Lecture 2-2

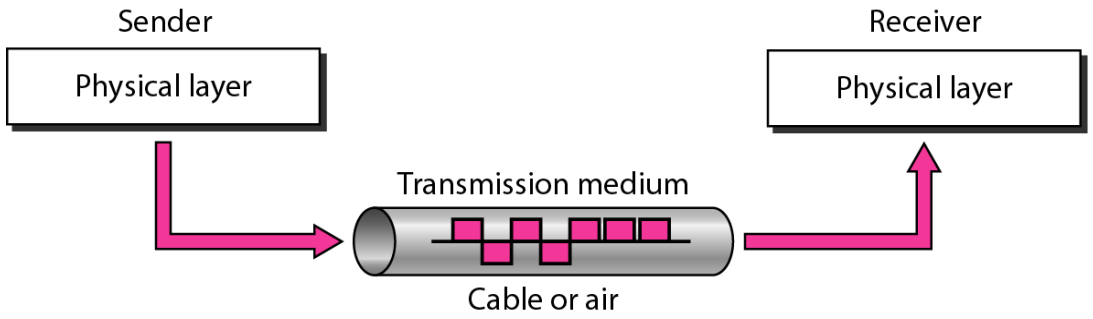
Transmission Medium

Transmission Medium: Human

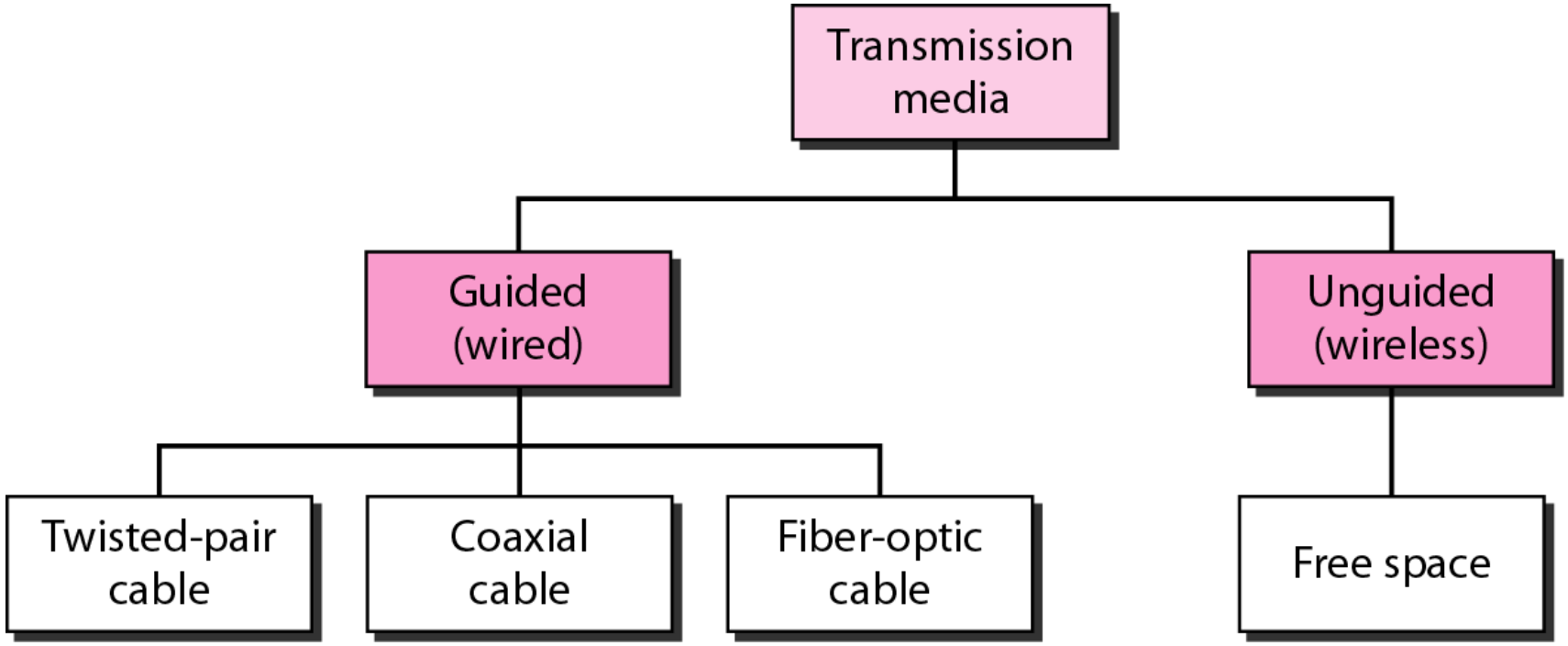
- When 2 parties want to communicate, we need a medium
- What is a transmission medium
  - Give examples
  - Air, smoke signal, cable
  - What else?

Transmission Medium: Data

- Data communication also needs a medium to transmit data
- Data transmission medium
  - Free space
  - Metallic cable
  - Fiber-optic cable
  - What else?



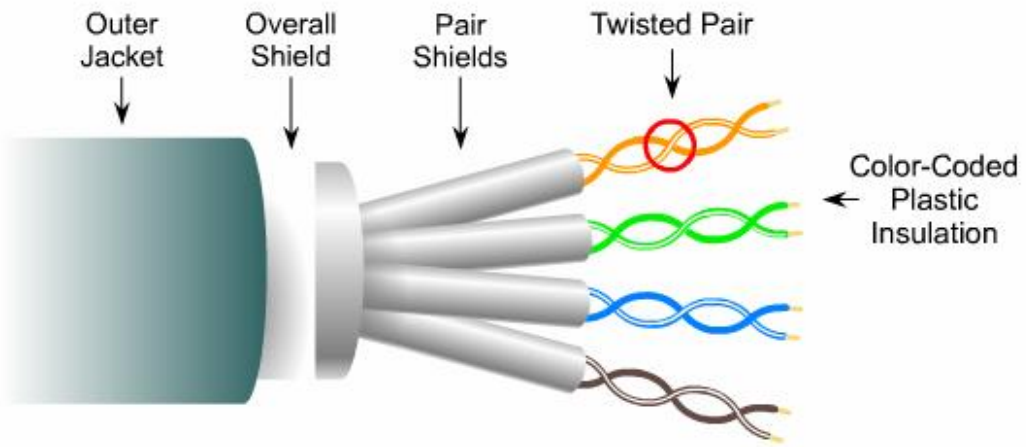
Transmission Medium

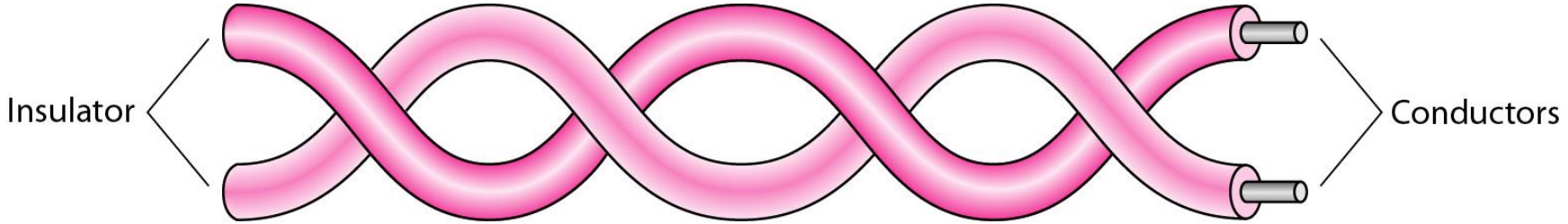


Guided Medium

- Twisted-Pair Cable
  - Signal: electrical current
- Coaxial Cable
  - Signal: electrical current
- Fiber-Optic Cable
  - Signal: light

