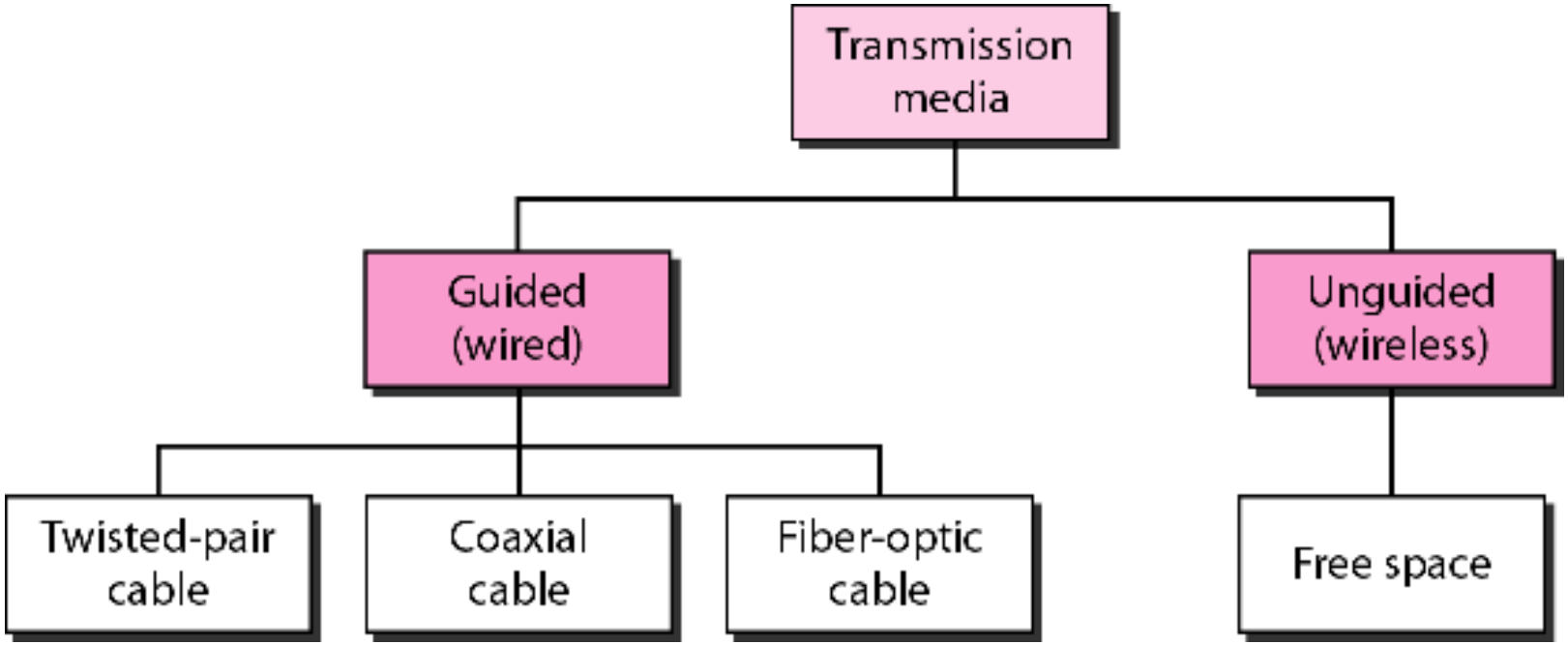
Transmission medium

Transmission Media

- By definition
  - Broadly defined as anything that can carry information from a source to a destination.
  - e.g., air, twisted-pair cable, coaxial cable, fiber-optic cable, conductor, and so on.
- Guided media
  - Provide a conduit from one device to another, include **twisted-pair cable**, **coaxial cable**, and **fiber-optic cable**.

Classes of transmission media



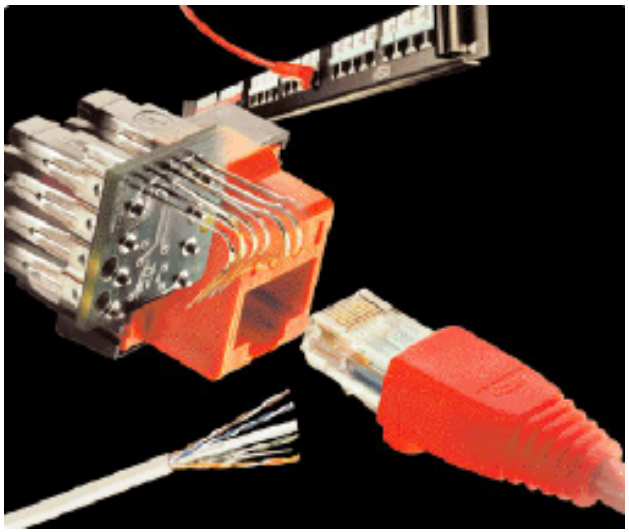
GUIDED MEDIA

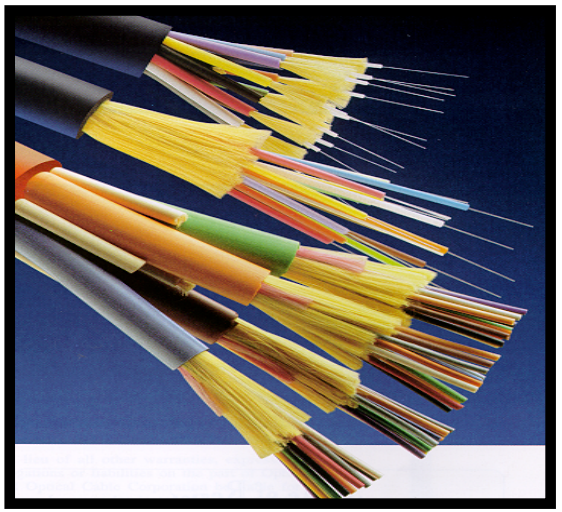
Guided media, which are those that provide a conduit from one device to another, include twisted-pair cable, coaxial cable, and fiber-optic cable.

