SWE 411:Computer Networks

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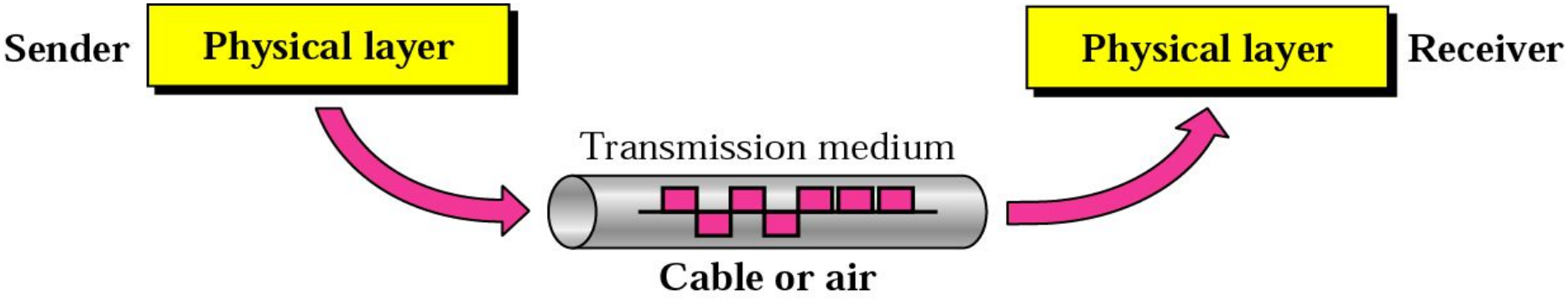
Transmission Media

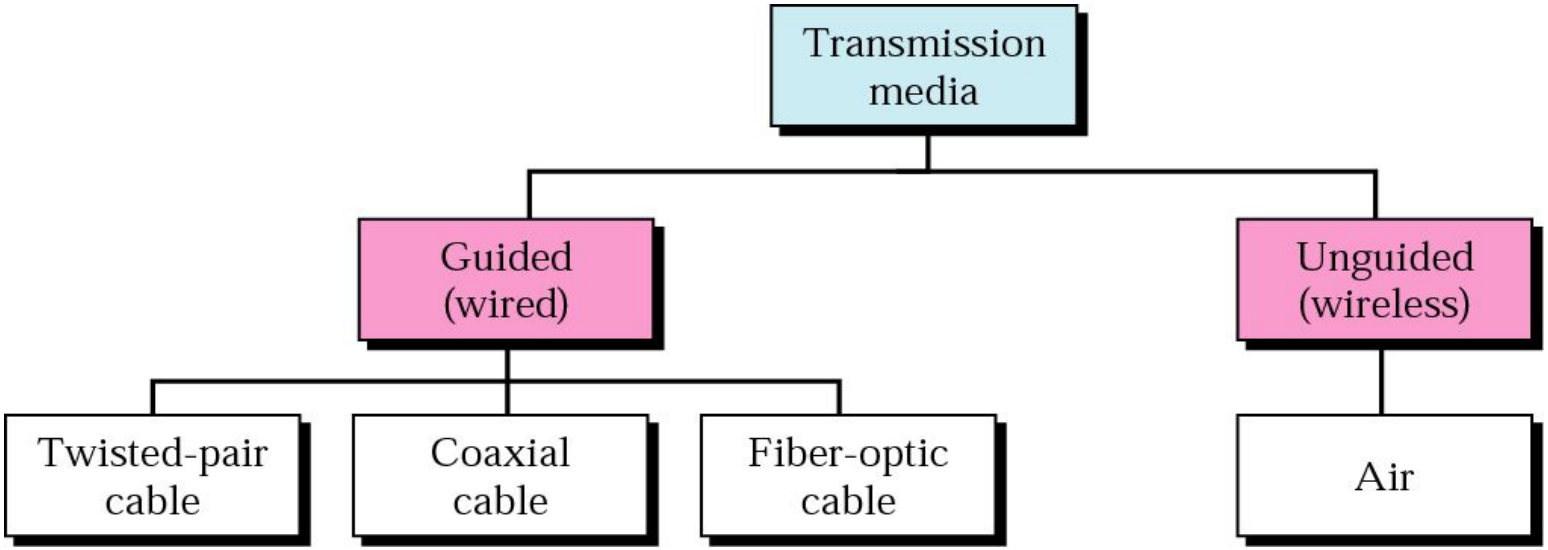
Overview:

- Guided media – provide a physical path (wire)
- Unguided – employ an antenna for transmission (wireless)
- Characteristics and quality determined by medium and signal
  - For guided, the **medium** is more important in determining the limitations on transmission.
  - For unguided, the **bandwidth** produced by the **antenna** is more important
- Key concerns are data rate and distance
  - The greater the data rate in greater distance is the better.


