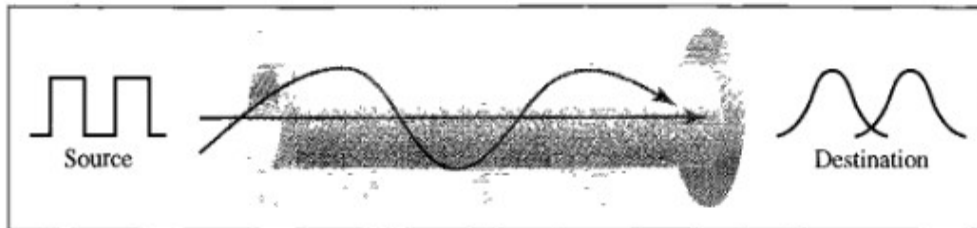
- Uses reflection to transmit



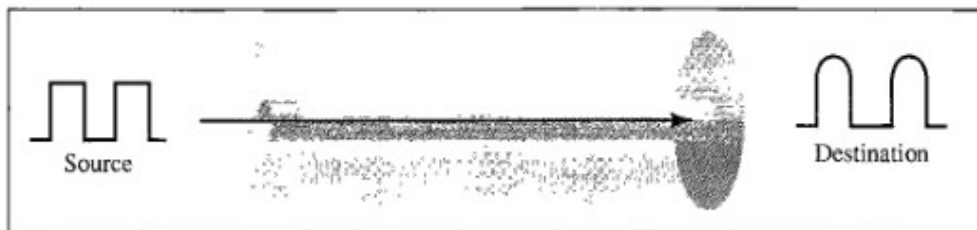
# Fiber Optics



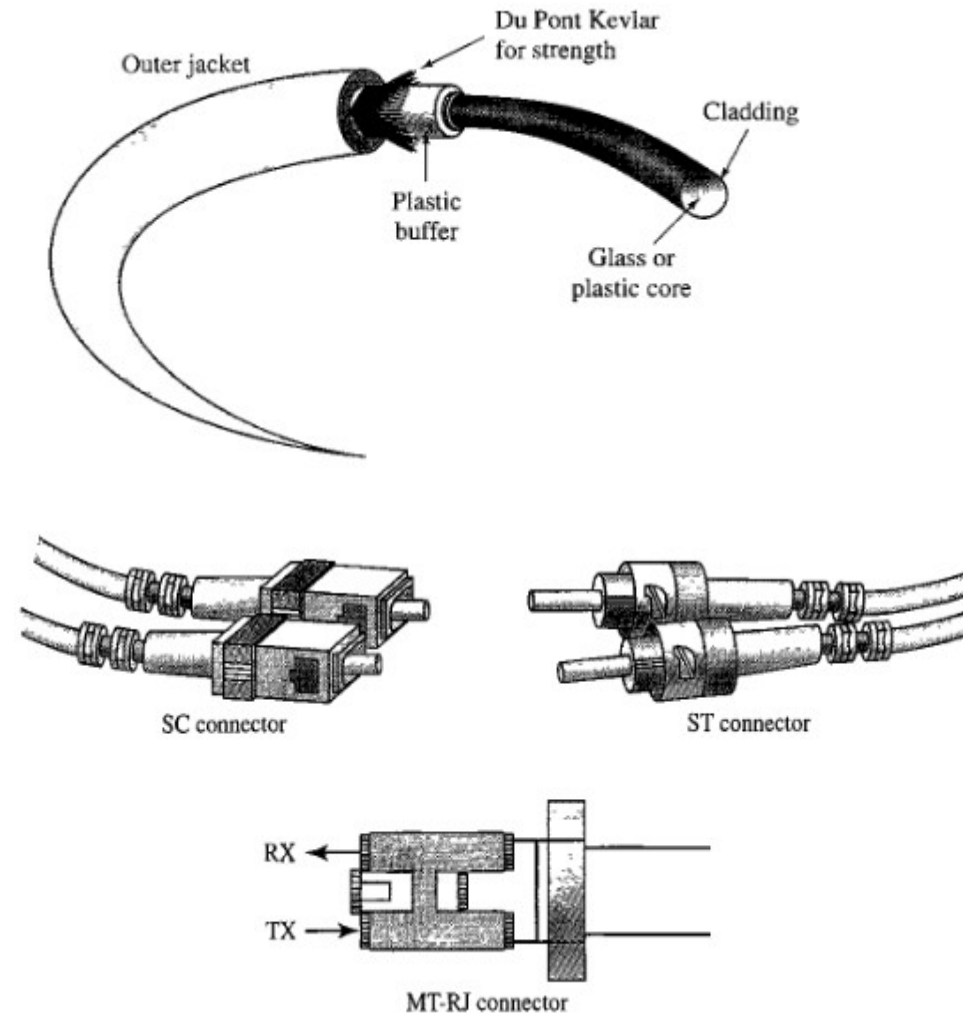
a. Multimode, step index



b. Multimode, graded index



c. Single mode



# Fiber Optics

- Advantages
  - Higher bandwidth
  - Less signal attenuation
  - Immunity to electromagnetic interference
  - Resistance to corrosive materials
  - Lightweight
  - Greater immunity to tapping

# Fiber Optics

- Disadvantages
  - Installation and maintenance
  - Unidirectional light propagation
  - Cost



# UNGUIDED MEDIA: WIRELESS

- Transmit without a physical conductor
- Aka **wireless communication**
- Signals broadcasted through free space and available to anyone with a receiver