Topics discussed in this section:

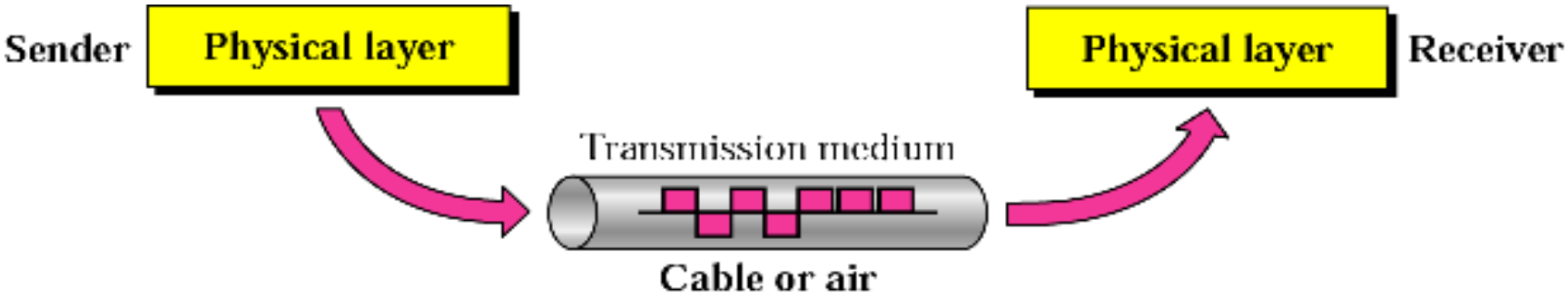
Twisted-Pair Cable
Coaxial Cable
Fiber-Optic Cable

PHYSICAL MEDIA





Physical Media

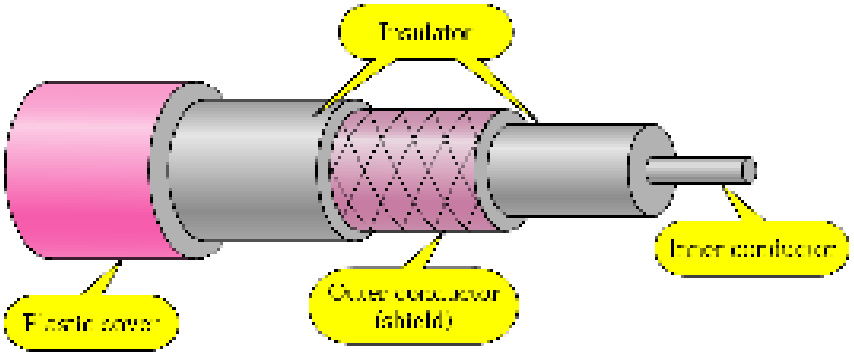


Physical Media

- **Copper**
  - Coaxial Cable - Thick or Thin
  - Unshielded Twisted Pair - CAT 3,4,5,5e&6
- **Optical Fiber**
  - Multimode
  - Singlemode
- **Wireless**
  - Short Range
  - Medium Range (Line of Sight)
  - Satellite

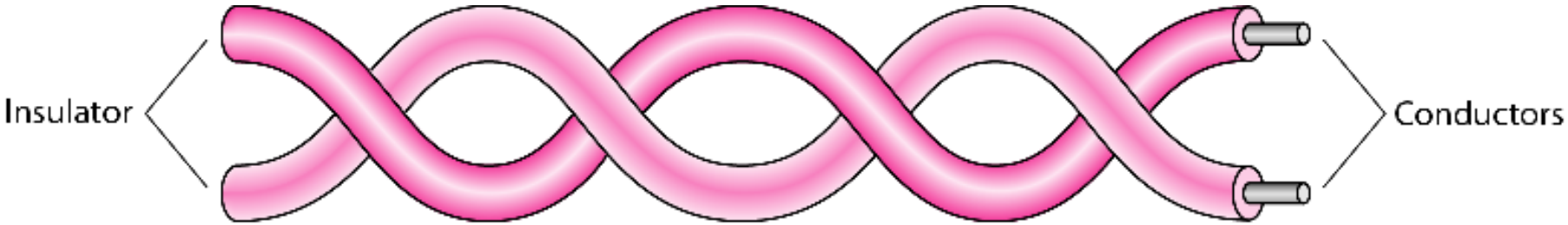
Copper Media: Coaxial Cable

- Coaxial cable is a copper-cored cable surrounded by a heavy shielding and is used to connect computers in a network.
- Outer conductor shields the inner conductor from picking up stray signal from the air.
- High bandwidth but lossy channel.
- Repeater is used to regenerate the weakened signals.