Sender
Physical layer
Physical layer
Receiver
Transmission medium
Cable or air

Design Factors:

- Bandwidth
  - Higher bandwidth gives higher data rate
- Transmission impairments
  - Attenuation, limit the distance.
- Interference
  - From competing signals in overlapping frequency bands.
  - Particular concern for unguided media. Also a problem with guided media.
- Number of receivers
  - In guided media, a shared link with multiple attachments.
  - Each attachment introduce some attenuation


Transmission media
Guided (wired)
Unguided (wireless)
Twisted-pair cable
Coaxial cable
Fiber-optic cable
Air

Guided Media

Twisted-Pair Cable

Coaxial Cable

Fiber-Optic Cable

Twisted-Pair Cable:

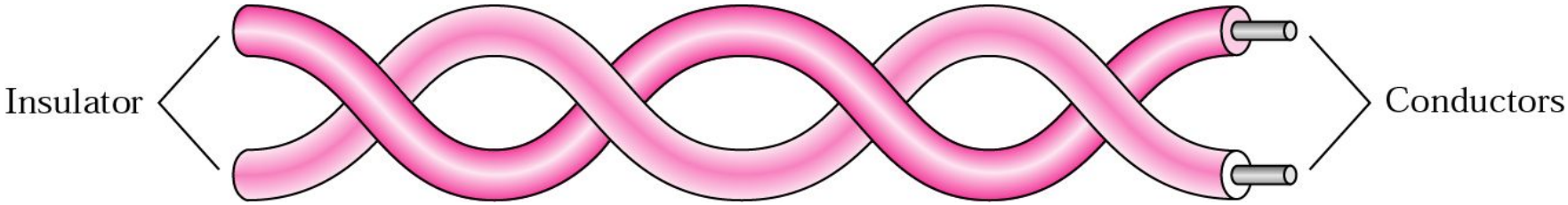
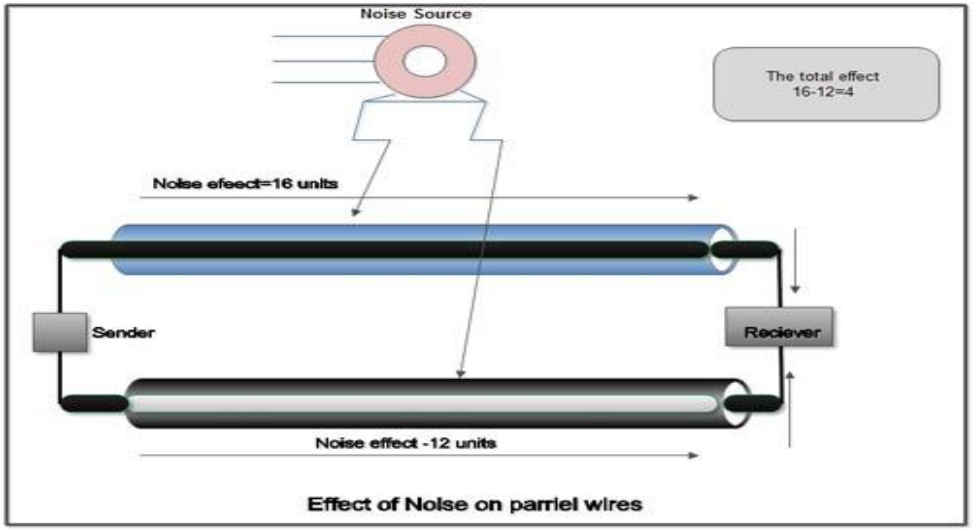