Twisted-Pair Cable



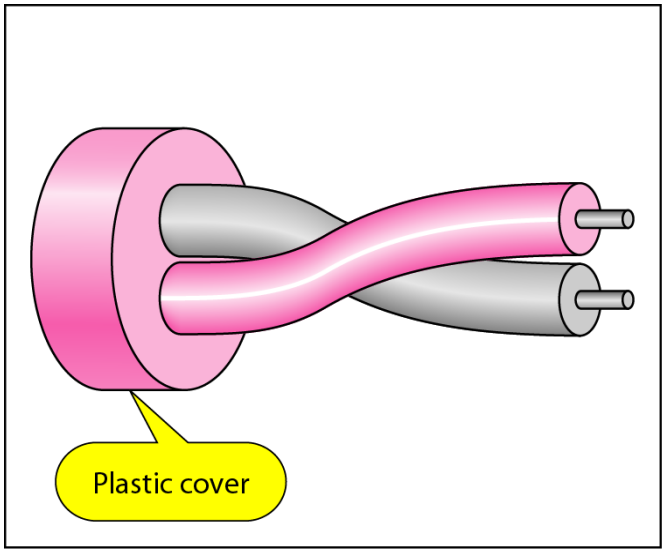


Twisted-Pair Cable 2

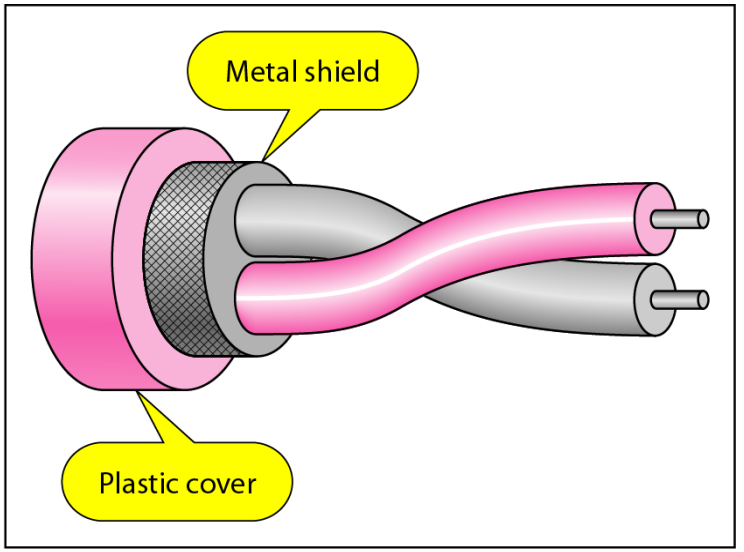
- 2 wires twisted together
  - One to carry signals to the receiver
  - Another is used as a reference
  - The receiver uses the difference between the two wires as data signals
- 4 pairs in a wire, with different numbers of twists
- The number of twists per unit of length has some effect on the quality of the cable
  - More twists = higher data rate

UTP and STP Cables

- Unshielded Twisted Pair (UTP)
- Shielded Twisted Pair (STP)



a. UTP

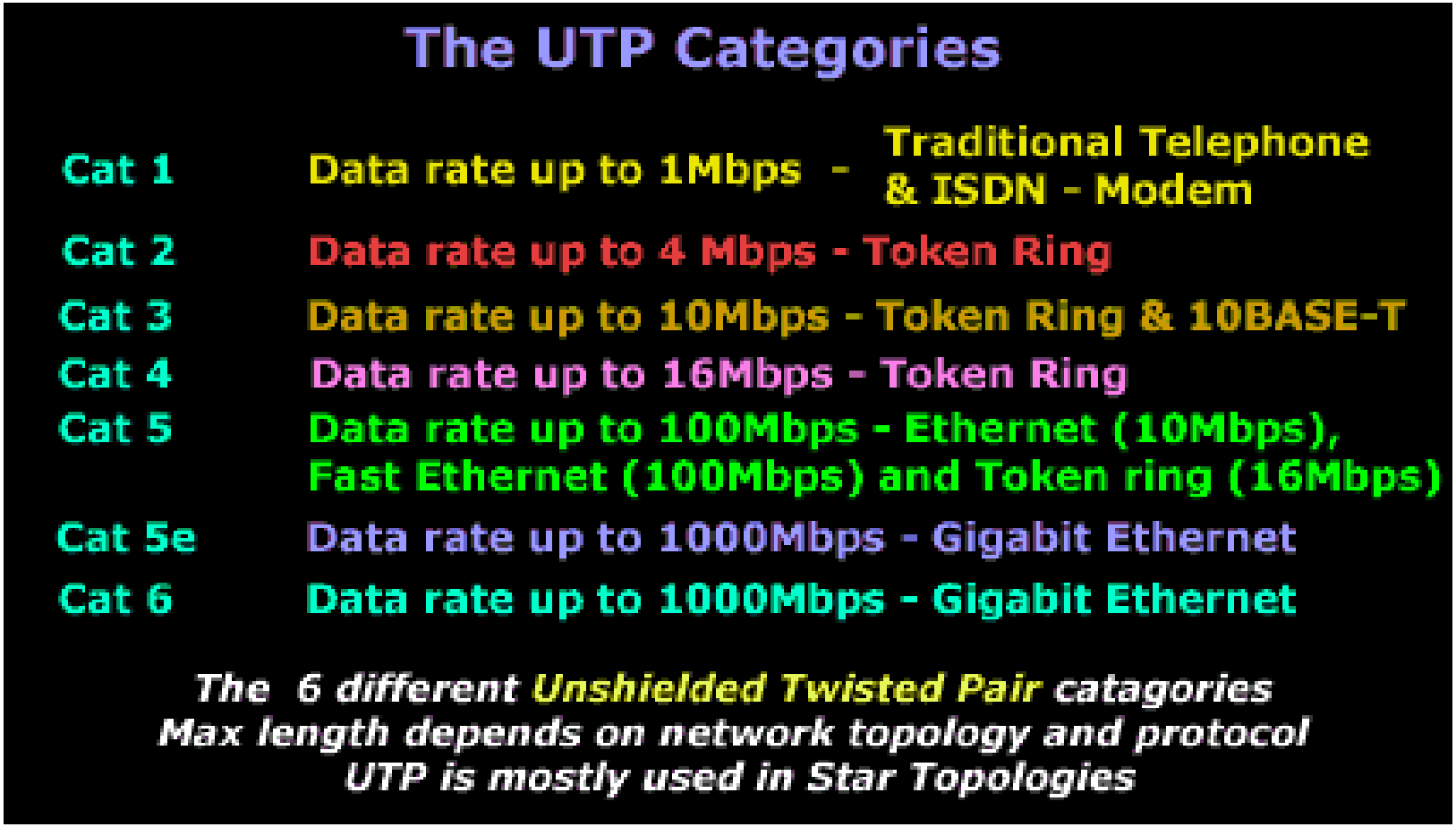


b. STP

UTP and STP Cables 2

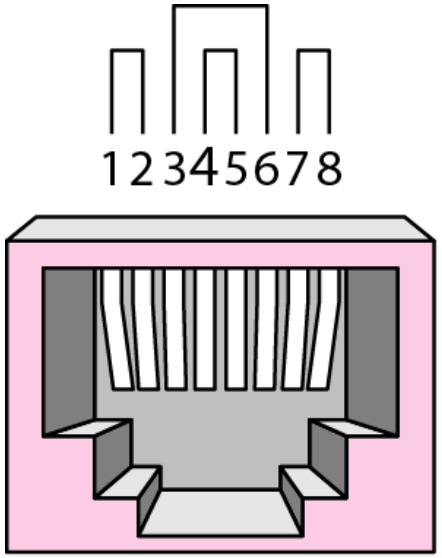
- UTP is cheaper
  - But sensitive to radio and electrical frequency interference
    - E.g. can't be placed near electrical motors, fluorescent lights
  - Speed varies from 1 Mbps – 10 Gbps depending on categories
- STP has metal foil or braided-mesh for each pair
  - Improve quality of cable be preventing noise and crosstalk
  - Bulkier and expensive -> only IBM used it