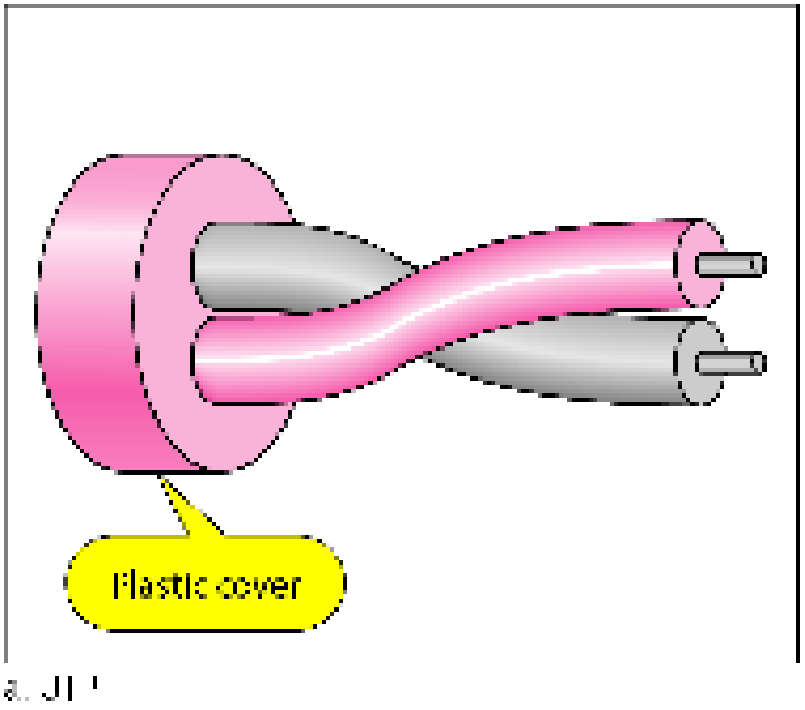


Category	Impedance	Use
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet
RG-11	50 Ω	Thick Ethernet

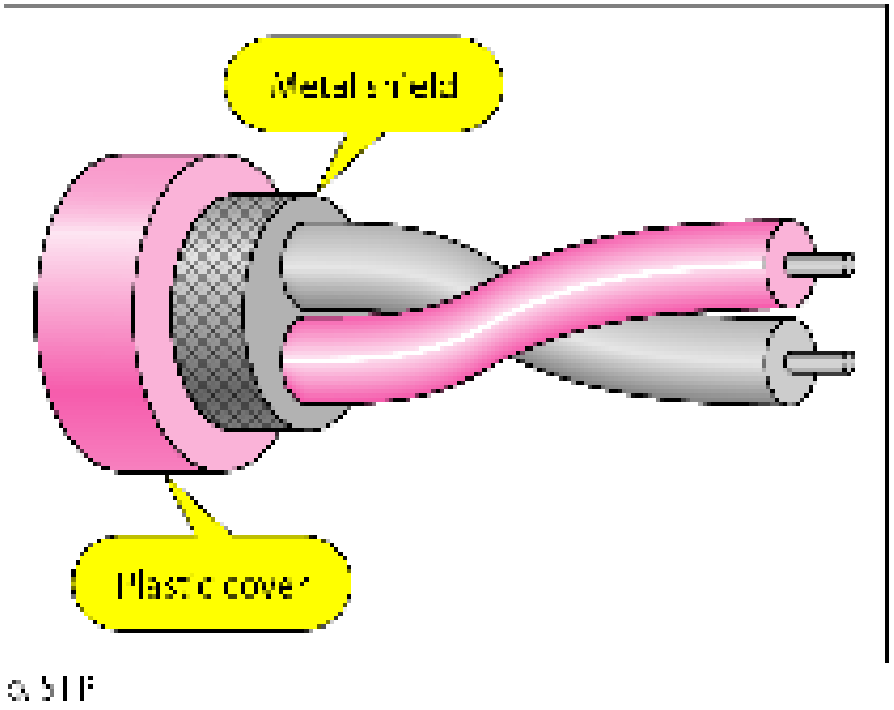
Twisted-pair cable



UTP and STP cables



Unshielded Twisted-Pair (UTP)



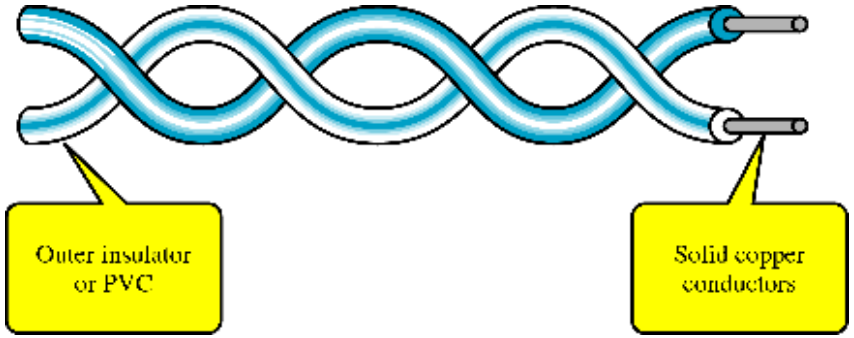
Shielded Twisted-Pair (STP)

Unshielded vs Shielded Twisted-Pair Cable

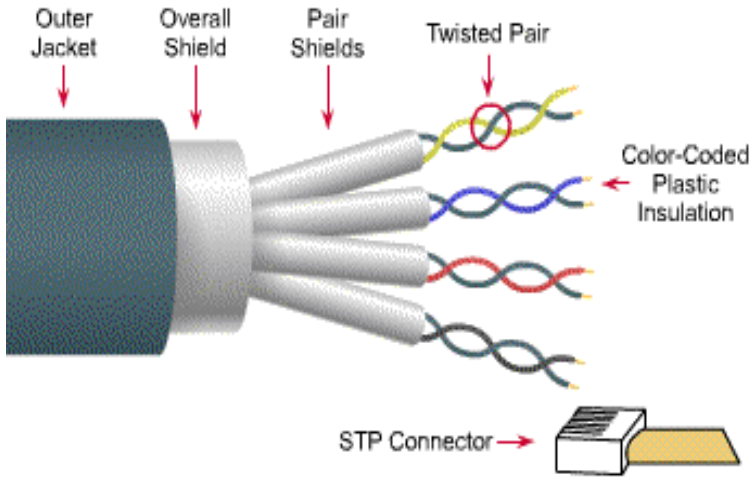
- Unshielded twisted-pair (UTP)
- Shielded twisted-pair (STP)
  - Has a metal foil or braided-mesh covering that encases each pair of insulated conductors.
- Category
  - Electronic Industries Association (EIA) has developed standards to classify unshielded twisted-pair cable into seven categories. Table 7.1 shows these categories.
- Connectors
  - Most common UTP connector is **RJ-45** (RJ stands for registered jack).