Figure: ***Twisted-pair cable***

Noise effect on twisted pair cable



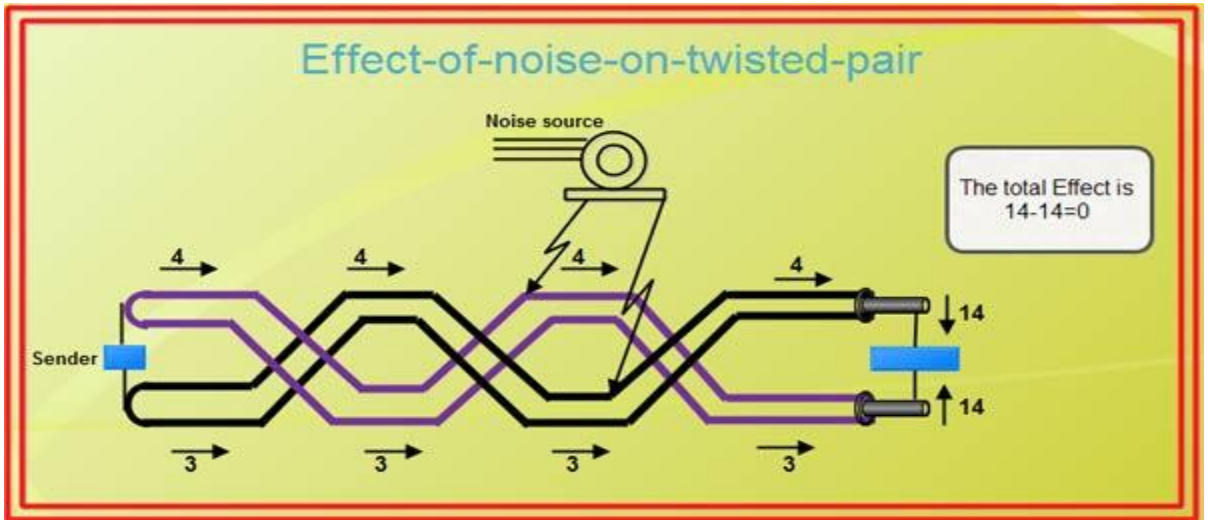
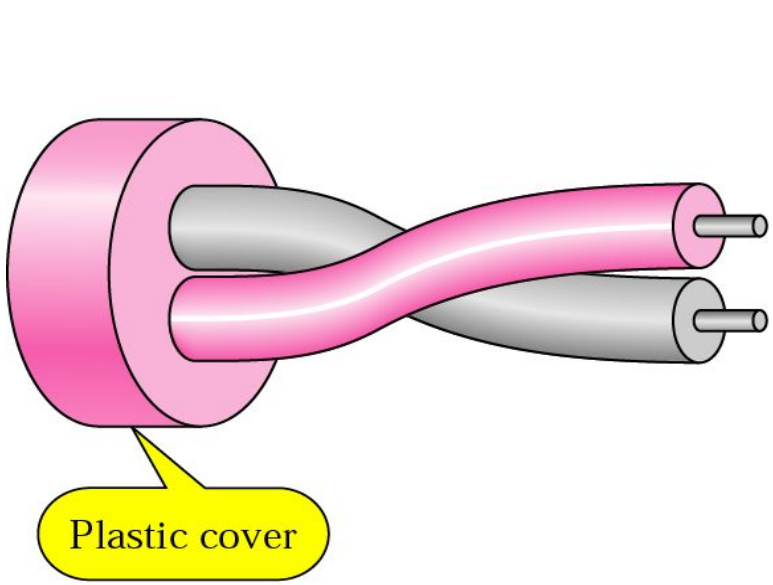
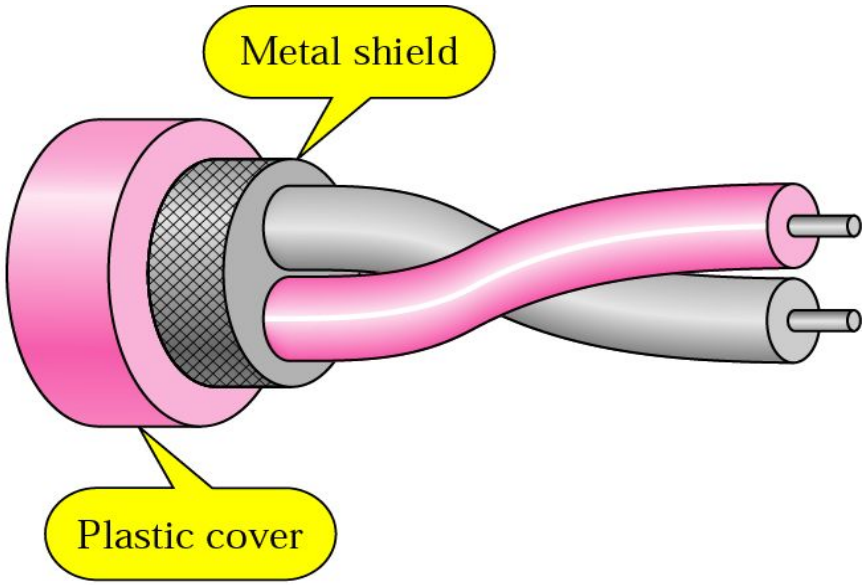