UTP Categories

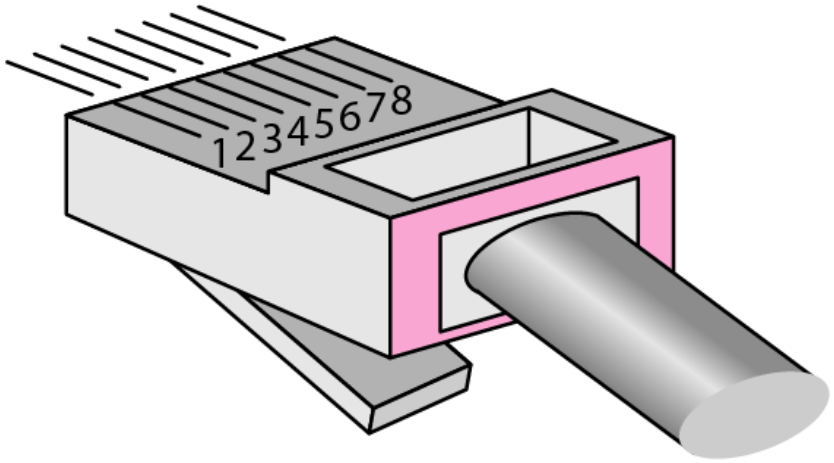


http://www.firewall.cx/networking-topics/cabling-utp-fibre/112-network-cabling-utp.html

RJ45 (Registered Jack-45)

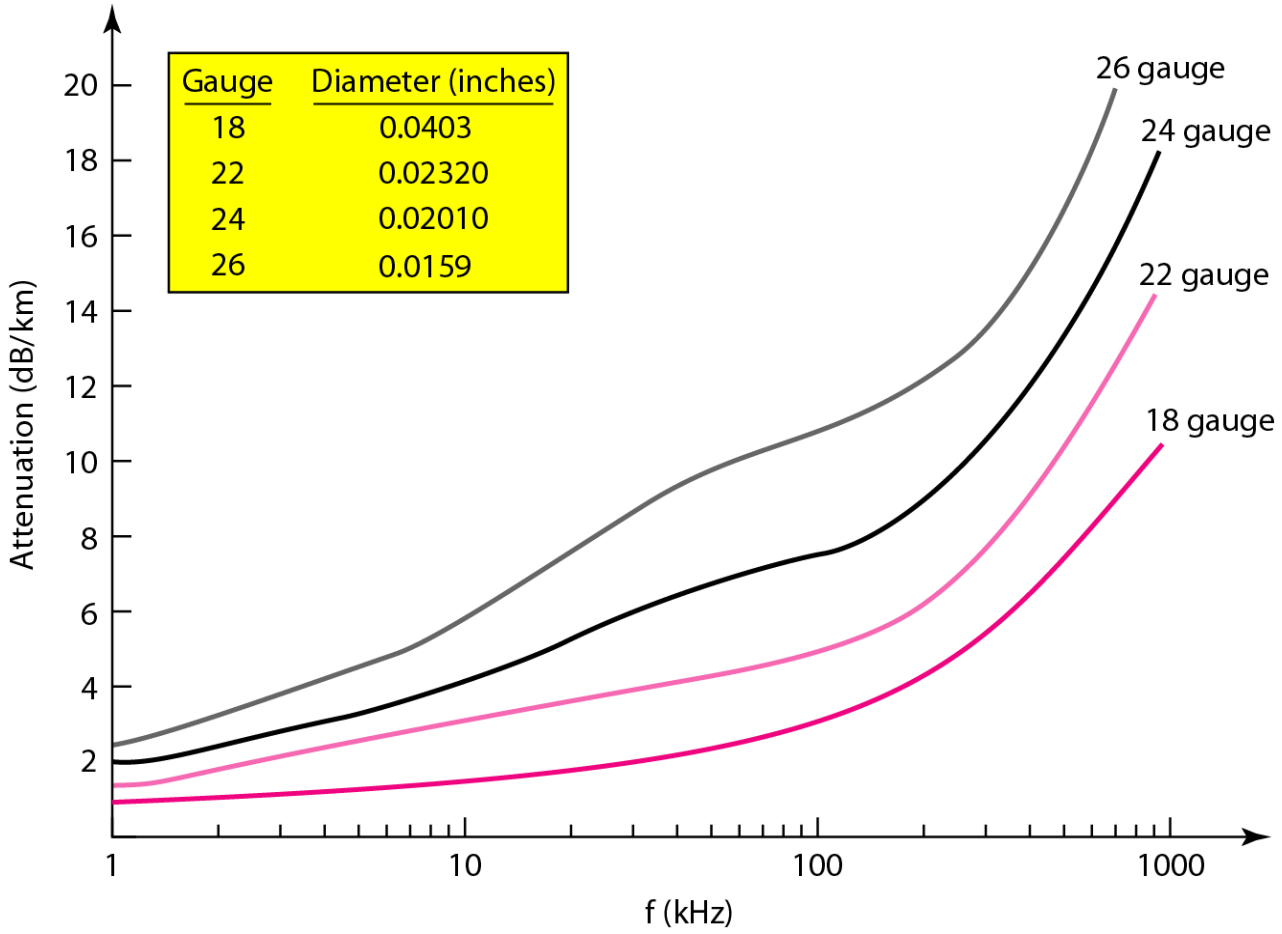


RJ-45 Female



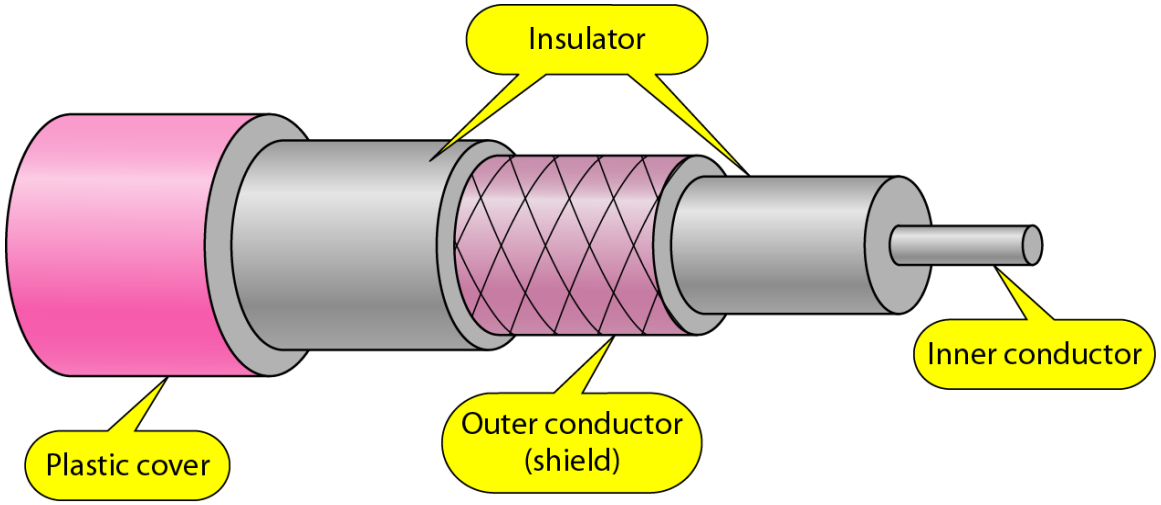
RJ-45 Male

Performance



- The increase of frequency, the attenuation, measured in db/km sharply increase with frequency above 100 MHz

Coaxial Cable



- Carries signals of higher frequency than those of twisted pair
- So what?

