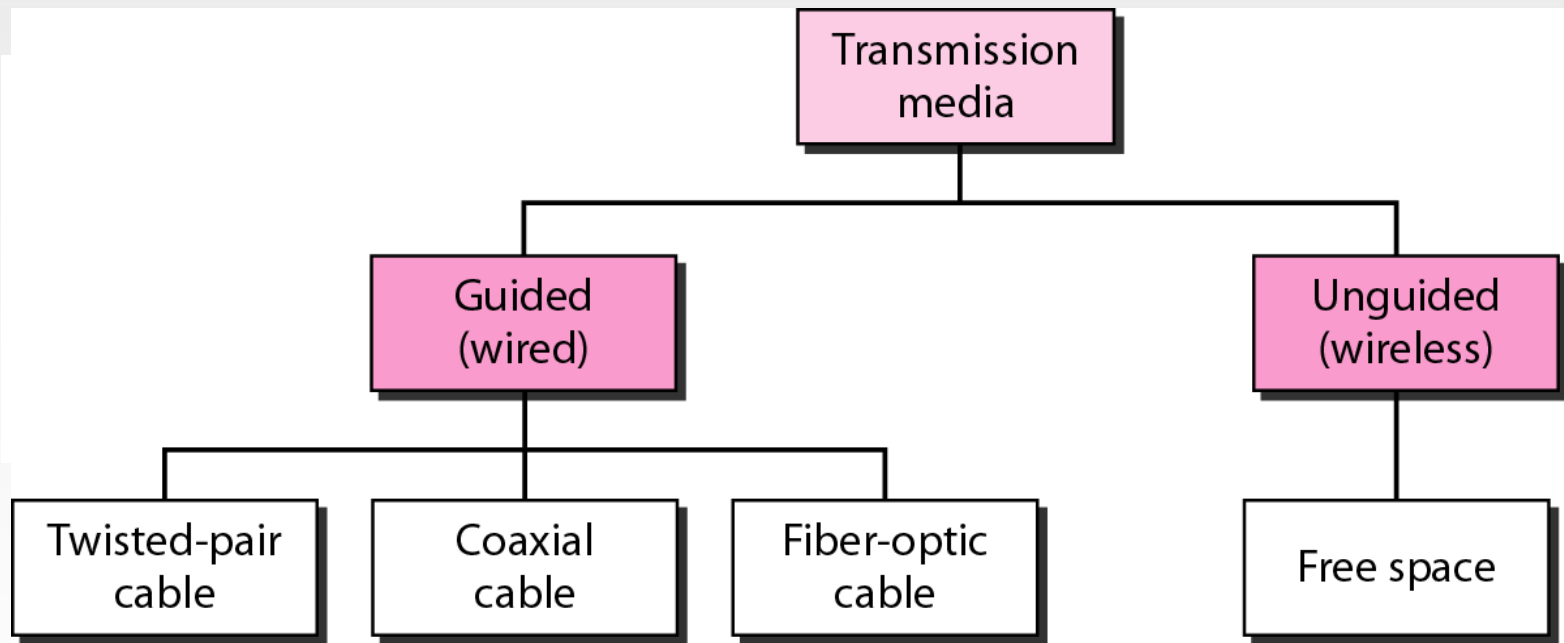


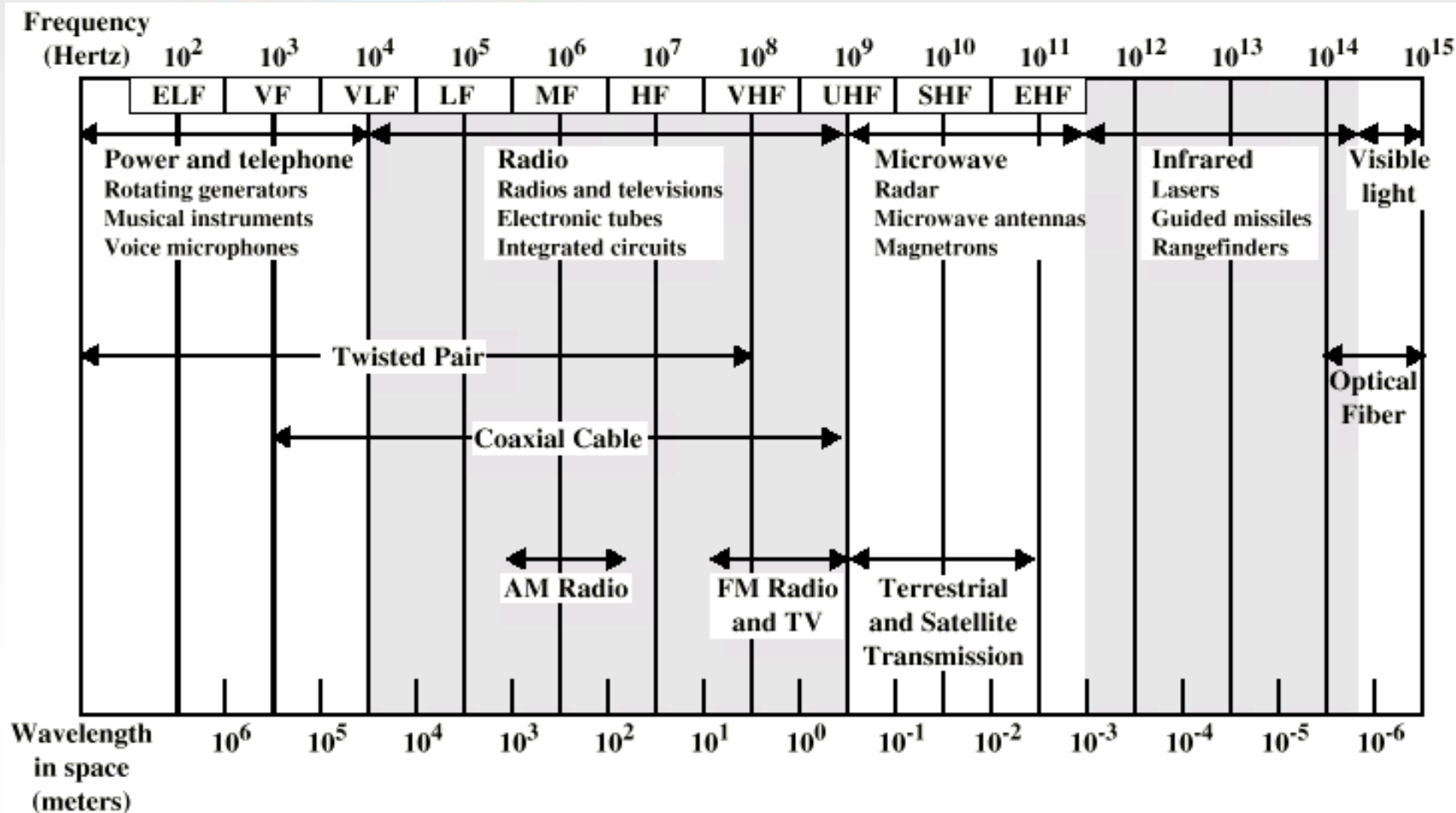
Transmission Media

Classes of Transmission Media:



- Guided or wired media provides a conduit from one device to another.
- Unguided or wireless media transports electromagnetic signals without using a physical conductor.

Electromagnetic Spectrum:



ELF = Extremely low frequency

VF = Voice frequency

VLF = Very low frequency

LF = Low frequency

MF = Medium frequency

HF = High frequency

VHF = Very high frequency

UHF = Ultrahigh frequency

SHF = Superhigh frequency

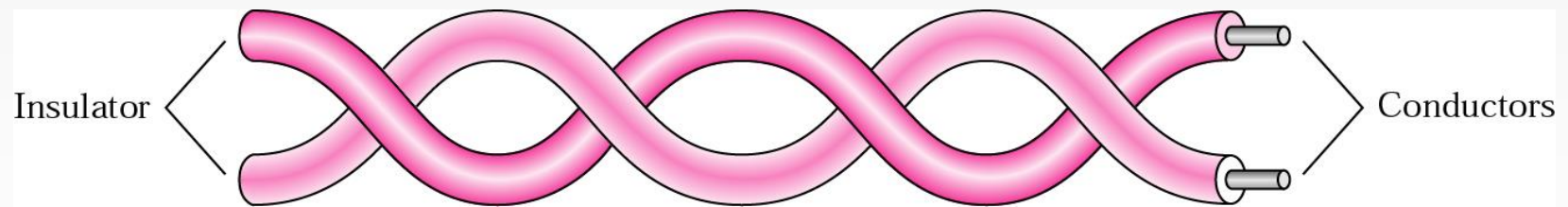
EHF = Extremely high frequency

Design Factors:

- Bandwidth
- Higher bandwidth gives higher data rate
- Transmission Impairments
- Attenuation
- Interference
- Number of Receivers

