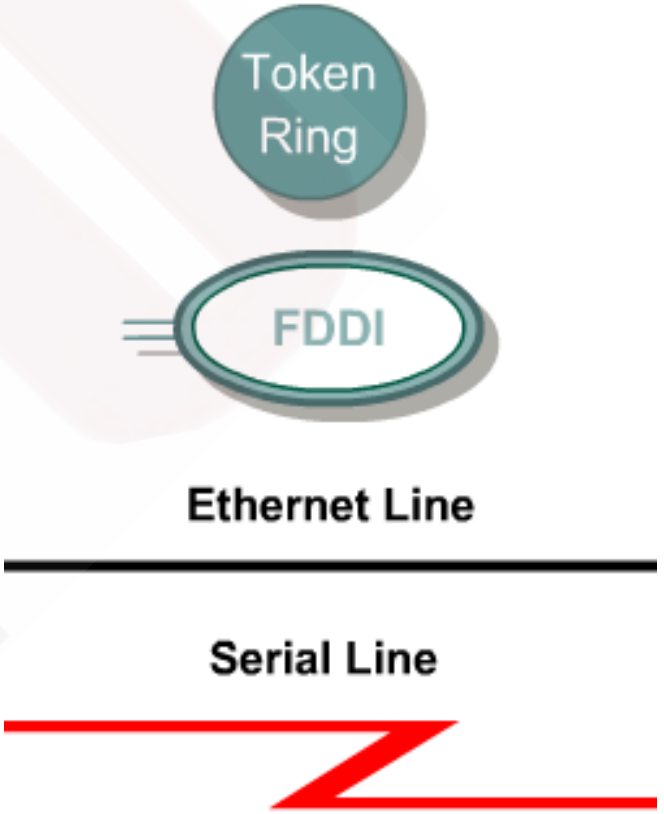
The Networking Media

LAN Physical Layer

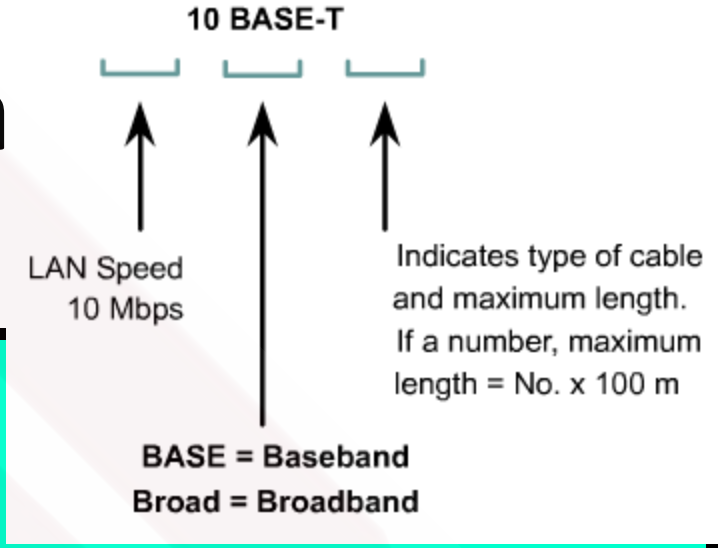
Various symbols are used to represent media types.

The function of media is to carry a flow of information through a LAN.Networking media are considered Layer 1, or physical layer, components of LANs.

Each media has advantages and disadvantages.
Some of the advantage or disadvantage comparisons concern:
Cable length •
Cost •
Ease of installation •
Susceptibility to interference •
Coaxial cable, optical fiber, and even free space can carry network signals. However, the principal medium that will be studied is Category 5 unshielded twisted-pair cable (Cat 5 UTP)



Cable Specifica



10BASE-T

The T stands for twisted pair.