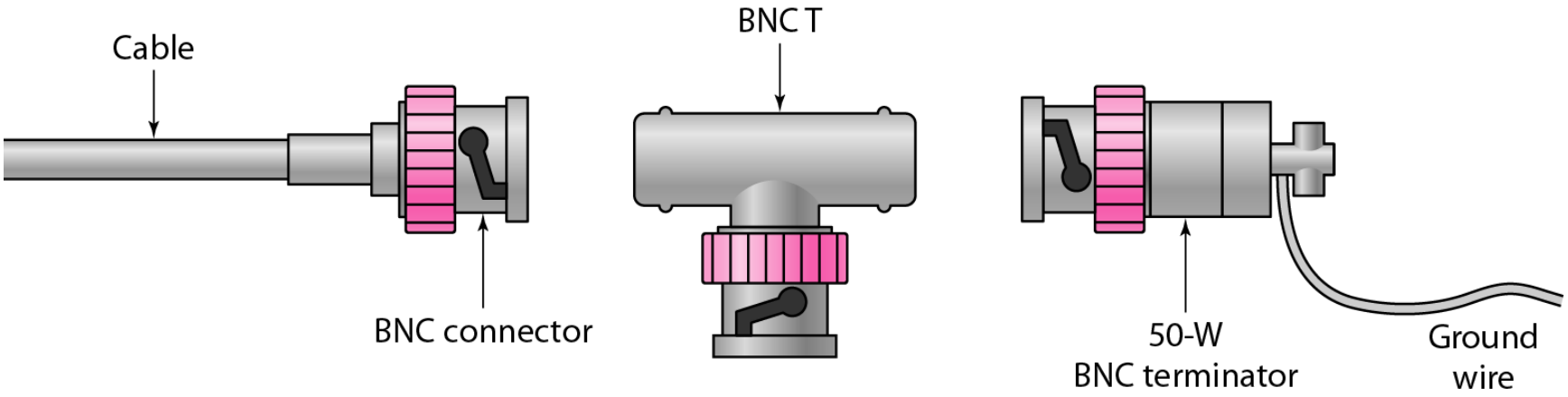
Categories of Coaxial Cables

- RG (Radio Government) number denotes a unique set of physical specifications
  - Wire gauge of the inner conductor
  - Thickness of insulator
  - Type of insulator

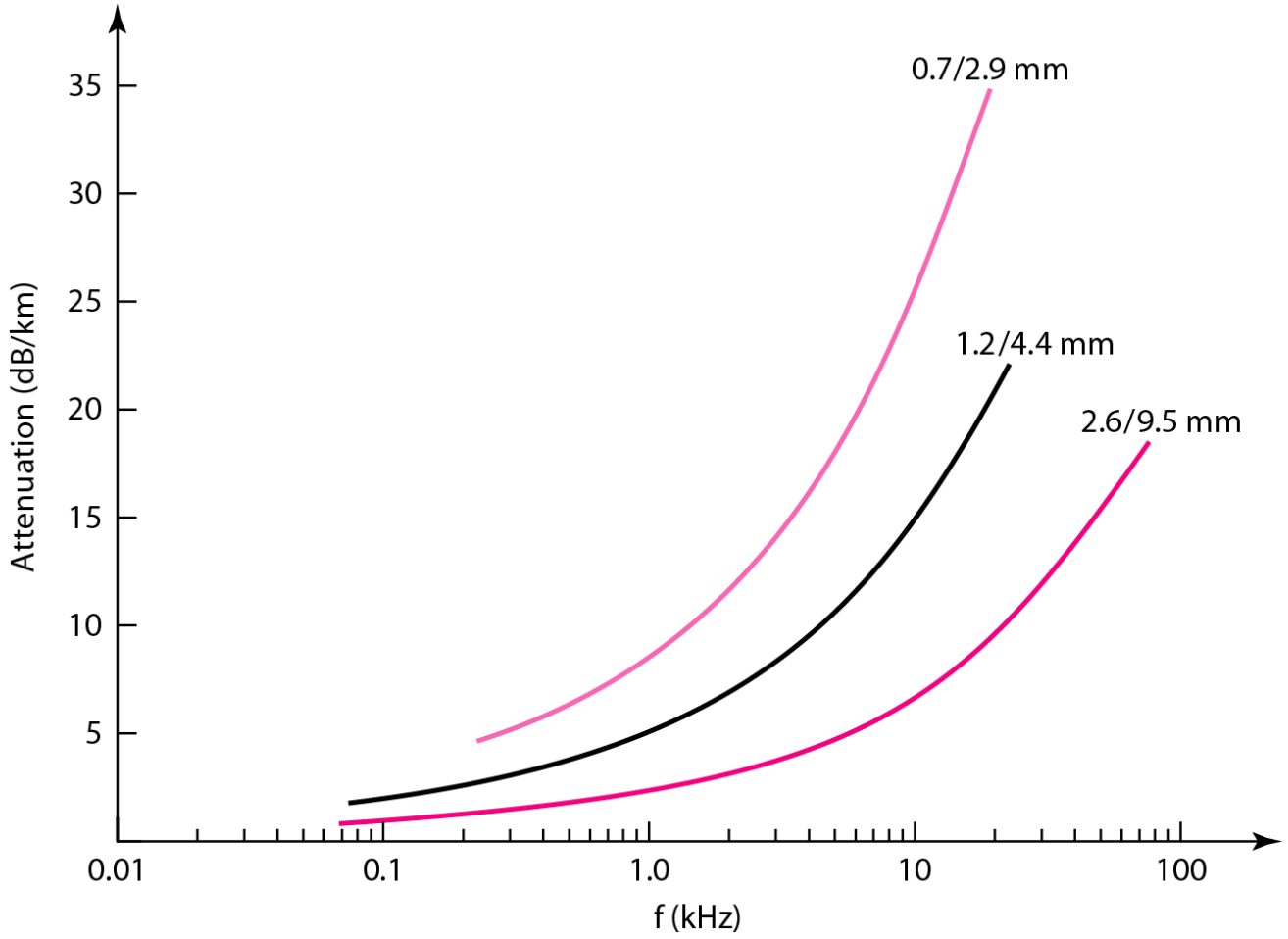
Category	*Impedance*	*Use*
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet
RG-11	50 Ω	Thick Ethernet

Coxial Cable Connectors

- Most common type: **Bayone-Neill-Concelman** (**BNC**)
- BNC terminator is used at the end of the cable to prevent the reflection of the signal