Copper Media: Twisted Pair

- Twisted-pair is a type of cabling that is used for telephone communications and most modern Ethernet networks.
- A pair of wires forms a circuit that can transmit data. The pairs are twisted to provide protection against crosstalk, the noise generated by adjacent pairs.
- There are two basic types, shielded twisted-pair (STP) and unshielded twisted-pair (UTP).

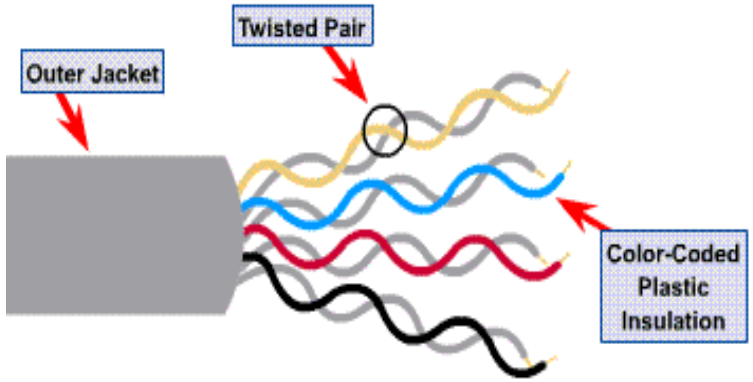


Shielded Twisted Pair (STP)



- Speed and throughput: 10-100 Mbps
- Cost per node: Moderately expensive
- Media and connector size: Medium to Large
- Maximum cable length: 100m (short)

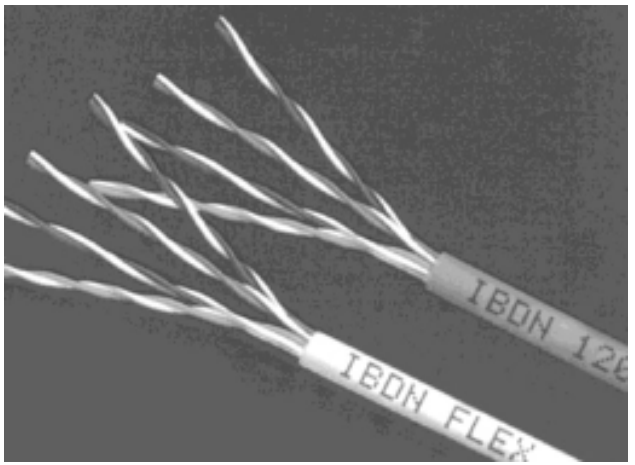
Unshielded Twisted Pair (UTP)

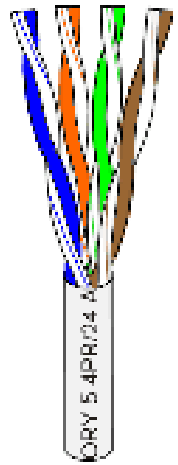


- Speed and throughput: 10-100 Mbps
- Cost per node: Least Expensive
- Media and connector size: Small
- Maximum cable length: 100m (short)

Unshielded Twisted Pair (UTP)

- Consists of 4 pairs (8 wires) of insulated copper wires typically about 1 mm thick.
- The wires are twisted together in a helical form.
- Twisting reduces the interference between pairs of wires.
- High bandwidth and High attenuation channel.
- Flexible and cheap cable.
- Category rating based on number of twists per inch and the material used
- CAT 3, CAT 4, CAT 5, Enhanced CAT 5 and now CAT 6.





Categories of UTP

- UTP comes in several categories that are based on the number of twists in the wires, the diameter of the wires and the material used in the wires.
- Category 3 is the wiring used primarily for telephone connections.
- Category 5e and Category 6 are currently the most common Ethernet cables used.

Table *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

Categories of UTP: CAT 3

- Bandwidth 16 Mhz
- 11.5 dB Attenuation
- 100 ohms Impedance
- Used in voice applications and 10baseT (10Mbps) Ethernet

Categories of UTP: CAT 4

- 20 MHz Bandwidth
- 7.5 dB Attenuation
- 100 ohms Impedance
- Used in 10baseT (10Mbps) Ethernet

Categories of UTP: CAT 5

- 100 MHz Bandwidth
- 24.0 dB Attenuation
- 100 ohms Impedance
- Used for high-speed data transmission
- Used in 10BaseT (10 Mbps) Ethernet & Fast Ethernet (100 Mbps)

Categories of UTP: CAT 5e

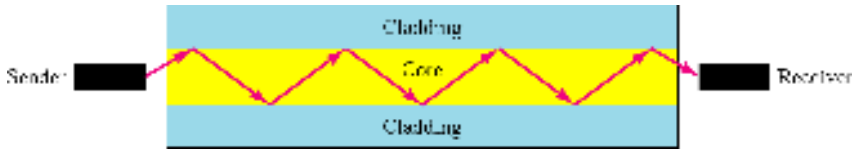
- 150 MHz Bandwidth
- 24.0 dB Attenuation
- 100 ohms Impedance
- Transmits high-speed data
- Used in Fast Ethernet (100 Mbps), Gigabit Ethernet (1000 Mbps) & 155 Mbps ATM