10BASE5

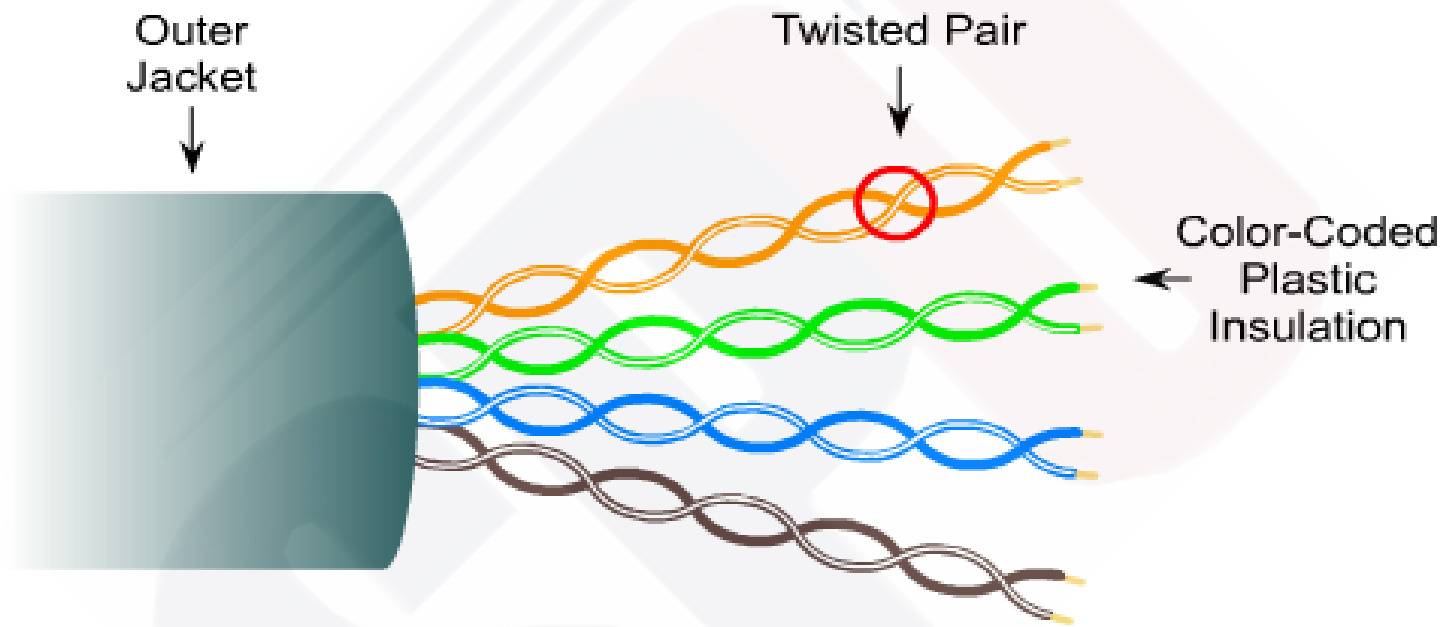
The 5 represents the fact that a signal can travel for approximately 500 meters 10BASE5 is often referred to as Thicknet.

10BASE2

The 2 represents the fact that a signal can travel for approximately 200 meters 10BASE2 is often referred to as Thinnet.

All 3 of these specifications refer to the speed of transmission at 10 Mbps and a type of transmission that is baseband, or digitally interpreted. Thinnet and Thicknet are actually a type of networks, while 10BASE2 & 10BASE5 are the types of cabling used in these networks.

Unshielded Twisted Pair (UTP) Cable



- Speed and throughput: 10 - 100 - 1000 Mbps (depending on the quality/category of cable)
- Average $ per node: Least Expensive
- Media and connector size: Small
- Maximum cable length: 100m

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.

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)

UTP Implementation

EIA/TIA specifies an RJ-45 connector for UTP cable.

The RJ-45 transparent end connector shows eight colored wires.

Four of the wires carry the voltage and are considered “tip” (T1 through T4).
The other four wires are grounded and are called “ring” (R1 through R4).
The wires in the first pair in a cable or a connector are designated as T1 & R1

Connection Media

The registered jack (RJ-45) connector and jack are the most common.