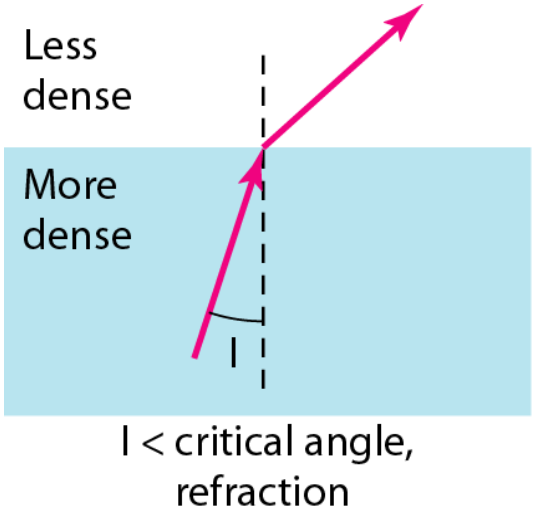


Coaxial Cable Performance

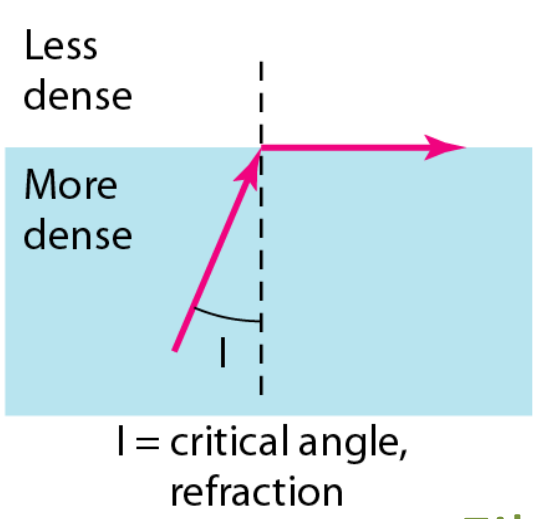


Fiber Optic Cable

- Use light (on-off) to carry data
- Depend on a **critical angle**

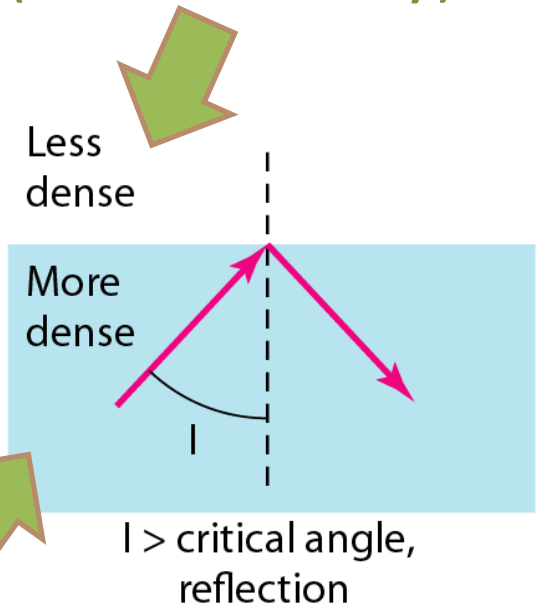


I < critical angle, refraction



I = critical angle, refraction

Fiber optic cladding (lower density)

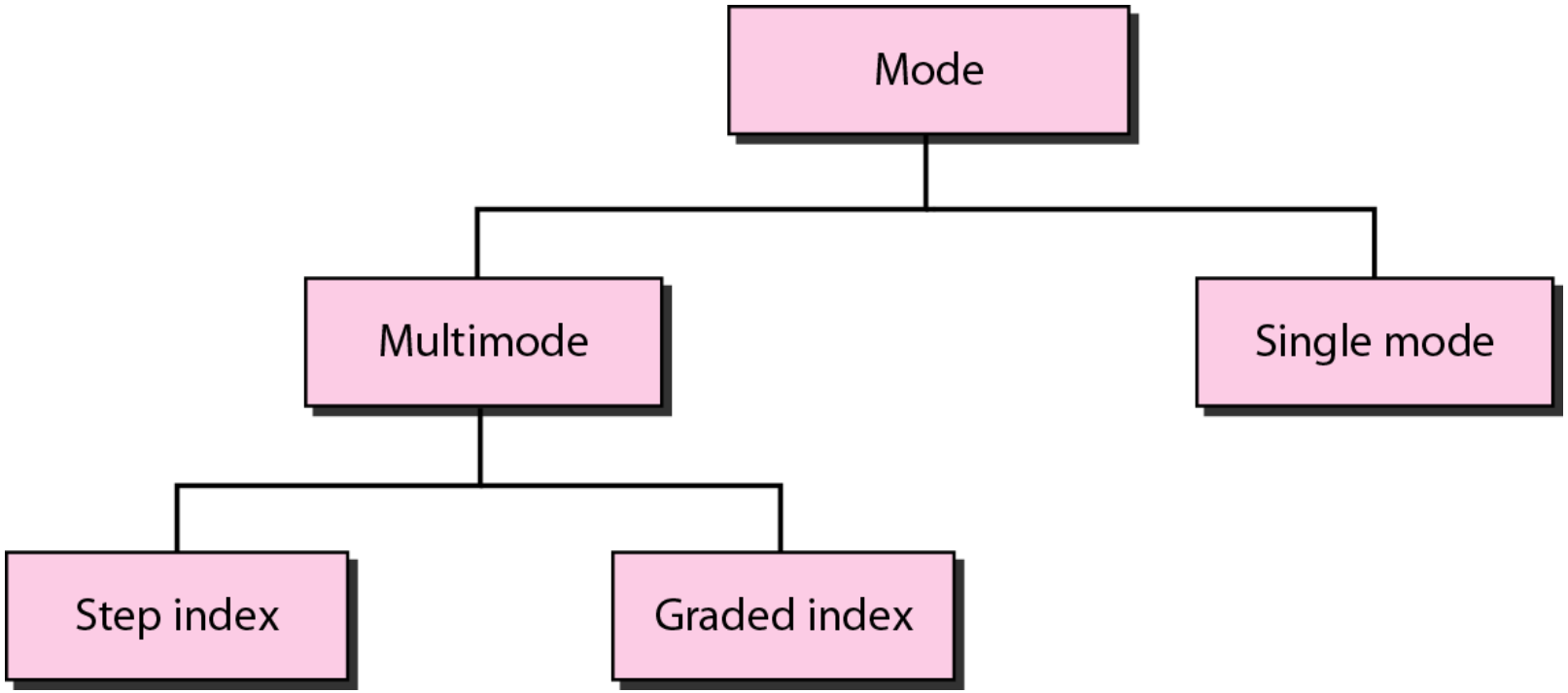


I > critical angle, reflection

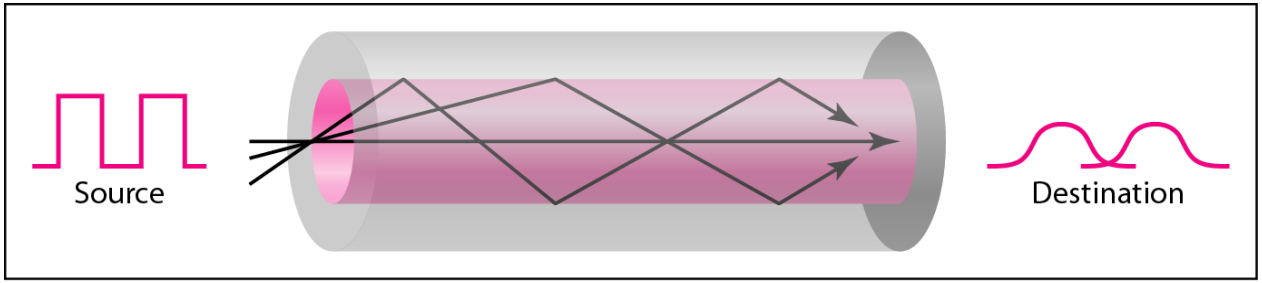
Fiber optic core (high density)

Propagation Modes

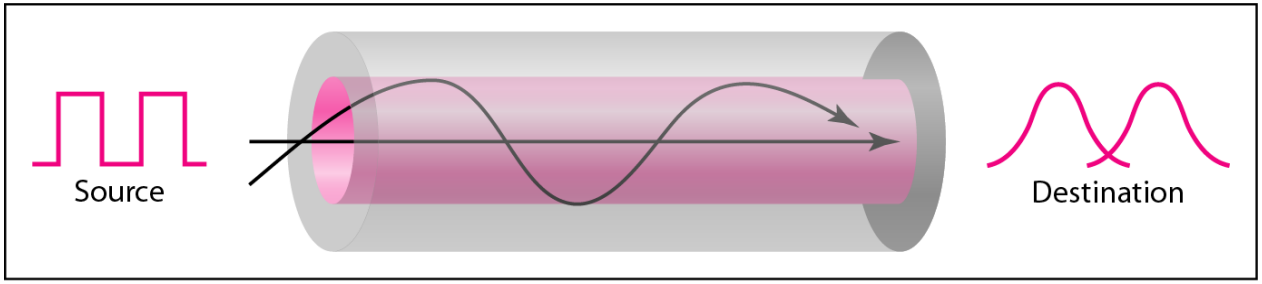
- Depend on physical characteristics



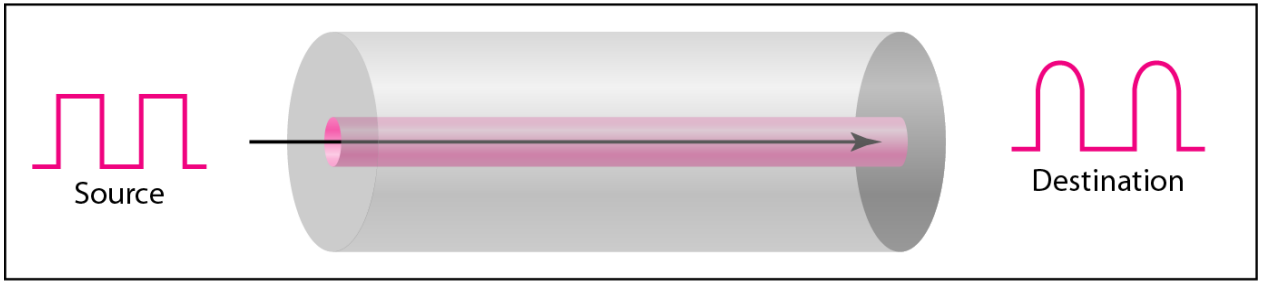
Propagation Modes



a. Multimode, step index



b. Multimode, graded index



c. Single mode

Multimode

- Multiple beams from a light source move through the core in different paths
  - Step-index fiber: the density of the core constant from the center to the edges
  - Graded-index fiber: density is highest at the center of the core and decreases gradually to its lowest at the edge.