Categories of UTP: CAT 6

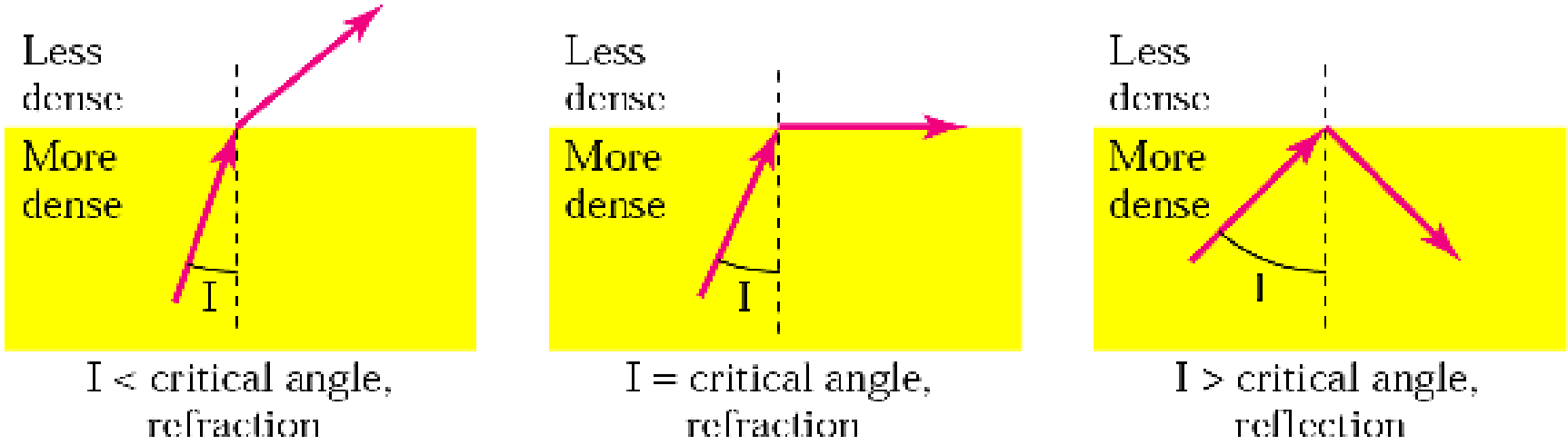
- 250 MHz Bandwidth
- 19.8 dB Attenuation
- 100 ohms Impedance
- Transmits high-speed data
- Used in Gigabit Ethernet (1000 Mbps) & 10 Gig Ethernet (10000 Mbps)

Fiber Media

- Optical fibers use light to send information through the optical medium.
- It uses the principal of total internal reflection.
- Modulated light transmissions are used to transmit the signal.



Total Internal Reflection



I < critical angle, refraction

I = critical angle, refraction

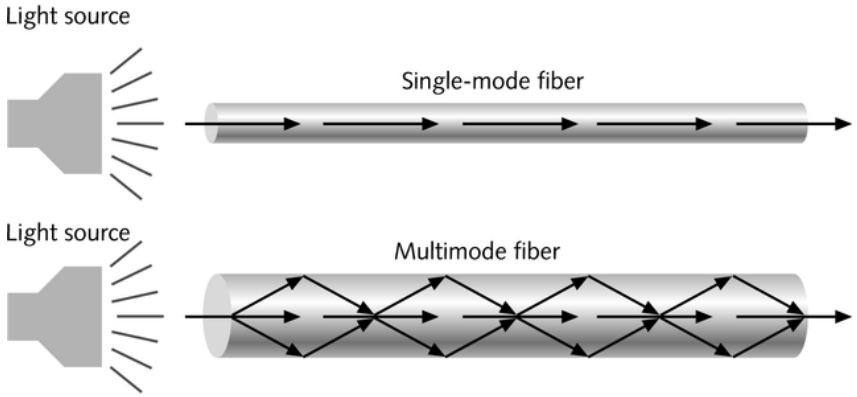
I > critical angle, reflection

Fiber Media

- Light travels through the optical media by the way of total internal reflection.
- Modulation scheme used is intensity modulation.
- Two types of Fiber media :
  - Multimode
  - Singlemode
- Multimode Fiber can support less bandwidth than Singlemode Fiber.
- Singlemode Fiber has a very small core and carry only one beam of light. It can support Gbps data rates over > 100 Km without using repeaters.

Single and Multimode Fiber

- **Single-mode fiber**
  - Carries light pulses along single path
  - Uses Laser Light Source
- **Multimode fiber**
  - Many pulses of light generated by LED travel at different angles