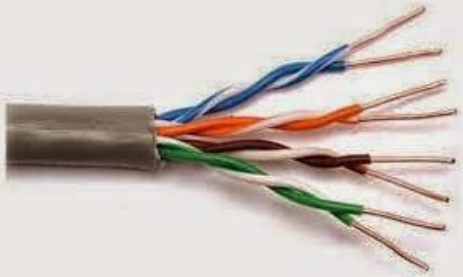
Figure 7.4



a. UTP



b. STP

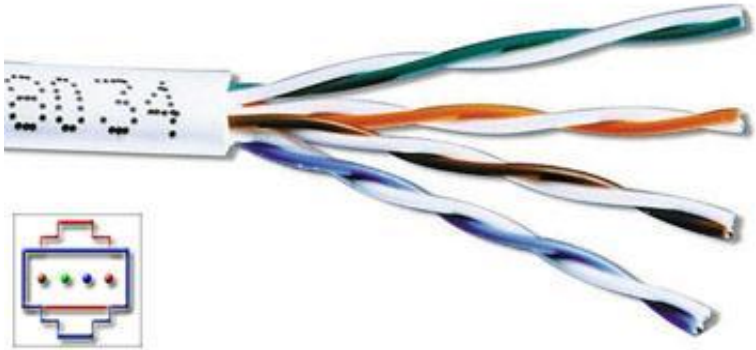


UTP Cable

STP Cable

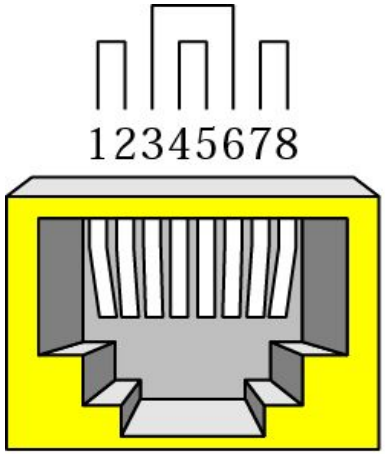
Shielded twisted pair (STP)

Unshielded twisted pair (UTP)

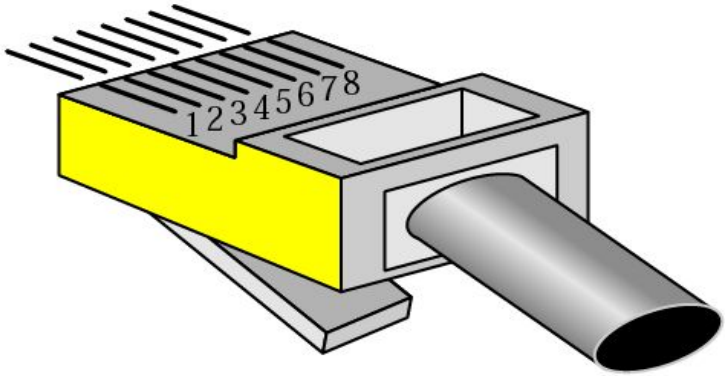


Twisted Pair : Characteristics

- Shielding and twisting reduce interference.
- May be used for analog and digital transmission.
  - Analog: amplifiers every 5km to 6km
  - Digital:
    - Repeater every 2km or 3km
- Twisted pair is limited in distance, bandwidth (1MHz) and data rate (100Mbps).
- Susceptible to interference and noise:
  - Easy coupling with electromagnetic fields.
  - Impulse noise also introduces into twisted pair.