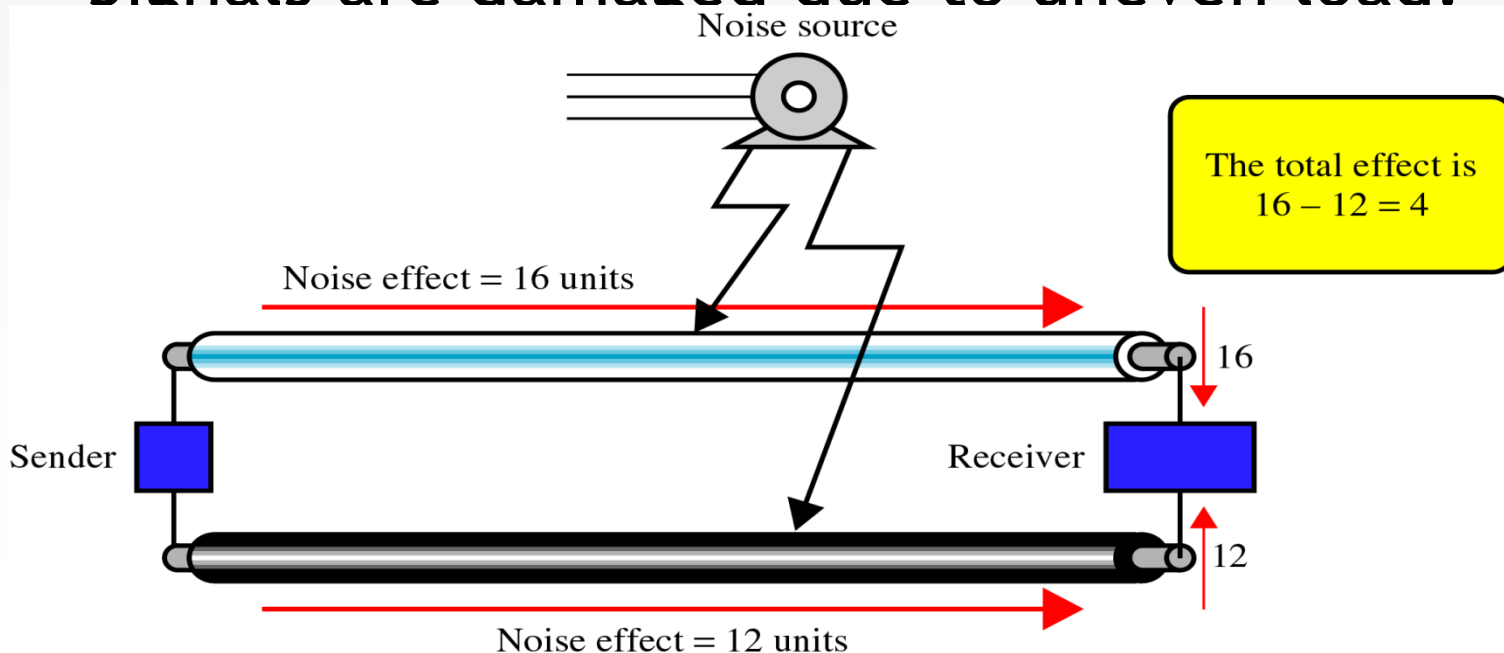
Twisted Pair:

- Consists of two copper conductors.
- Each surrounded by an insulating material.



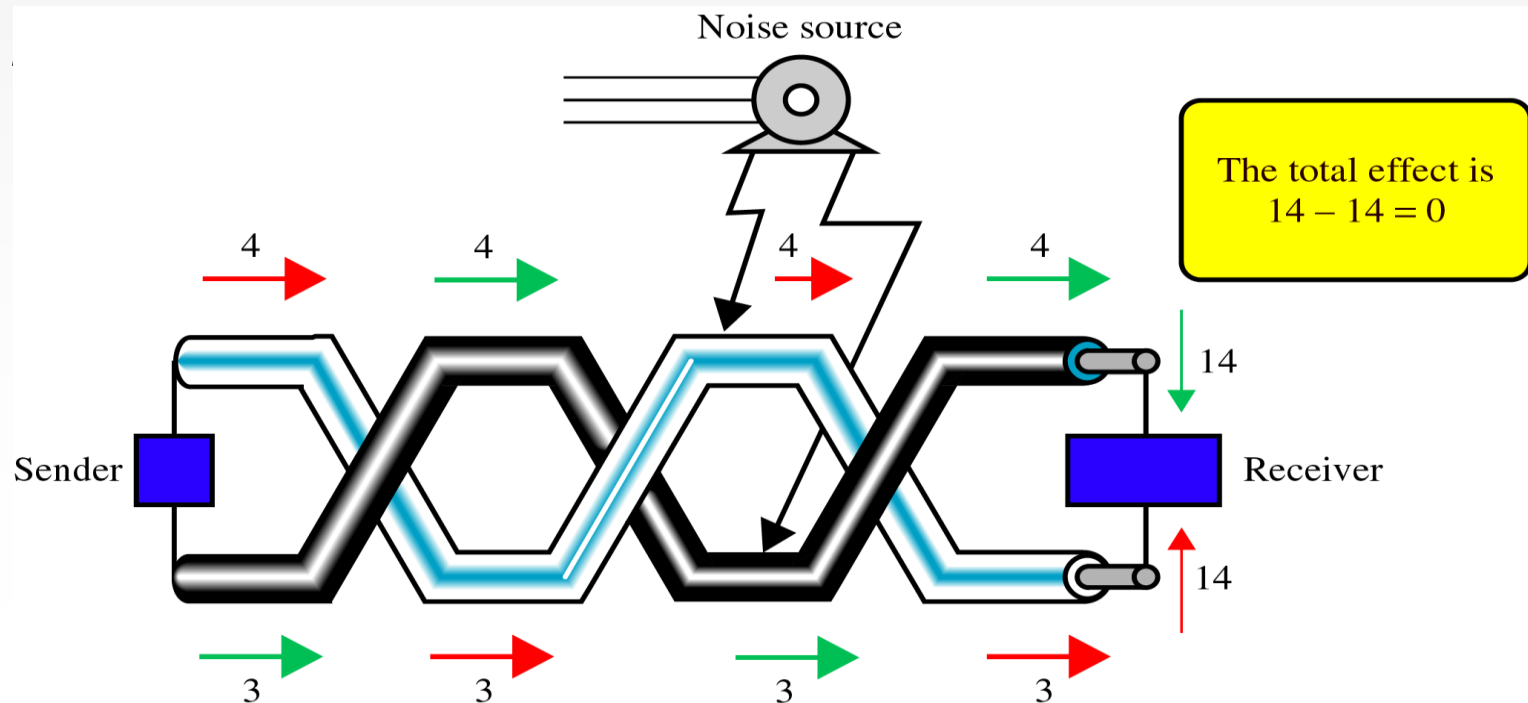
Why twisting the wires?

- Without twisting, we have two parallel wires:
 - Wire closest to the noise source is affected most by the noise source.
 - Signals are damaged due to uneven load.



Why twisting the wires?

- With twisting:
 - The cumulative effect of the interference is equal on both wires.



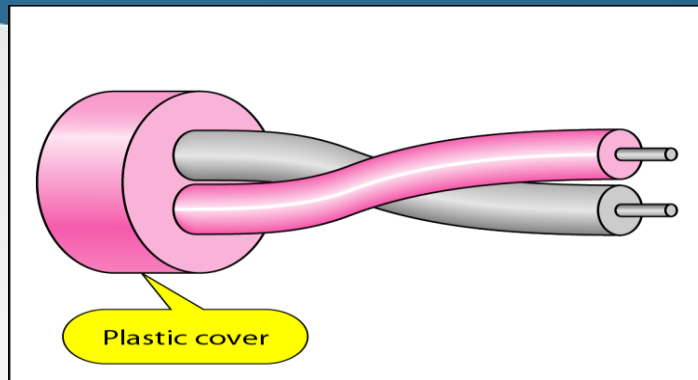
Twisted Pair: Transmission Characteristics

- **Limited Distance:**
 - Analog
 - Amplifiers every 5 km to 6 km
 - Digital
 - Repeater every 2 km or 3 km
- **Limited Bandwidth**
- **Susceptible to Interference and Noise**

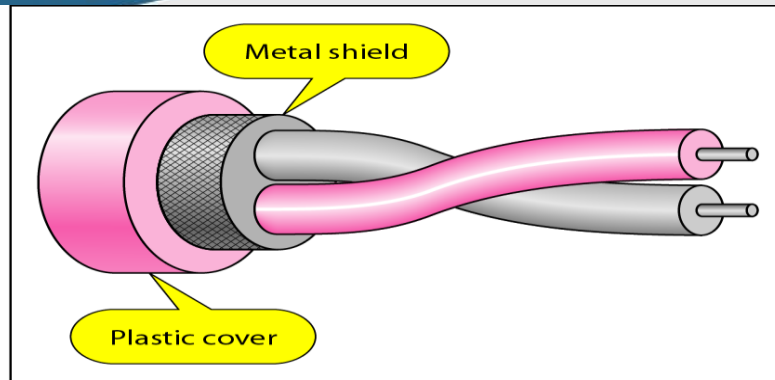
Twisted Pair - Applications:

- **Most Common Medium**
- **Telephone Network**
 - Between house and local exchange (subscriber loop)
- **Within Buildings**
 - To private branch exchange (PBX)
- **For Local Area Networks (LAN)**

Unshielded and Shielded TP:



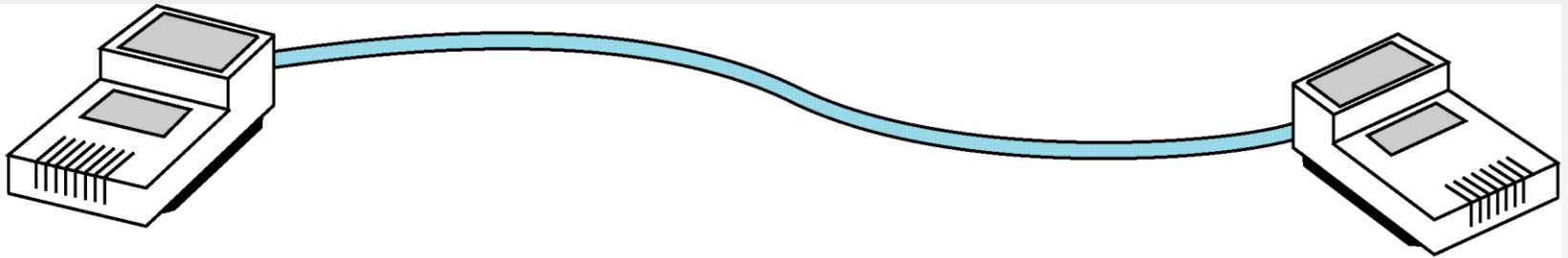
a. UTP



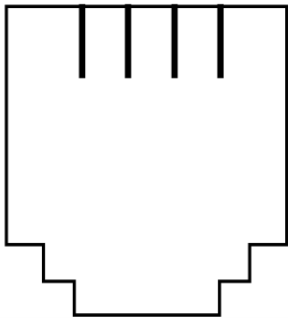
b. STP

- **Unshielded Twisted Pair (UTP)**
 - Ordinary telephone wire
 - Cheapest
 - Easiest to install
 - Suffers from external EM interference
- **Shielded Twisted Pair (STP)**
 - Metal braid or sheathing that reduces interference
 - More expensive
 - Harder to handle (thick, heavy)

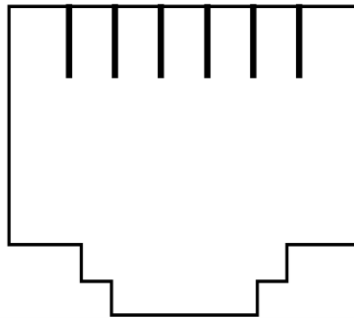
UTP Connectors:



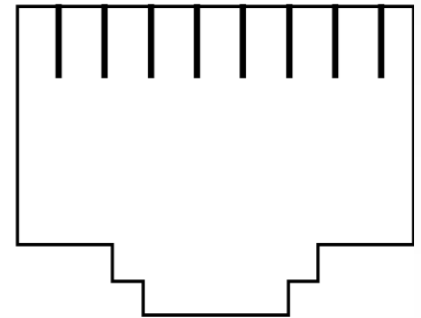
4-conductor



6-conductor



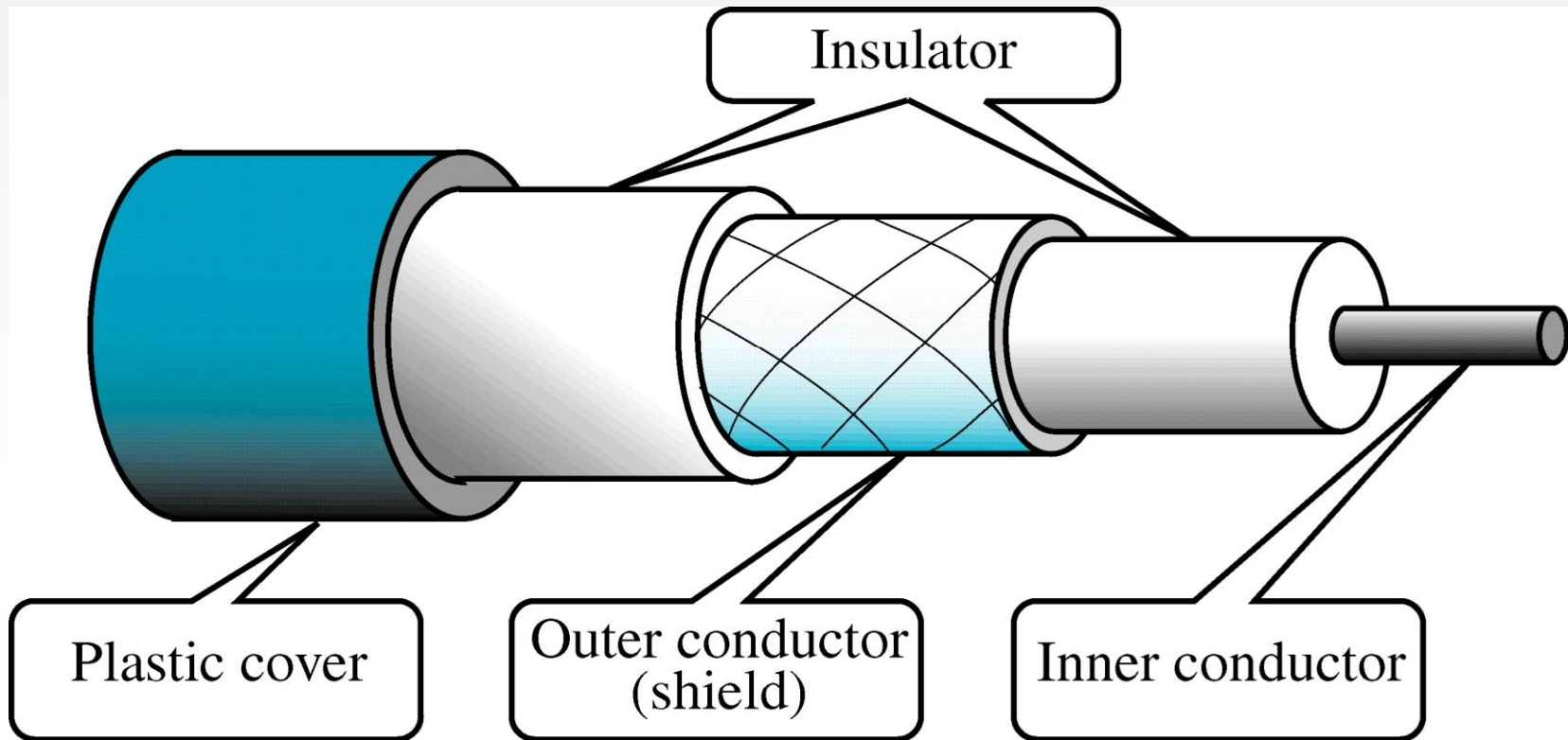
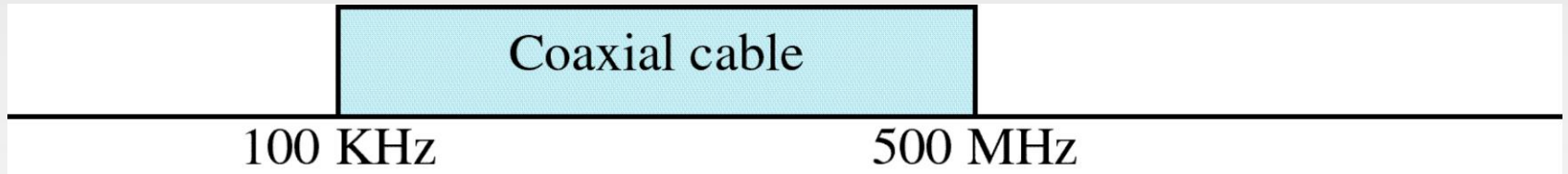
8-conductor



UTP Categories:

<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

Coaxial Cable:



Coaxial Cable Applications:

- **Television Distribution**
 - Aerial to TV
 - Cable TV
- **Long Distance Telephone Transmission**
 - Can carry 10,000 voice calls simultaneously
 - Nowadays, replaced by fiber optic
- **Short Distance Computer Systems Links**
- **Local Area Networks**

Coaxial Cable Categories:

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

Optical Fiber:

- **Greater capacity**
 - Data rates of hundreds of Gbps
- **Lower attenuation**
- **Smaller size & weight**
- **Electromagnetic Isolation**
- **Greater Repeater Spacing**
 - More than 40 km

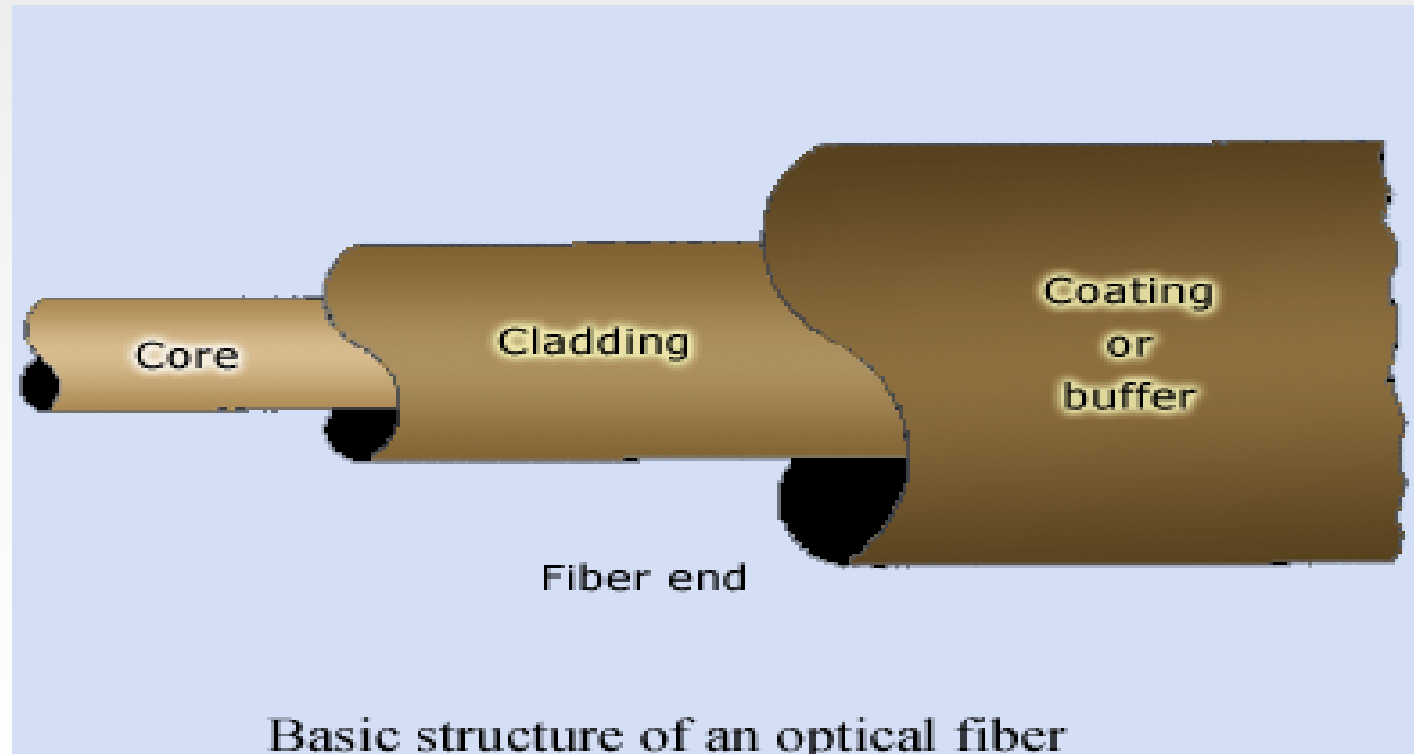
Optical Fiber - Applications:

- Long-haul trunks
- Metropolitan trunks
- Rural exchange trunks
- Subscriber loops
- LANs

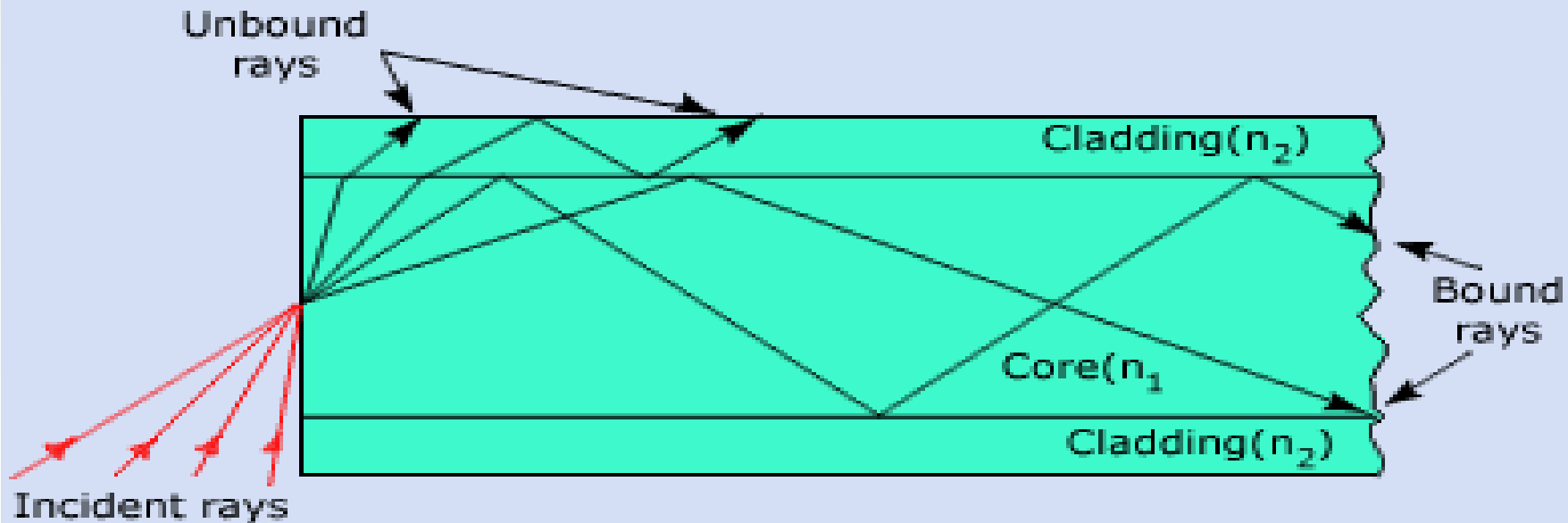
Optical Fiber:

- **Based on total internal reflection**
- **For Communication, main components required:**
 - **Driving Circuit**
 - **Optical Source**
 - **Optical Connectors**
 - **Optical Detector**
 - **Electronic Receiver**

Optical Fiber: A waveguide:

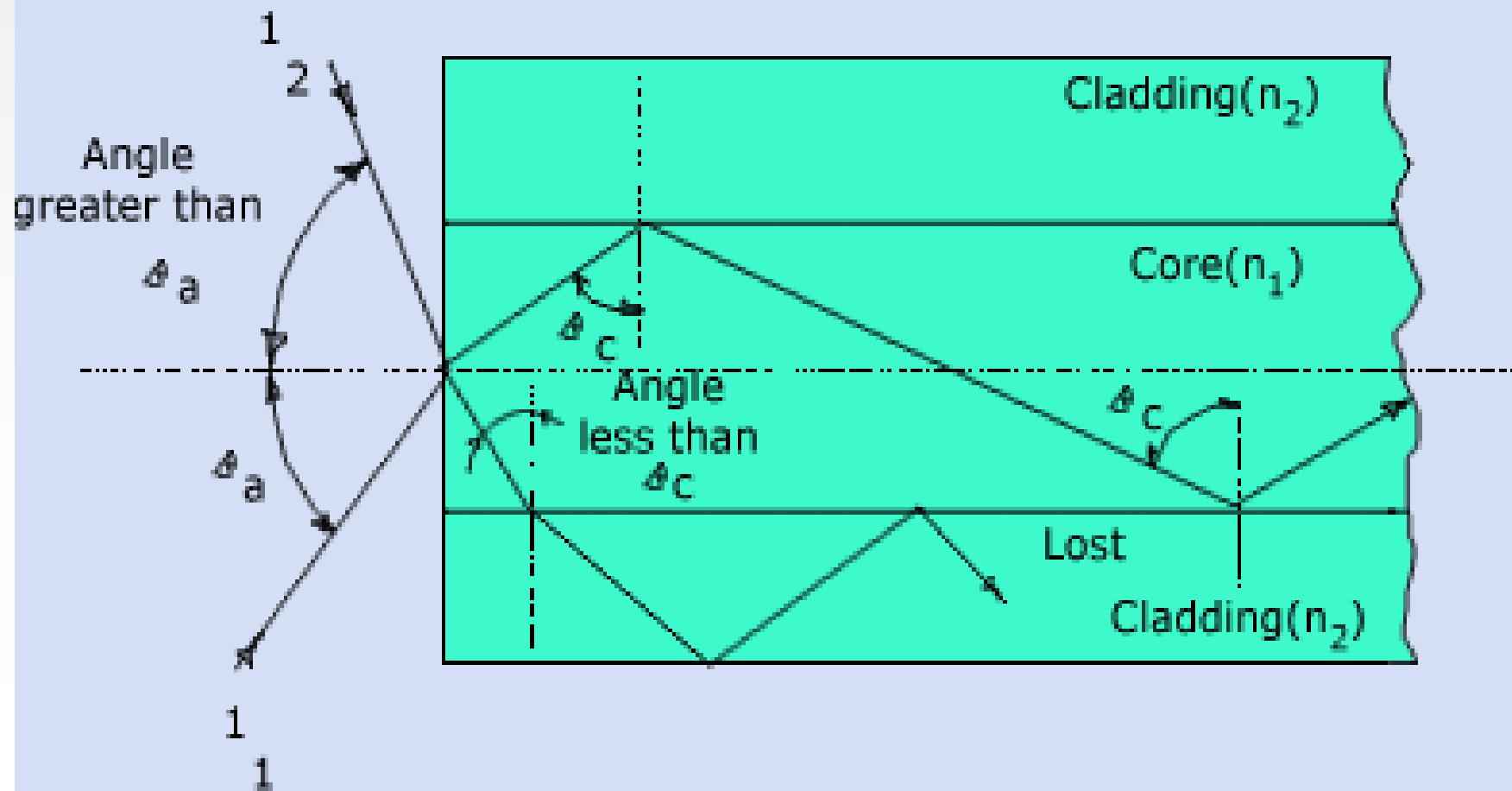


Light Propagation:

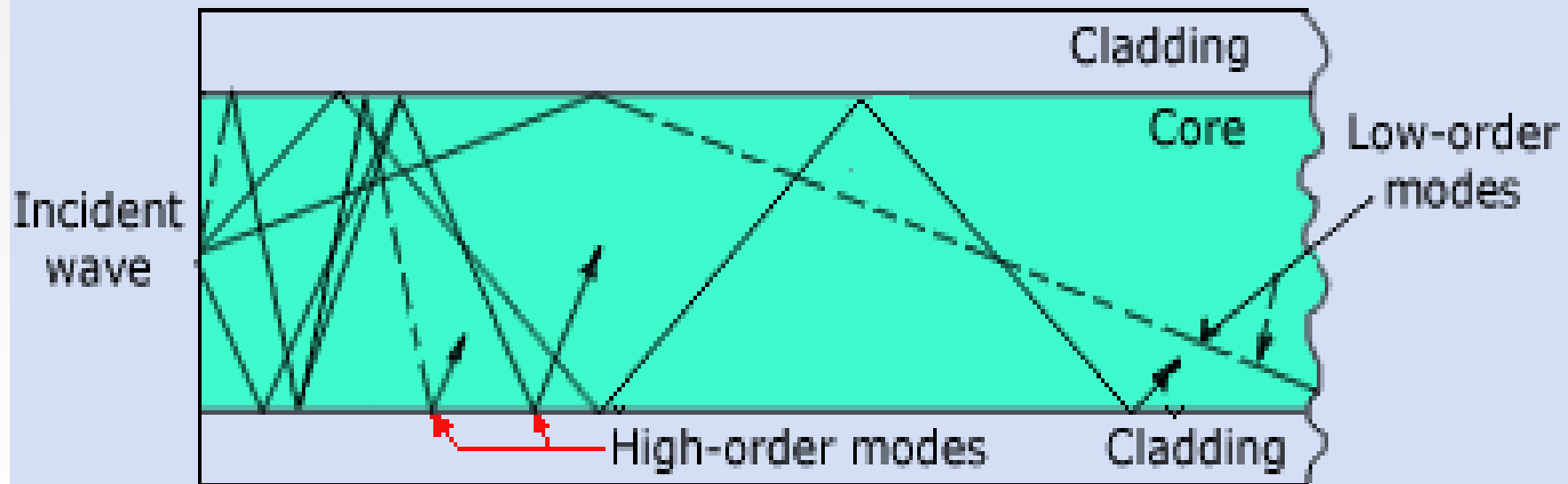


Bound and unbound rays in a step-index fiber

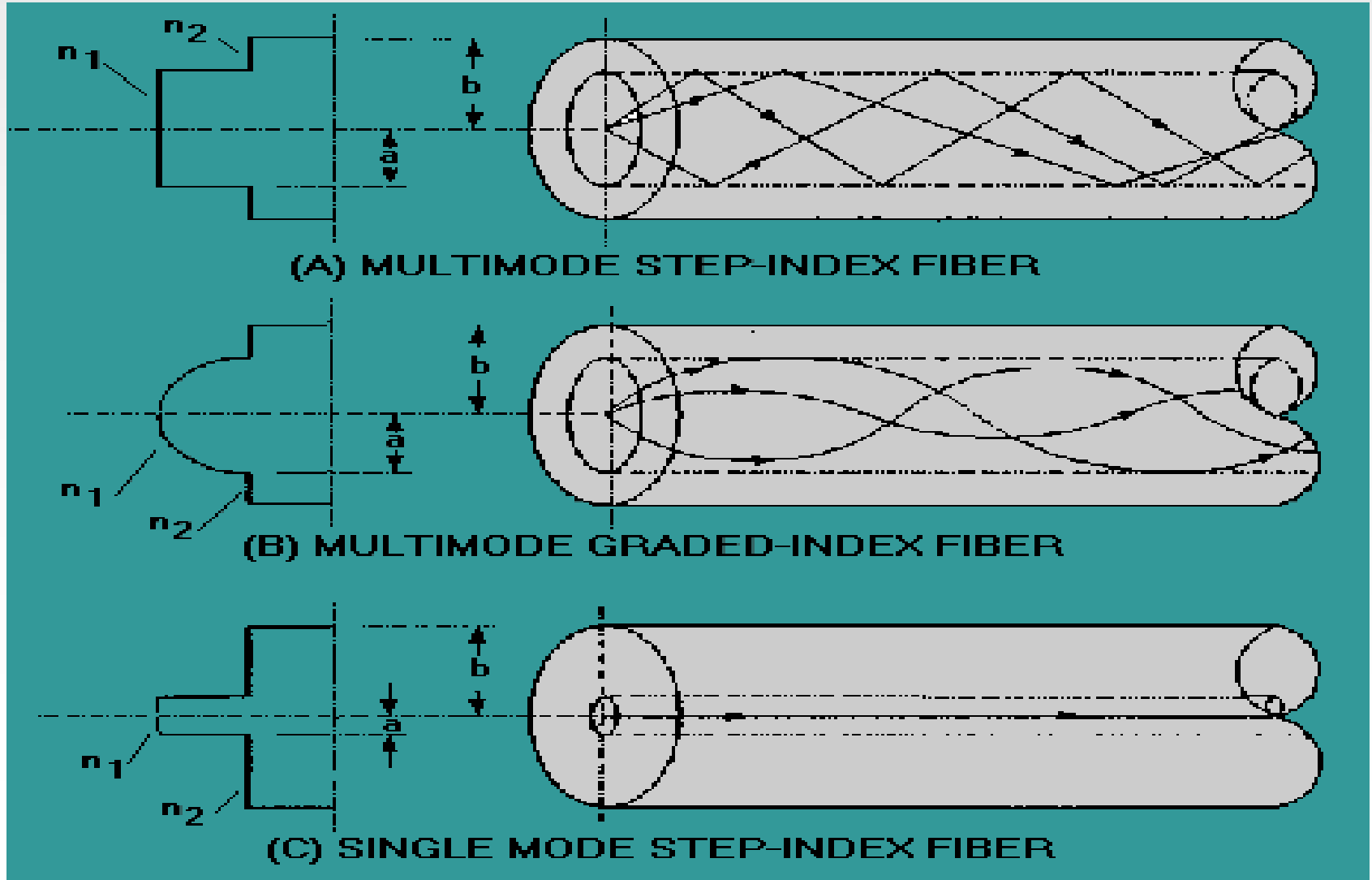
Light Propagation:



Light Propagation:

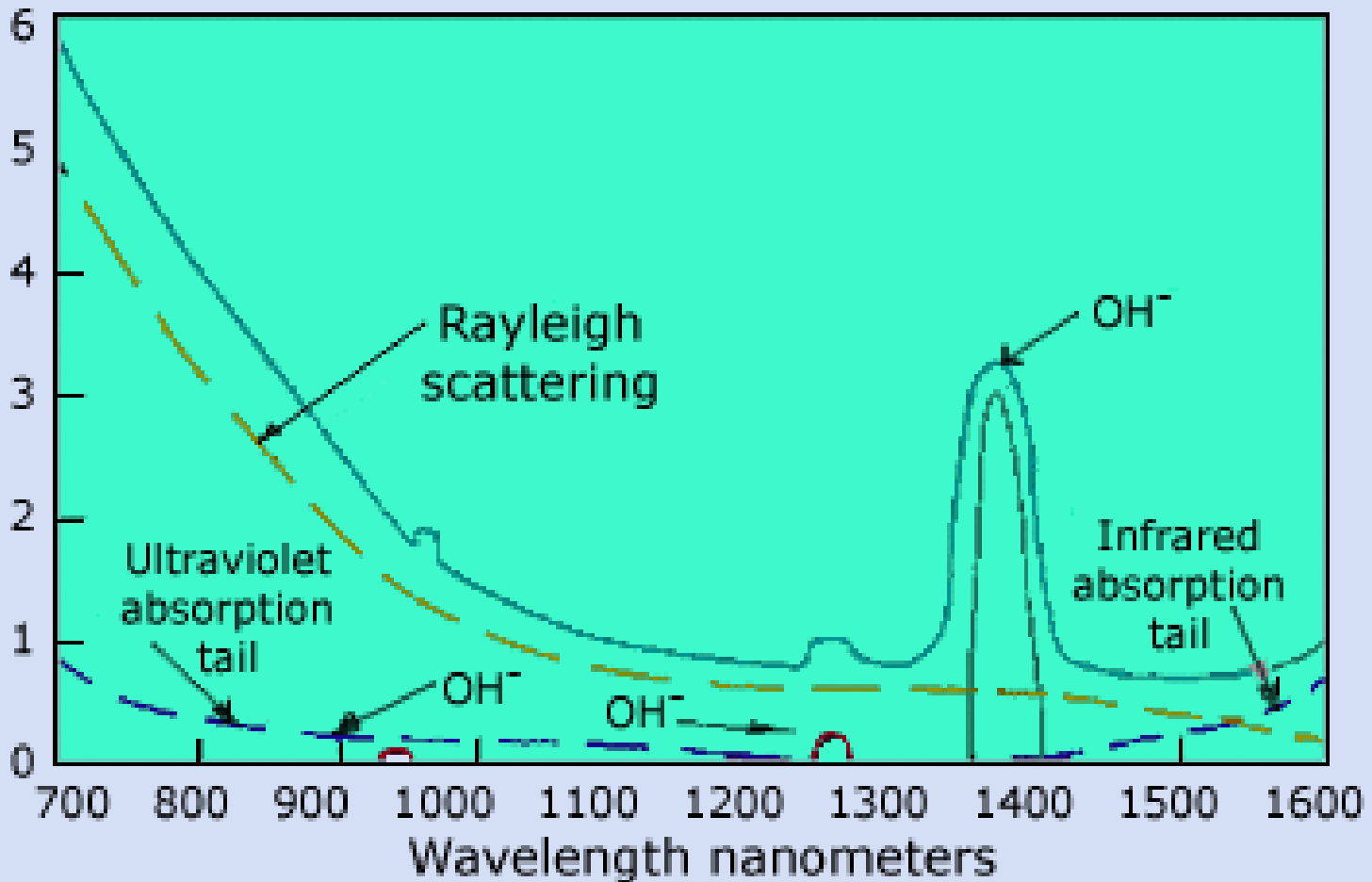


Optical Fiber Structures:

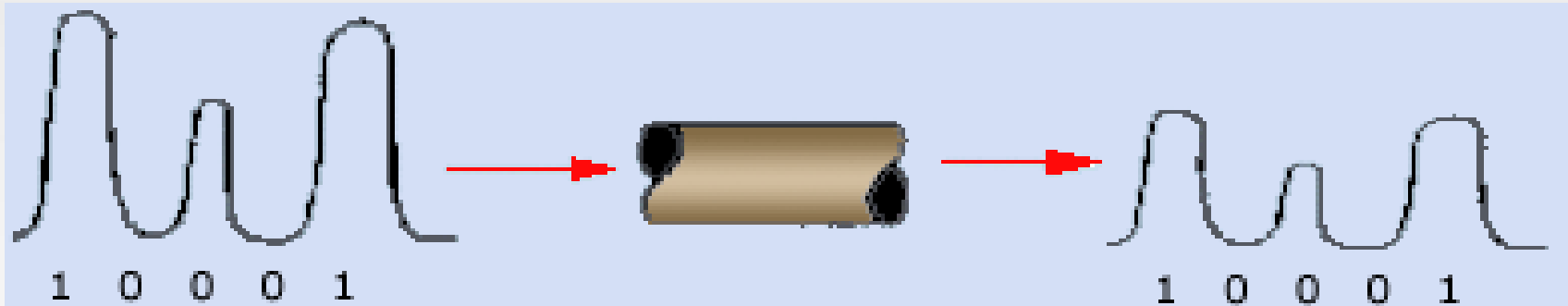


Transmission Characteristics:

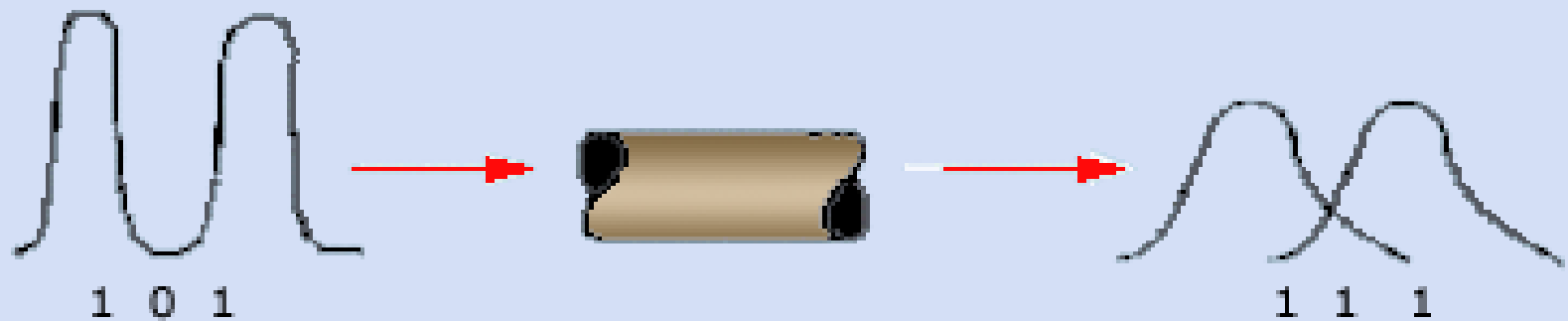
Attenuation dB/km



Dispersion in Optical Fiber:



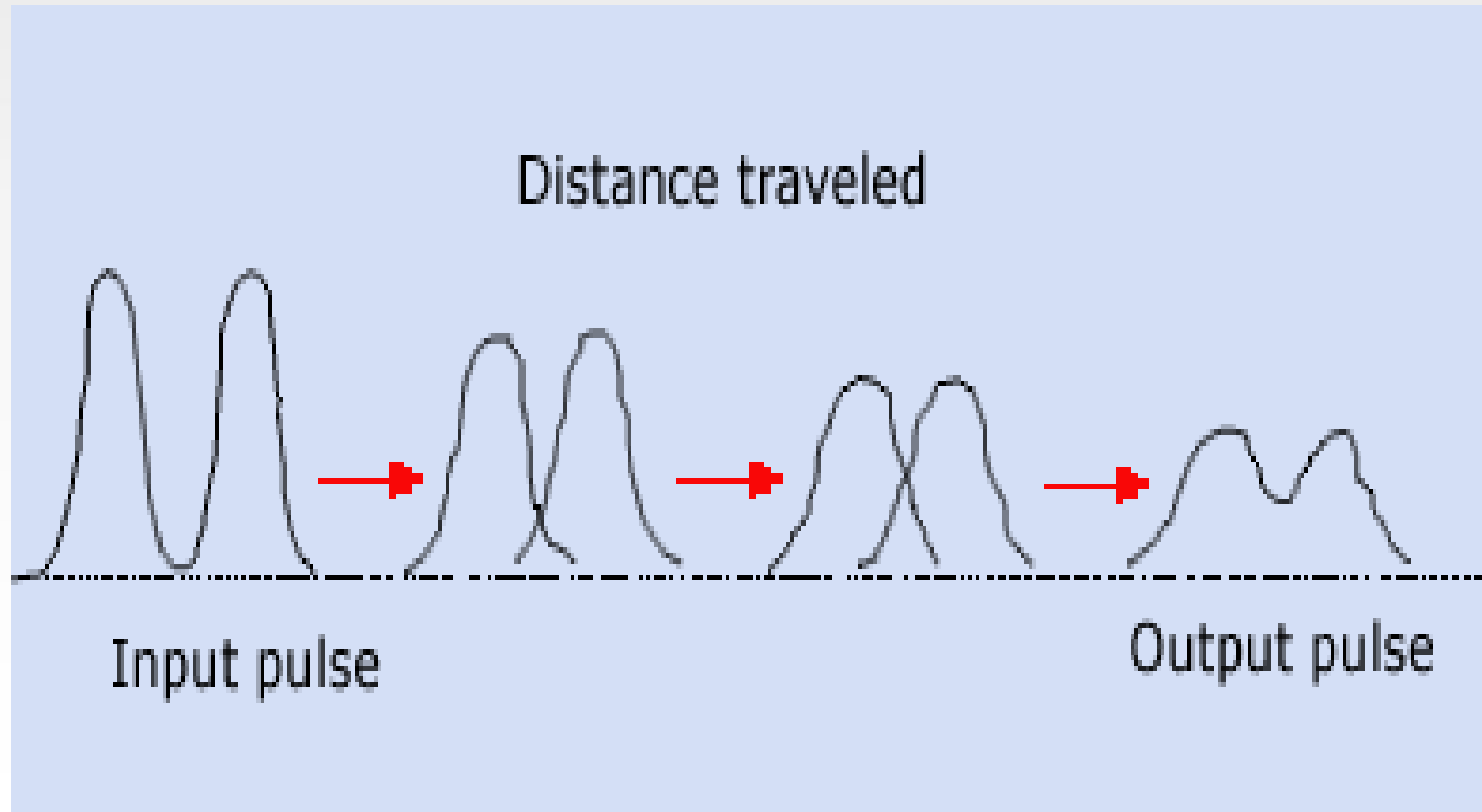
Attenuation-Reduces power



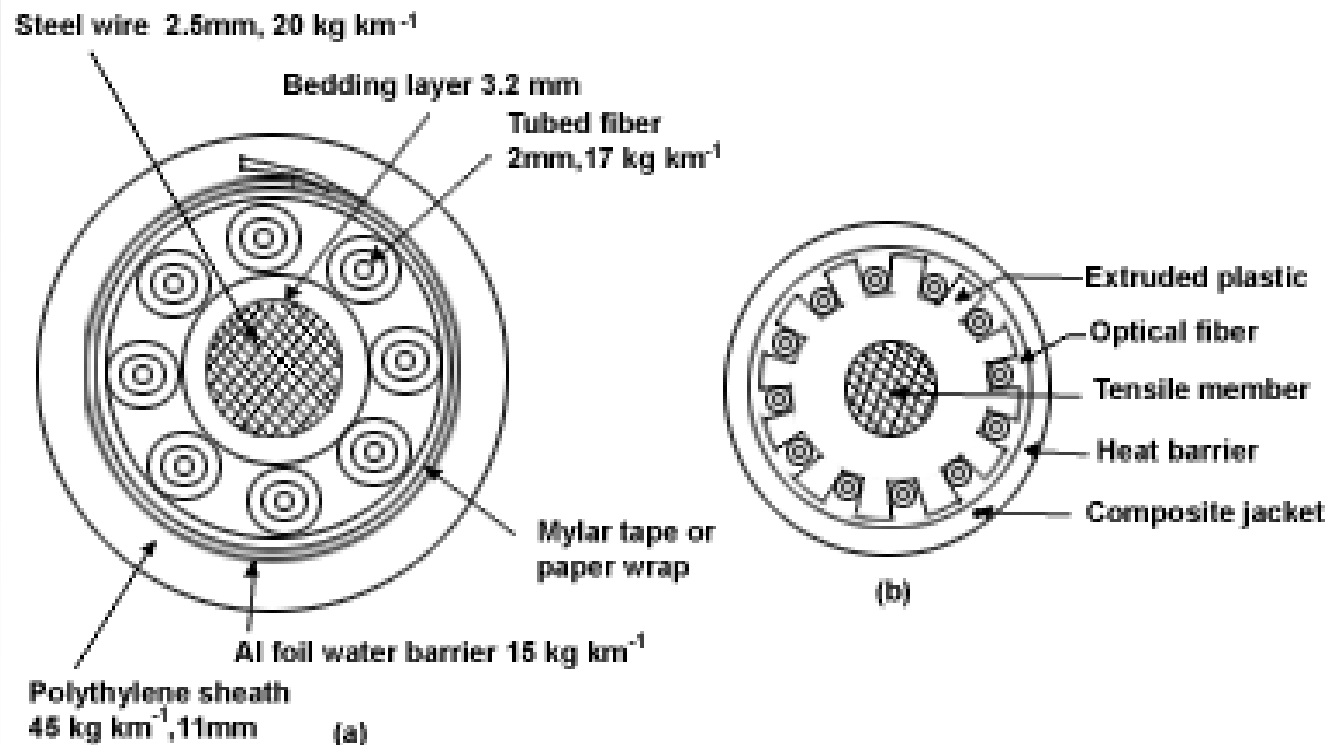
Dispersion - Spreads The Pulse

Fiber transmission properties

ISI in Digital Communication:



Cable Design:

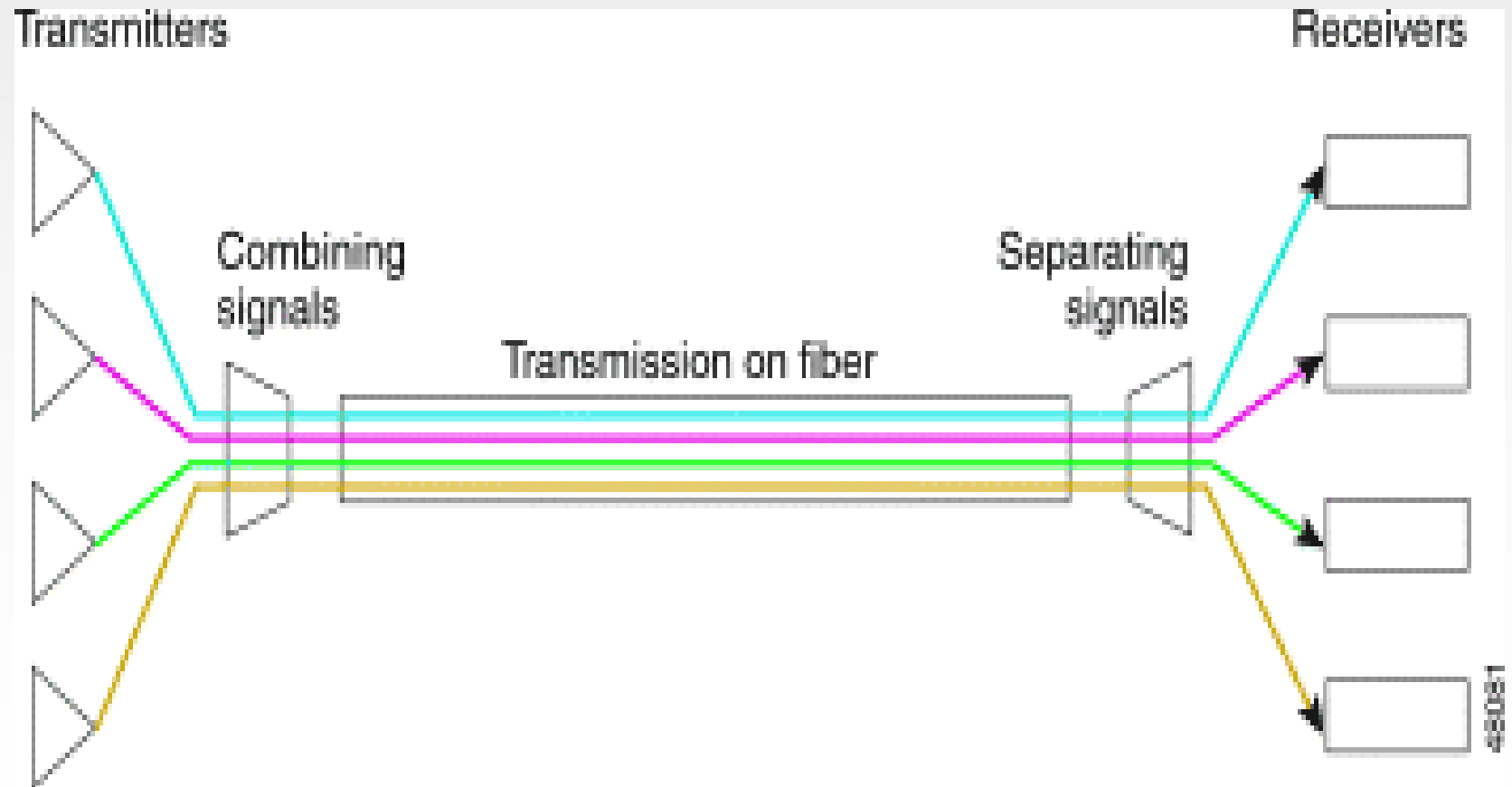


Structural and strength members in optical fiber cables:

(a) central steel wire structural and strength member [Ref.58];

(b) Northern Telecom unit core cable with central steel strength member and extruded plastic structural member [Ref.69].

Wavelength Division Multiplexing:



Wireless Transmission:

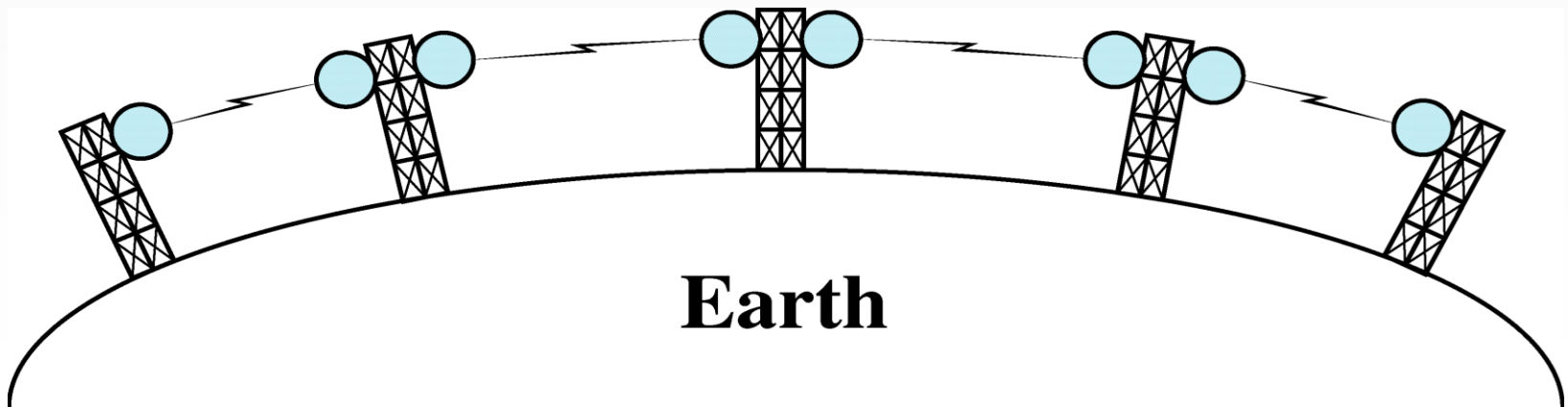
- **Unguided media**
- **Transmission and reception via antenna**
- **Directional**
 - Focused beam
 - Careful alignment required
- **Omnidirectional**
 - Signal spreads in all directions
 - Can be received by many antenna's

Frequencies:

- **2 GHz to 40 GHz**
 - Microwave
 - Highly directional
 - Point to point
 - Satellite
- **30 MHz to 1 GHz**
 - Omnidirectional
 - Broadcast radio
- **3×10^{11} to 2×10^{14}**
 - Infrared
 - Local Use

Terrestrial Microwave:

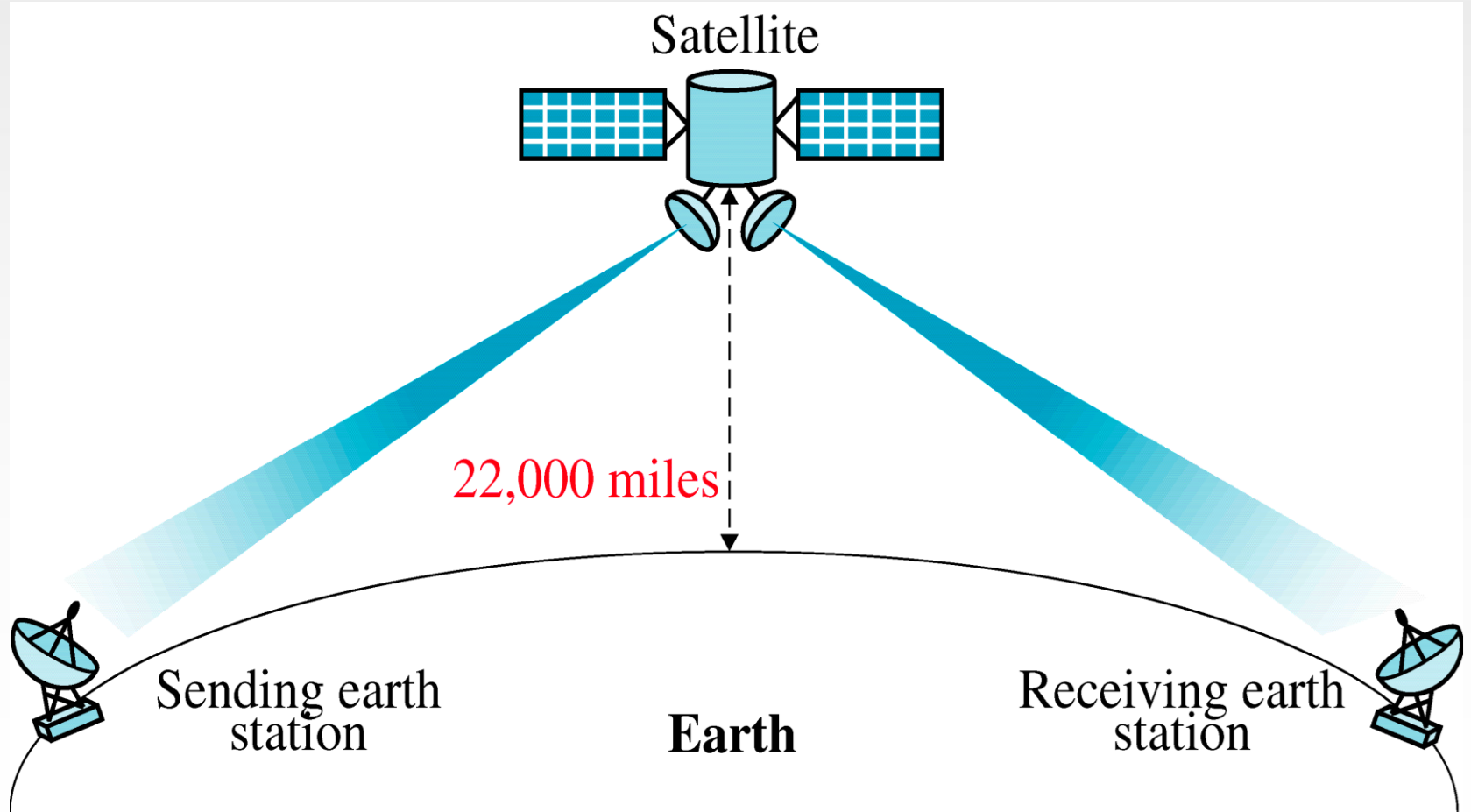
- Parabolic dish
- Focused beam
- Line of sight
- Long haul communications