Single Mode

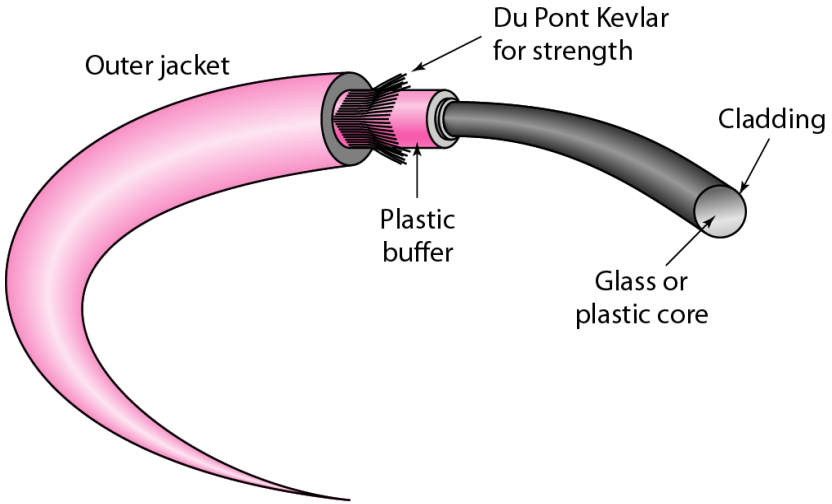
- A single beam from a light source
- A highly focused source of light that limits beam to a small range of angles

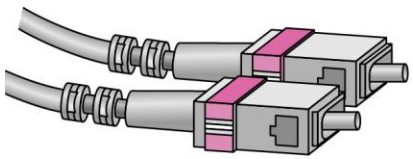
Fiber Types

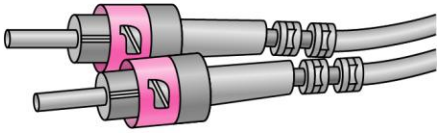
- Optical fiber: the ratio of the diameter of their core to the diameter of their cladding (micrometers)

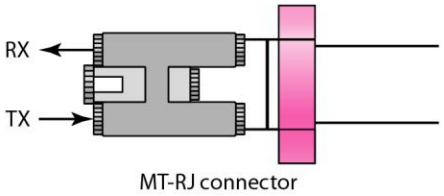
Type	*Core (μm)*	*Cladding (μm)*	*Mode*
50/125	50.0	125	Multimode, graded index
62.5/125	62.5	125	Multimode, graded index
100/125	100.0	125	Multimode, graded index
7/125	7.0	125	Single mode

Fiber Contruction & Connectors



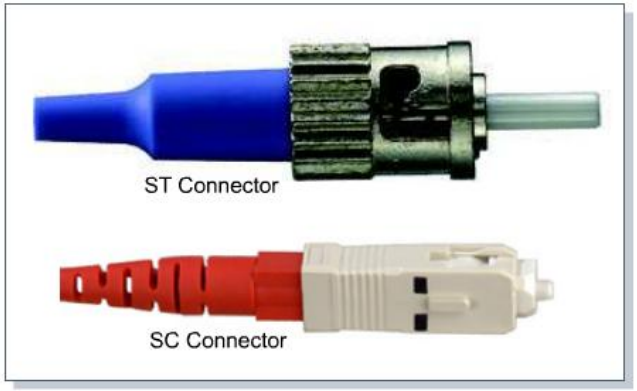

SC connector


ST connector



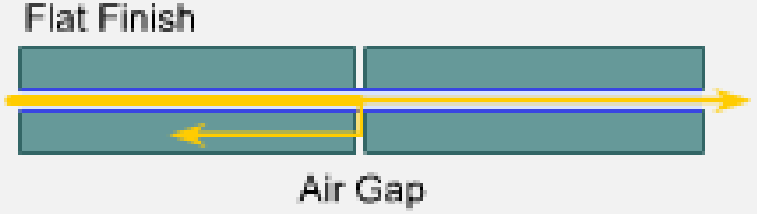
MT-RJ connector

- SC (subscriber channel): for cable TV
- ST(straight-tip) connector: for connecting cable to networking devices
- MT-RJ: Same size as RJ-45

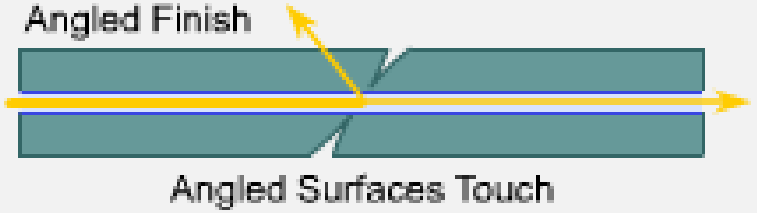


Fiber End Face Finishes

Flat: Finish causes light to be reflected back into the fiber due to a step in the refractive index caused by the glass-air-glass interface.