RJ-45 Female



RJ-45 Male

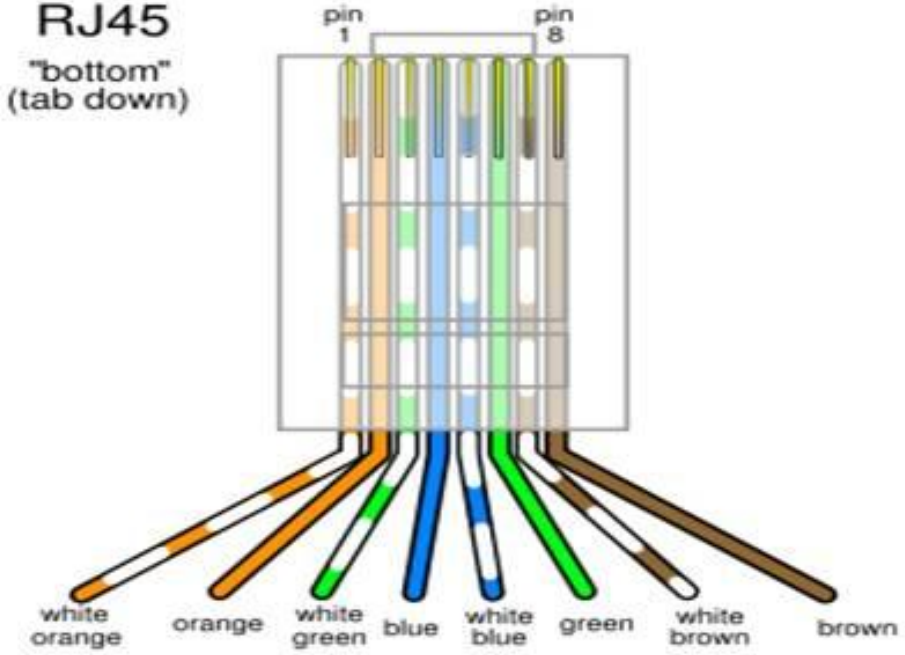


Table: Categories of unshielded twisted-pair cables

Type	No of Pairs	Transmission Rate	Implementation
Category 1	1	Voice Grade	• used in telephone industry • not suitable for long distance data transmission(used only for short distance)
Category 2	2	4 Mbps	• used for both data and voice transmission
Category 3	4	10 Mbps	• required 3 twist per foot • used for 10 base networks. • used for voice • communication
Category 4	4	16 Mbps	• required 3 twist per foot • used in IBM token ring networks