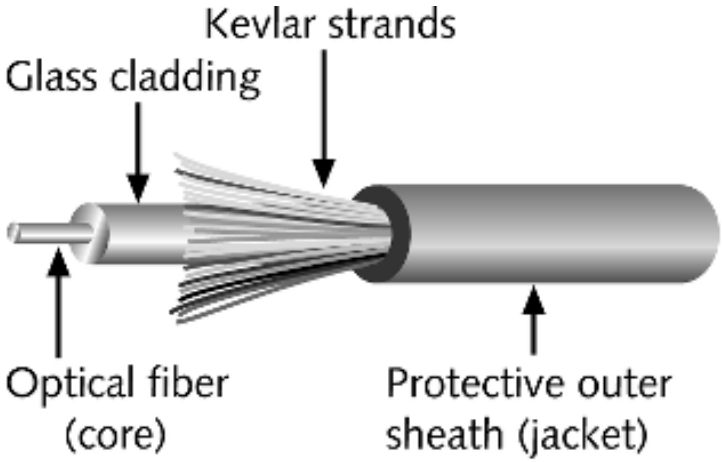


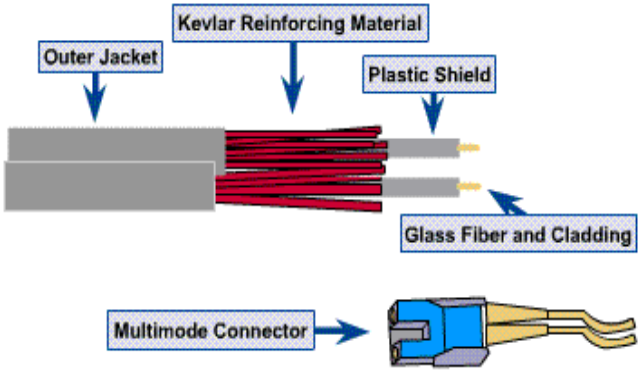
Fiber Media

- The bandwidth of the fiber is limited due to the dispersion effect.
- Distance Bandwidth product of a fiber is almost a constant.
- Fiber optic cables consist of multiple fibers packed inside protective covering.
- 62.5/125 µm (850/1310 nm) multimode fiber
- 50/125 µm (850/1310 nm) multimode fiber
- 10 µm (1310 nm) single-mode fiber

Fiber-Optic Cable

- Contains one or several glass fibers at its core
- Surrounding the fibers is a layer called cladding

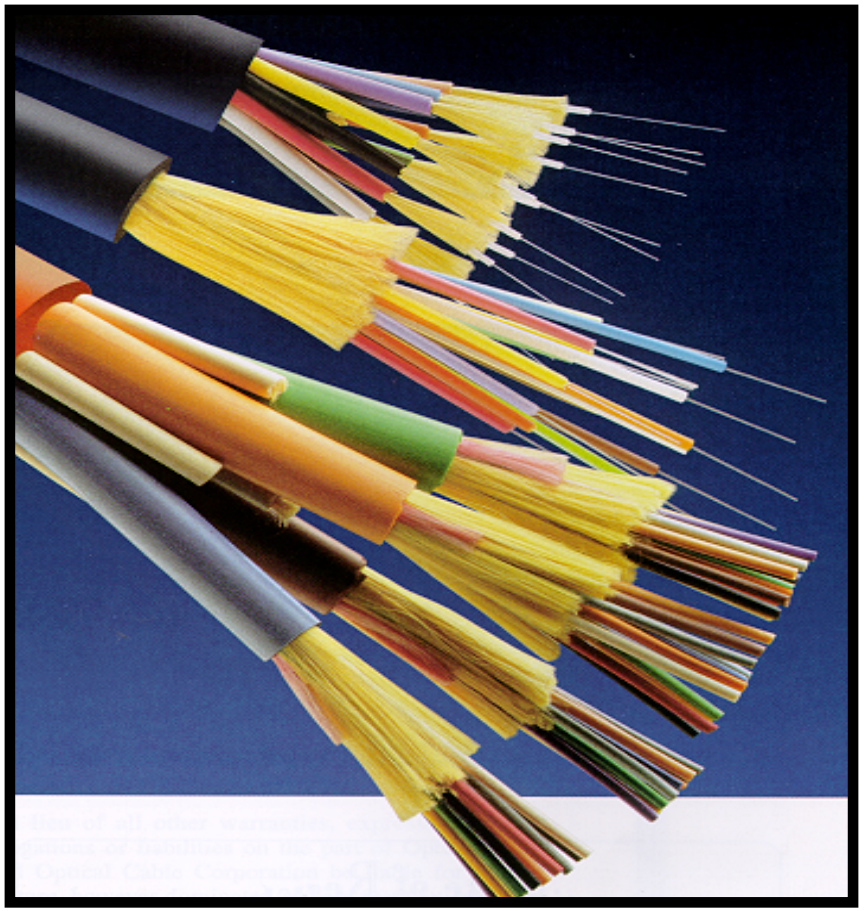




- Speed and throughput: 100+ Mbps
- Cost per node: Most Expensive
- Media and connector size: Small
- Single mode, maximum cable length: Up to 3000m
- Multimode mode, maximum cable length: Up to 2000m
- Single mode: One stream of laser-generated light
- Multimode: Multiple streams of LED-generated light

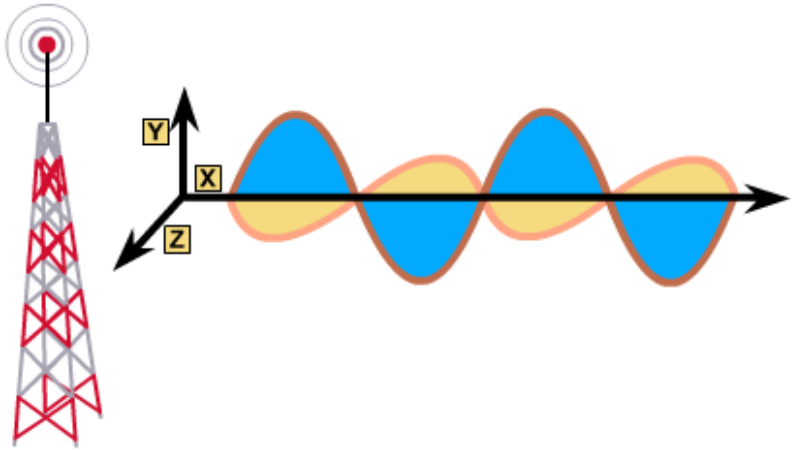
Fiber Optic Cable

- FO Cable may have 1 to over 1000 fibers



Wireless Media

- Very useful in difficult terrain where cable laying is not possible.
- Provides mobility to communication nodes.
- Right of way and cable laying costs can be reduced.
- Susceptible to rain, atmospheric variations and Objects in transmission path.