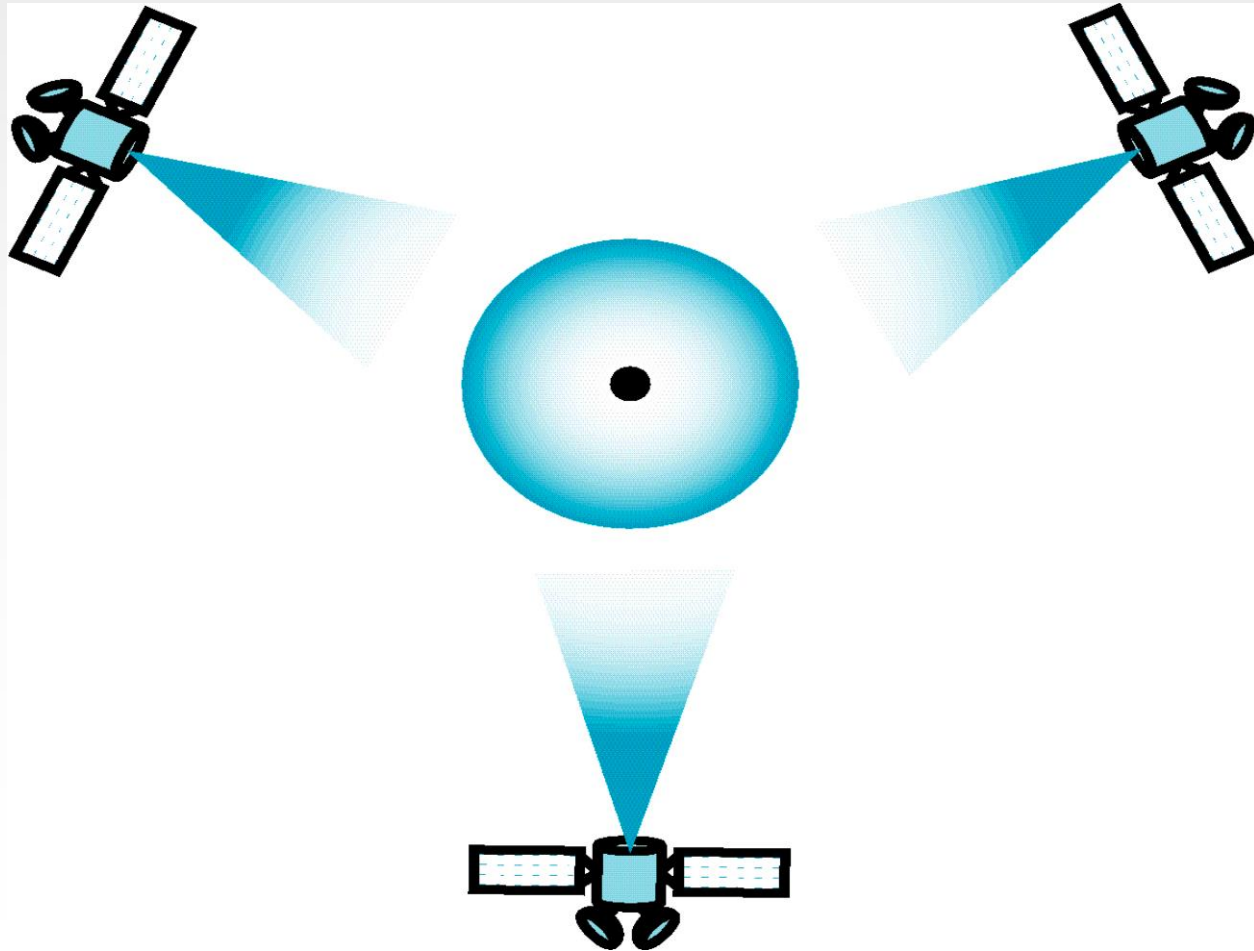
Satellite Microwave:

- Satellite is relay station
- Satellite receives on one frequency, amplifies or repeats signal and transmits on another frequency
- Requires geo-stationary orbit
 - Height of 35,784km
- Television
- Long distance telephone
- Private business networks

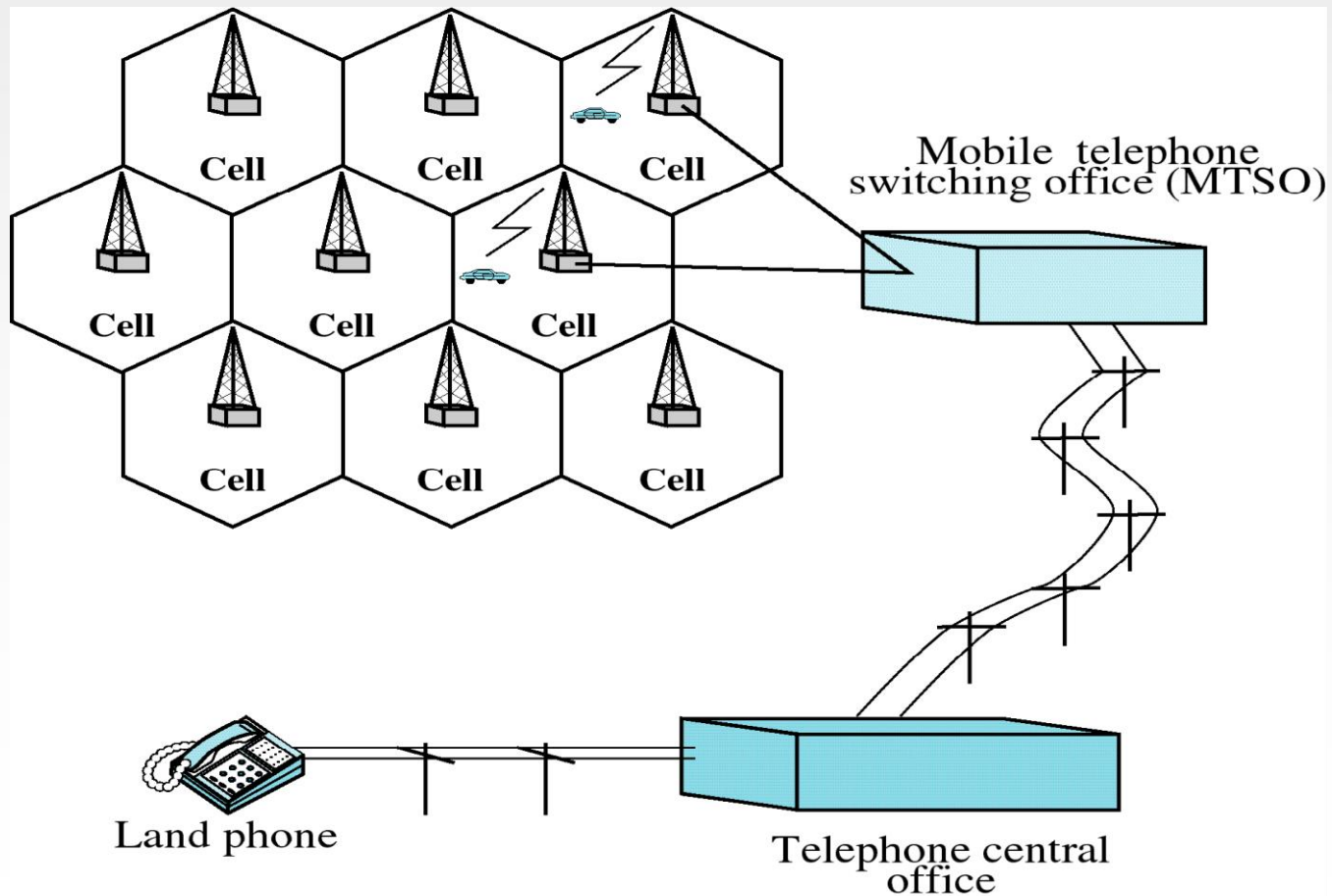
Satellite Communication:



Geosynchronous Orbit:



Cellular System:



Broadcast Radio:

- Omnidirectional
- FM radio
- Line of sight
- Suffers from multipath interference
 - Reflections

Unguided Optical Systems:

- Modulate optical signal (light)
- Line of sight (or reflection)
- Blocked by walls
- e.g. TV remote control, Blue tooth

Required Reading:

- Data and Computer Communication: Stallings Chapter 4
- Data and Computer Networking: B. Forouzan