Category 5	4	100 Mbps	• used in Ethernet and 100 Base-X networks
Category 6	4	100 Mbps and higher	• used in Ethernet and 1000 Base-X networks

Twisted Pair: Adv. and Disadv.

- Advantages
  ~ inexpensive and readily available
  ~ flexible and light weight
  ~ easy to work with and install
  ~ reduce interference and noise
- Disadvantages
  ~attenuation problem
  for analog, amplifiers needed every 5-6km
  for digital, repeaters needed every 2-3km
  ~ relatively low bandwidth

Coaxial cable

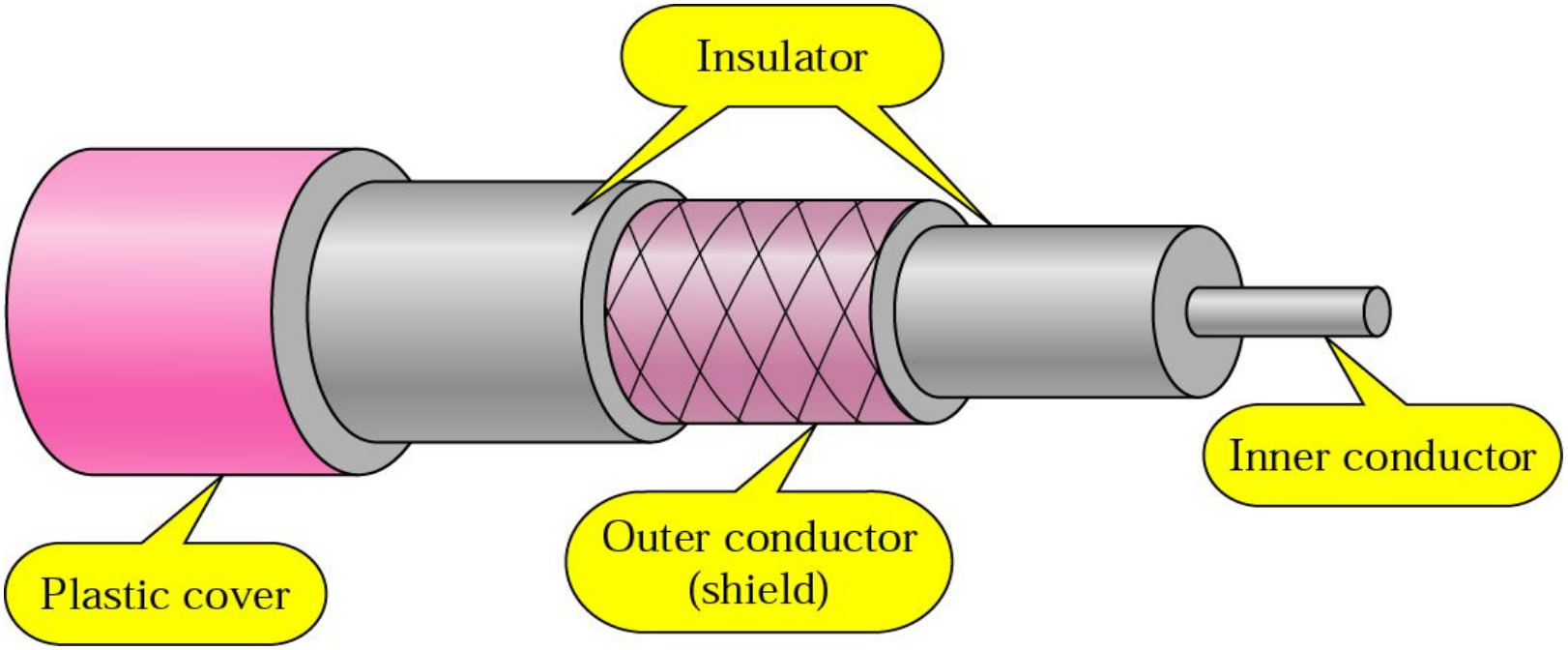
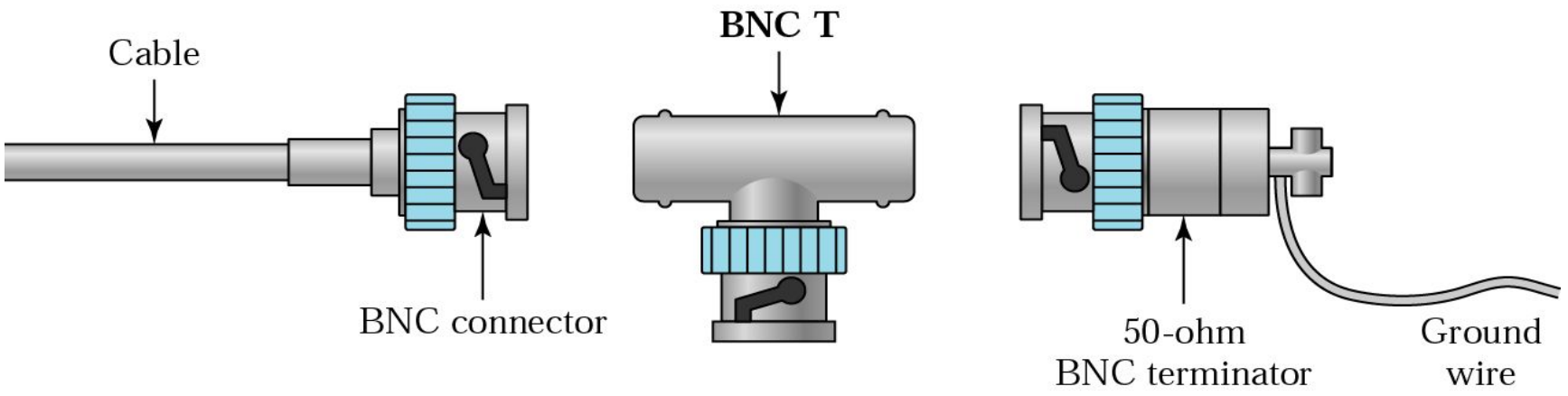