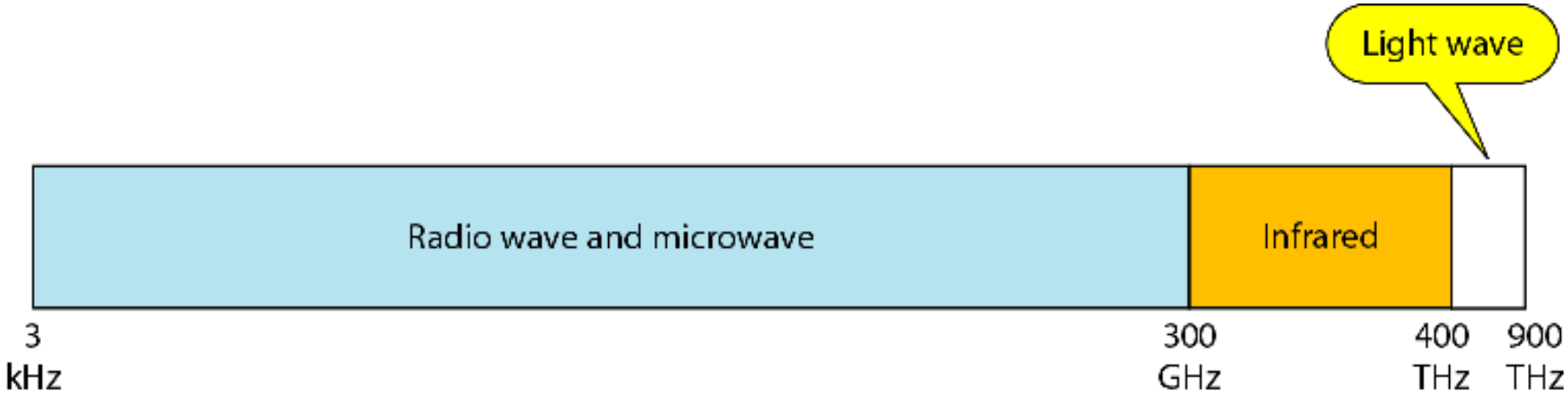
UNGUIDED MEDIA: WIRELESS

Unguided media transport electromagnetic waves without using a physical conductor. This type of communication is often referred to as wireless communication.

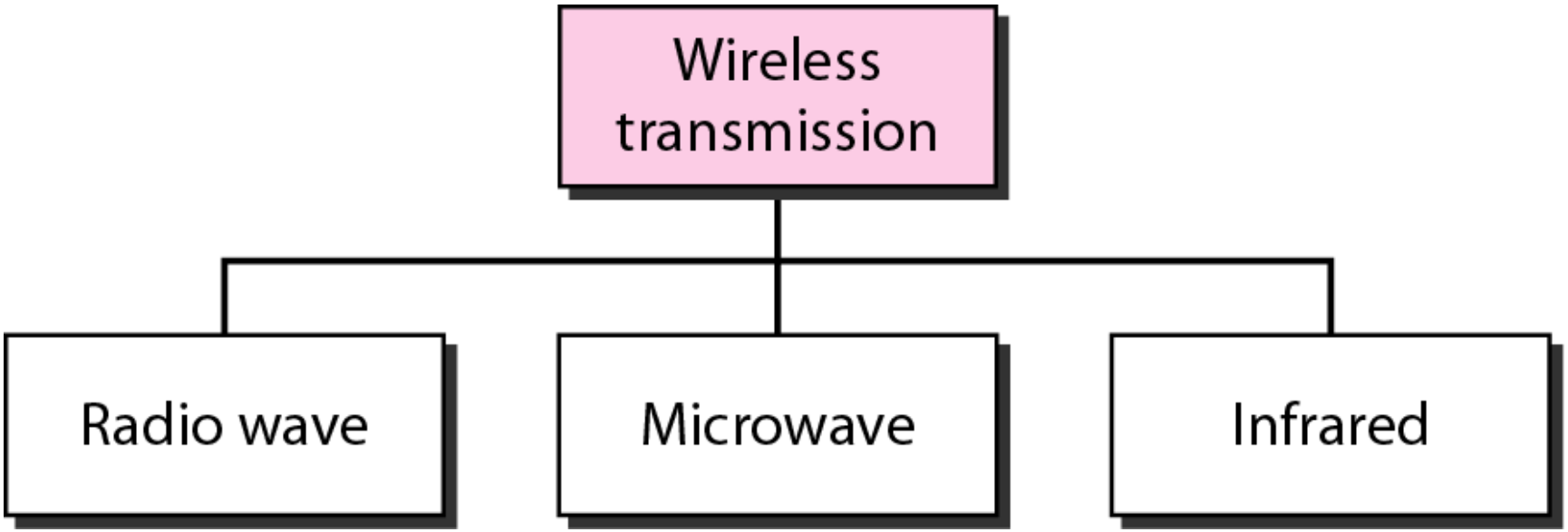
Topics discussed in this section:

Radio Waves
Microwaves
Infrared

Electromagnetic spectrum for wireless communication



Wireless transmission waves



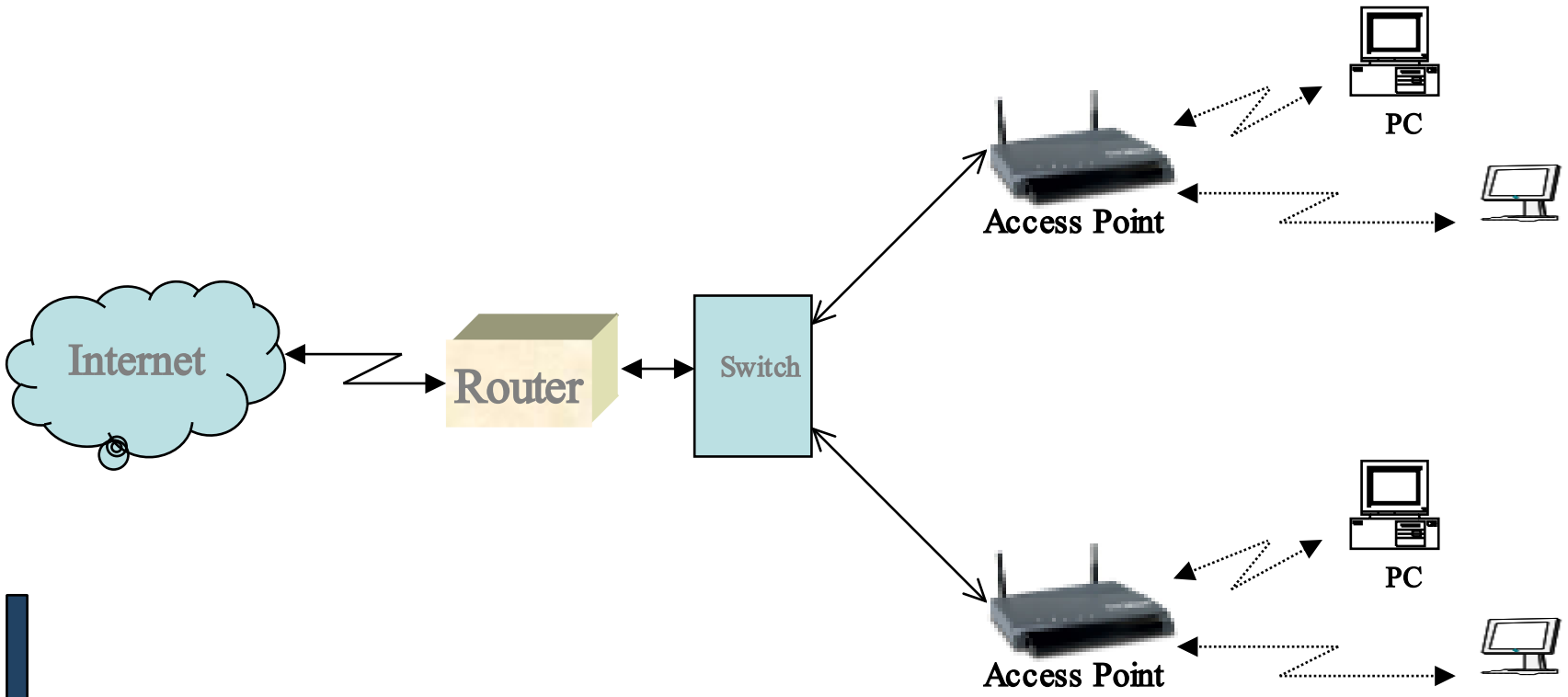
Wireless Media

- Indoor : 10 – 50m : BlueTooth, WLAN
- Short range Outdoor : 50 – 200m: WLAN
- Mid Range Outdoor : 200m – 5 Km : GSM, CDMA, WLAN Point-to-Point, Wi-Max
- Long Range Outdoor : 5 Km – 100 Km : Microwave Point-to-Point
- Long Distance Communication : Across Continents : Satellite Communication

Frequency Bands

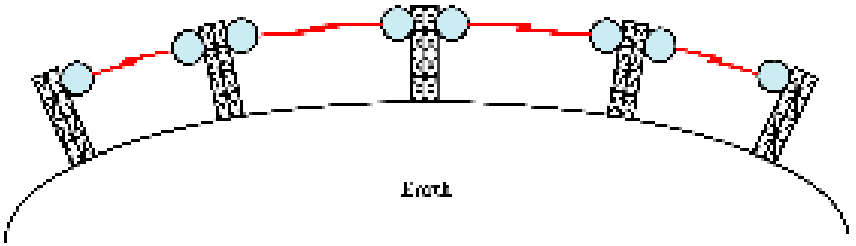
Band	Range	Propagation	Application
VLF	3–30 KHz	Ground	Long-range radio navigation
LF	30–300 KHz	Ground	Radio beacons and navigational locators
MF	300 KHz–3 MHz	Sky	AM radio
HF	3–30 MHz	Sky	Citizens band (CB), ship/aircraft communication
VHF	30–300 MHz	Sky and line-of-sight	VHF TV, FM radio
UHF	300 MHz–3 GHz	Line-of-sight	UHF TV, cellular phones, paging, satellite
SHF	3–30 GHz	Line-of-sight	Satellite communication
EHF	30–300 GHz	Line-of-sight	Long-range radio navigation

Wireless LAN



Terrestrial Microwave

- Microwaves do not follow the curvature of earth
- Line-of-Sight transmission
- Height allows the signal to travel farther
- Two frequencies for two way communication
- Repeater is used to increase the distance Hop-by-Hop



Satellite Communication