- **Ground propagation** – low-frequency signals travel through the lowest portion of the atmosphere
- **Sky propagation** – high-frequency signals radiate upward to the ionosphere
- **Line-of-sight propagation** – very high frequency signals transmitted in straight lines

# Propagation Methods

Ionosphere



Ground propagation  
(below 2 MHz)

Ionosphere



Sky propagation  
(2–30 MHz)

Ionosphere



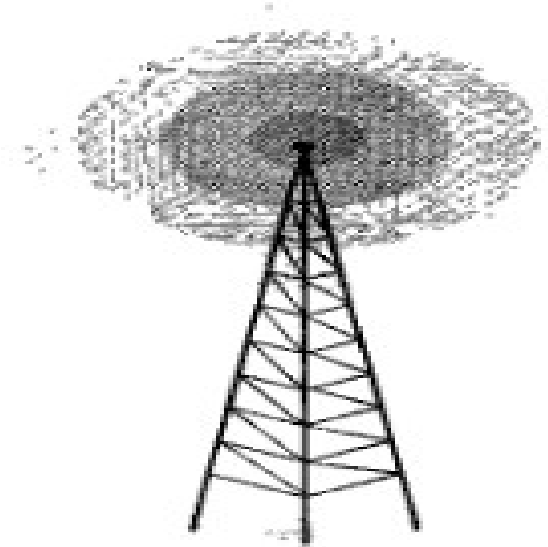
Line-of-sight propagation  
(above 30 MHz)

# 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

# Radio Waves

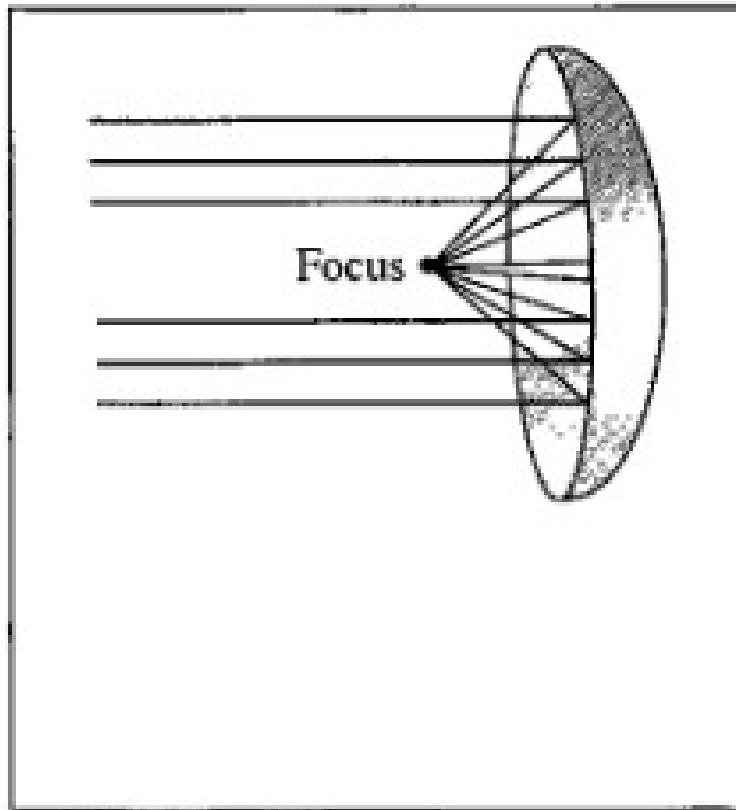
- Frequency range of 3kHz to 1 GHz
- Omnidirectional – signals propagate in all directions
- Signals can penetrate walls
- Applications: multicasting