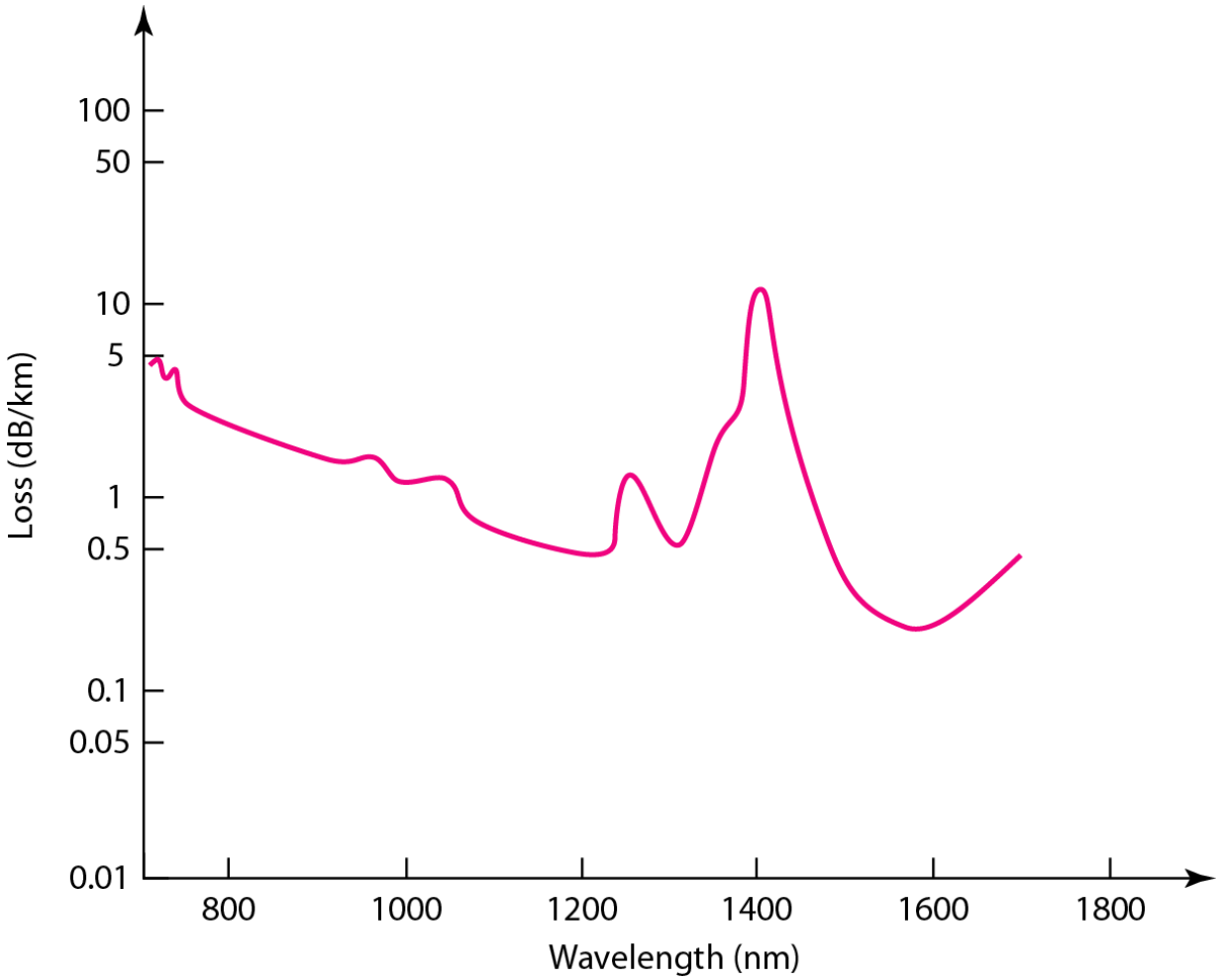
Angle: Polish connectors cause the reflection to exit the core and dissipate in the cladding.



Physical Contact (PC): Finish minimizes backreflection due to the very small refractive index discontinuity.

Ultra: Polish connector finish uses several grades of polishing film to achieve an untra-smooth surface.

Performance of a Fiber Optic Cable



Pros and Cons of Fiber Optic

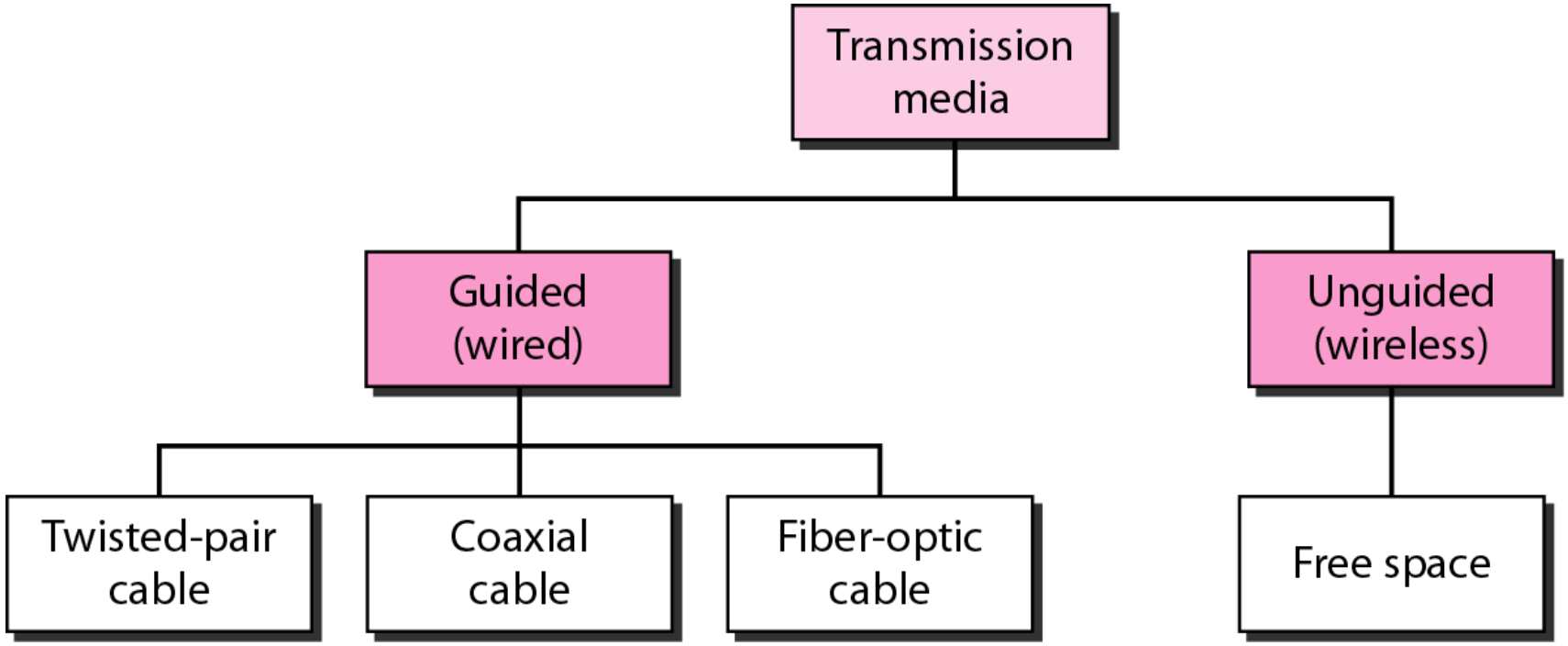
Advantages

- Higher bandwidth
- Less signal attenuation
- Immunity to electromagnetic interference
- Light weight
- Greater immunity to tapping