Figure ***Coaxial cable***

Table: Categories of coaxial cables

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


Cable
BNC connector
BNC T
50-ohm
BNC terminator
Ground
wire

Coaxial Cable Applications:

- Like twisted pair, coaxial cable consists of two conductors.
- Television distribution
  - Ariel TV
  - Cable TV
- Long distance telephone transmission
  - Can carry 10,000 voice calls simultaneously
  - Being replaced by fiber optic
- Short distance computer systems links
- Local area networks

Coaxial Cable : Characteristics

- Analog
  - Amplifiers every few km
  - Closer if higher frequency
  - Up to 500MHz, Bandwidth high
- Digital
  - Repeater every 1km
  - Closer for higher data rates

Coaxial Cable: Adv. Vs Disadv.

- Advantages
  ~ higher bandwidth - 400 to 600 Mhz
  - up to 10800 voice conversations
  ~ much less susceptible to interference than twisted pair

- Disadvantages
  ~ high attenuation rate makes it expensive over long distance

Optical Fiber:

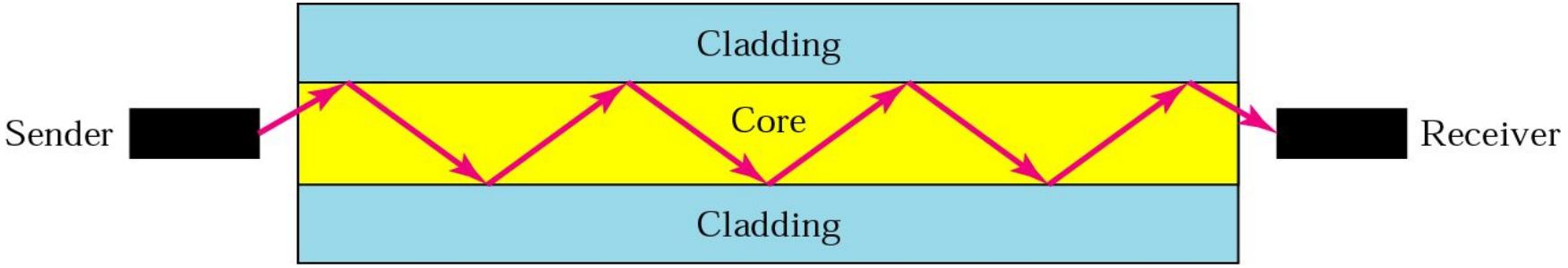