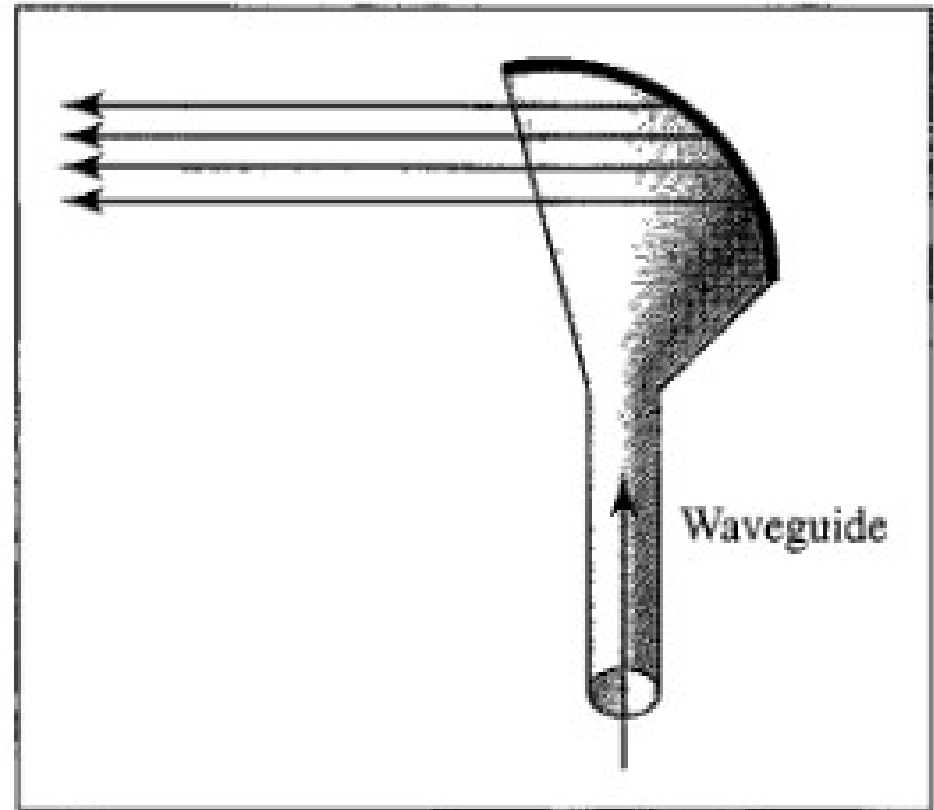
# Microwave

- Frequency range from 1 to 300 GHz
- Unidirectional – sending and receiving needs to be aligned
- Line-of-sight propagation
- Signals cannot penetrate walls
- Wider sub bands and higher data rate
- Applications: unicast, cellular networks, satellite networks, wireless LANs

# Microwave



**a. Dish antenna**



**b. Horn antenna**

# Infrared

- Frequency range from 300 GHz to 400 THz
- Short range communication
- Signals cannot penetrate walls
- Applications: IrDA (Infrared Data Association) port, communication between devices
- Line-of-sight propagation

Enjoy! :)