Disadvantages

- Installation & maintenance
- Unidirectional light propagation
- Cost

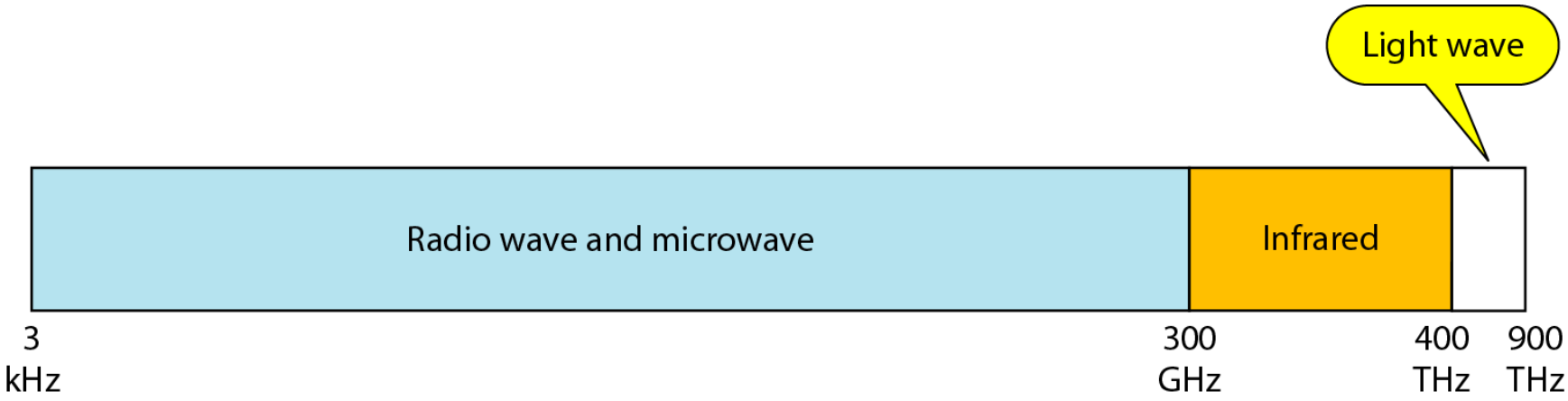
Transmission Medium



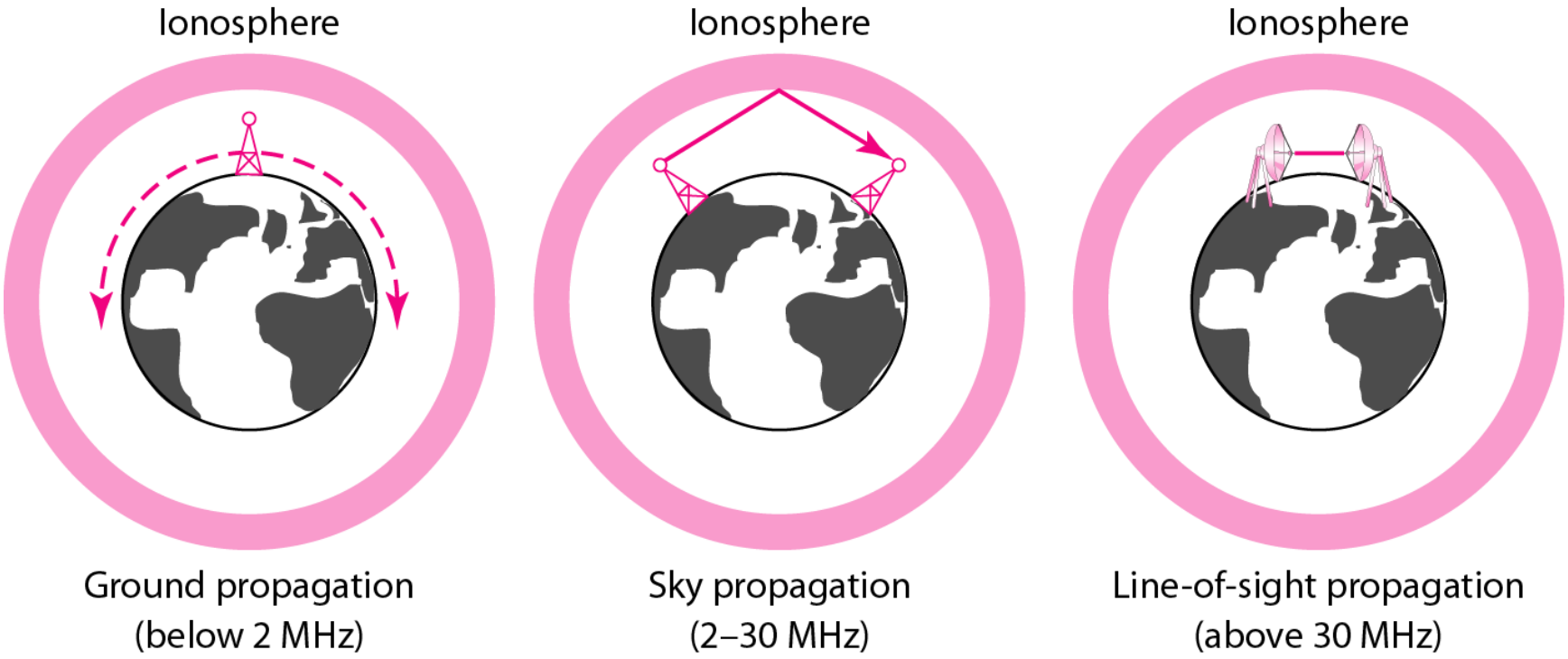
Unguided Medium

- Radio Wave
- Microwave
- Infrared

Electromagnetic Spectrum for Wireless Communication



Propagation Methods



Ground propagation
(below 2 MHz)

Sky propagation
(2–30 MHz)

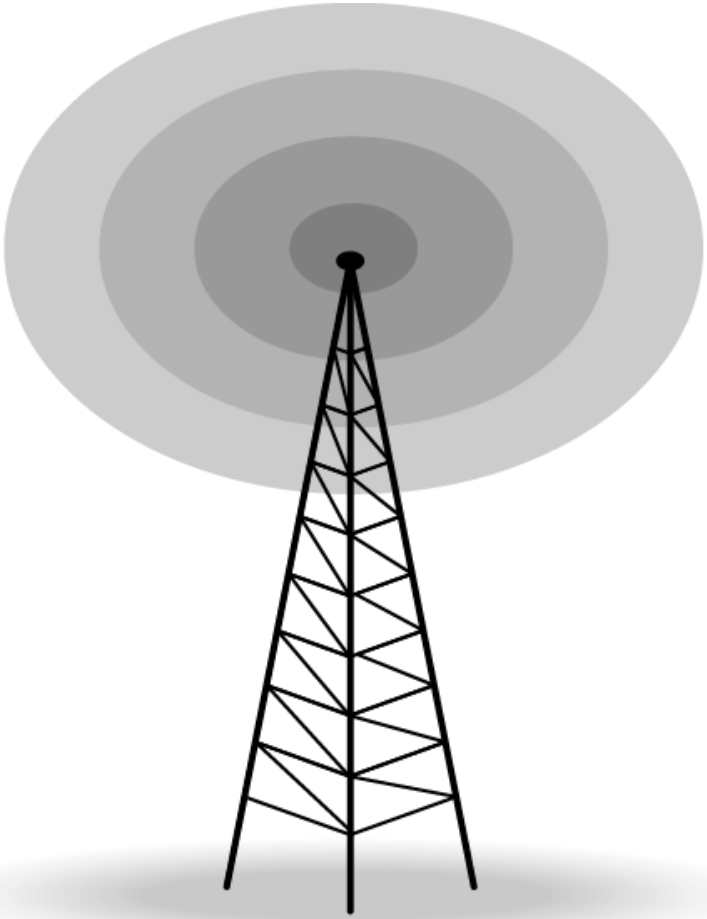
Line-of-sight propagation
(above 30 MHz)

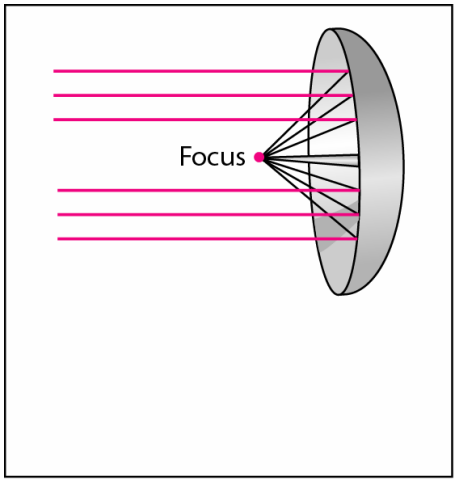
Where is 3G? (2.1 GHz)

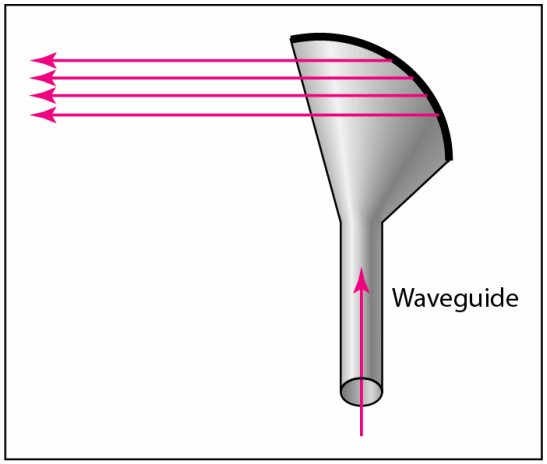
Bands

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

Antenna







Wireless LAN

- IEEE is the prime issuer of standards for wireless networks
  - 802.11 - operating within a 1 to 2 Mbps range
  - 802.11b - transmission capability up to 11 Mbps
  - 802.11a - data rate up to 54 Mbps, incompatible with 802.11b
  - 802.11g - data rate up to 54 Mbps, interoperate with 802.11b
  - 802.11n - data rate up to 600 Mbps

Adaptive Rate Selection