Figure ***Optical fiber***

Bending of light ray

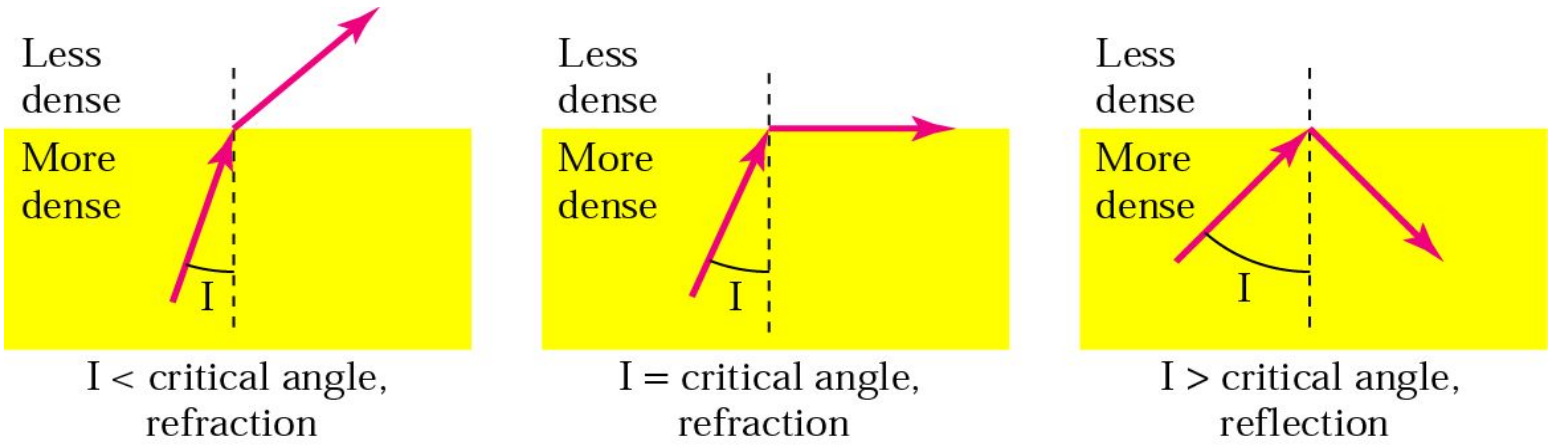


Figure ***Bending of light ray***

Figure *Fiber construction*

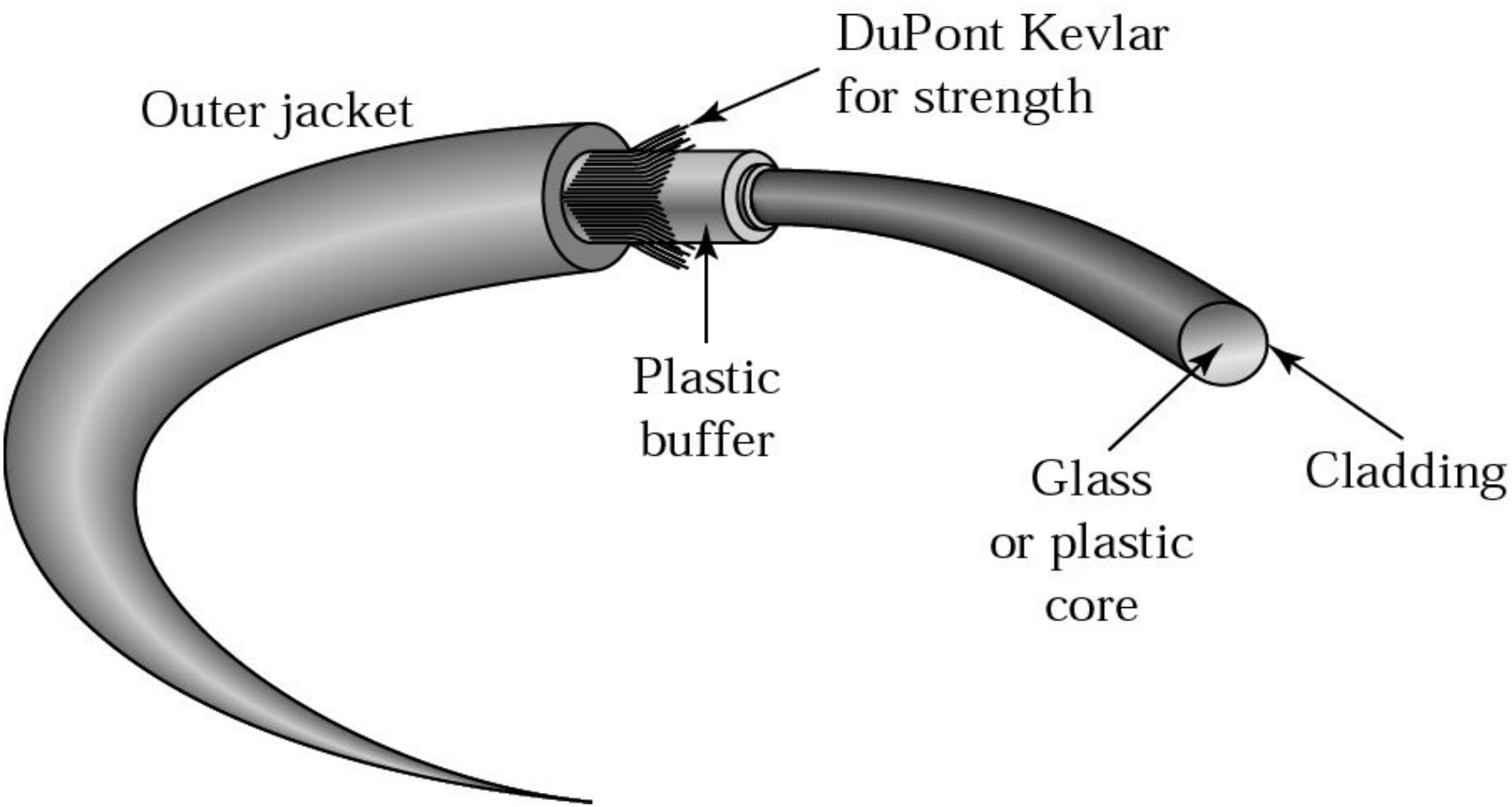
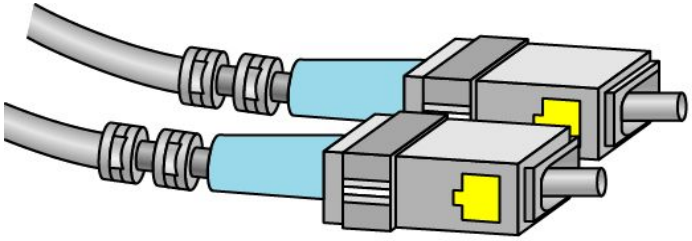
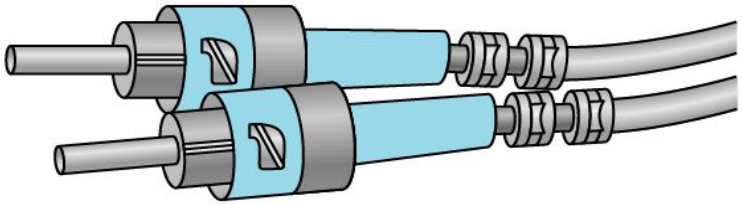


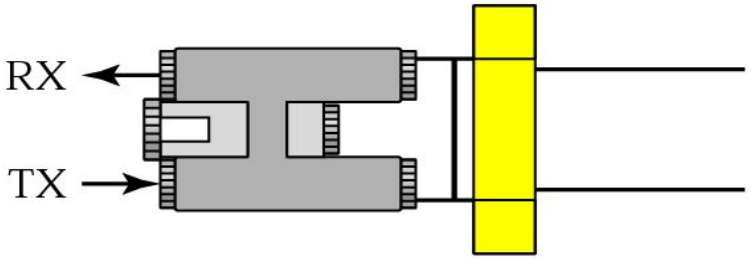
Figure *Fiber-optic cable connectors*



SC connector



ST connector



MT-RJ connector

Optical Fiber - Transmission Characteristics

- Total internal reflection of the signal.
- Act as wave guide for 10^{14} to 10^{15} Hz
- Light Emitting Diode (LED)
  - Cheaper
  - Wider operating temp range
  - Last longer
- Injection Laser Diode (ILD)
  - More efficient
  - Greater data rate

Optical Fiber:

- Advantages
  ~ greater capacity (bandwidth of up to 2 Gbps)
  ~ smaller size and lighter weight
  ~ lower attenuation
  ~ Less effected by environmental interference
- Disadvantages
  ~ expensive over short distance
  ~ requires highly skilled installers
  ~ adding additional nodes is difficult

Thank You !!!
Any Questions ???