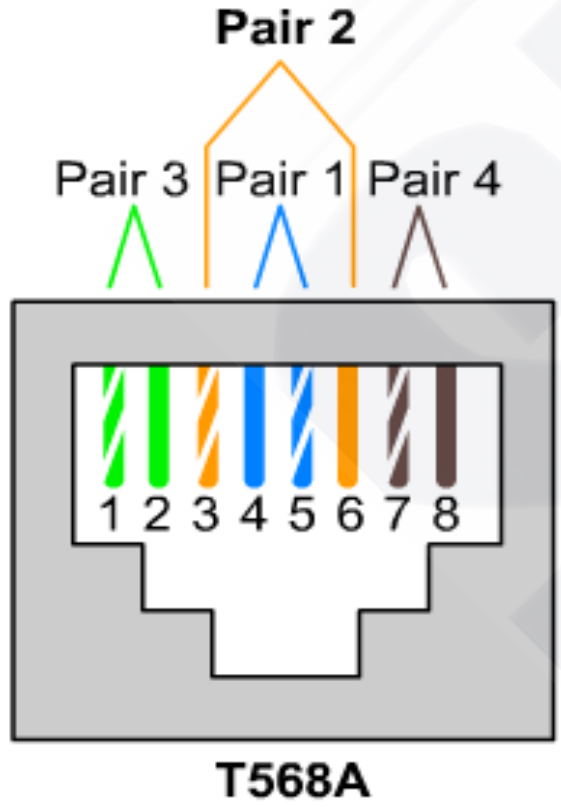
In some cases the type of connector on a network interface card (NIC) does not match the media that it needs to connect to.

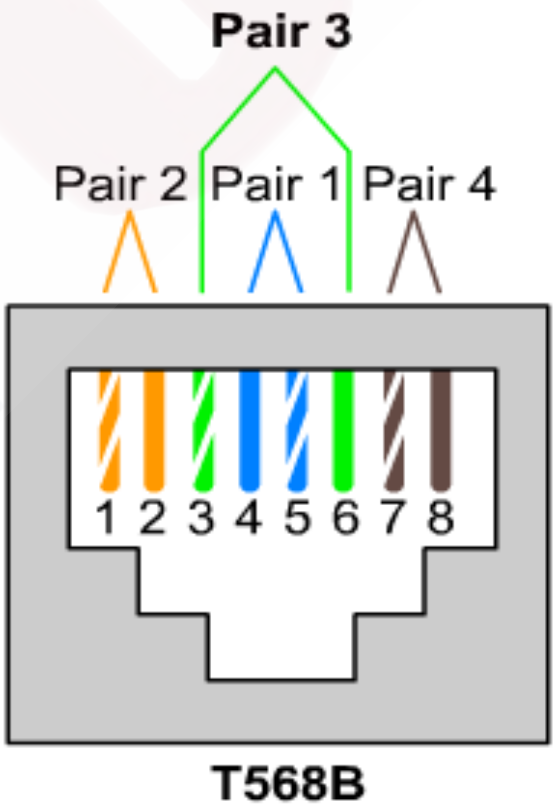
The attachment unit interface (AUI) connector allows different media to connect when used with the appropriate transceiver.

A transceiver is an adapter that converts one type of connection to another.

Ethernet Standards

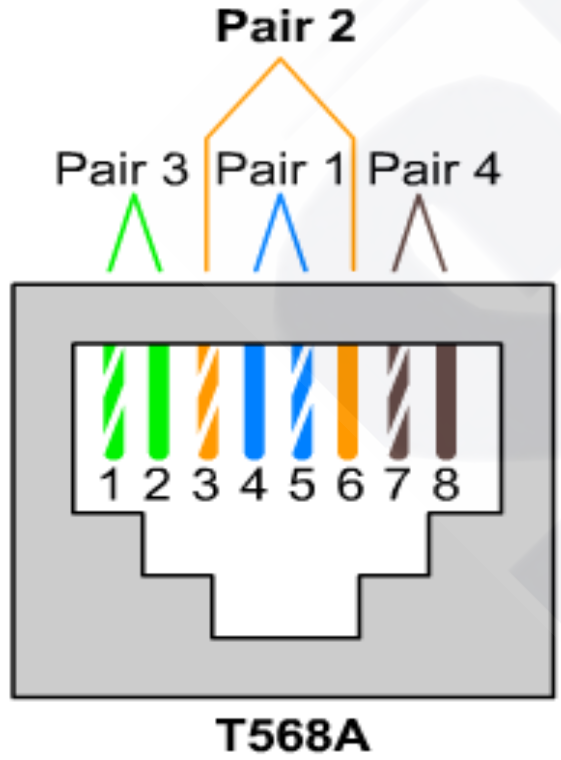
The Ethernet standard specifies that each of the pins on an RJ-45 connector have a particular purpose. A NIC transmits signals on pins 1 & 2, and it receives signals on pins 3 & 6.

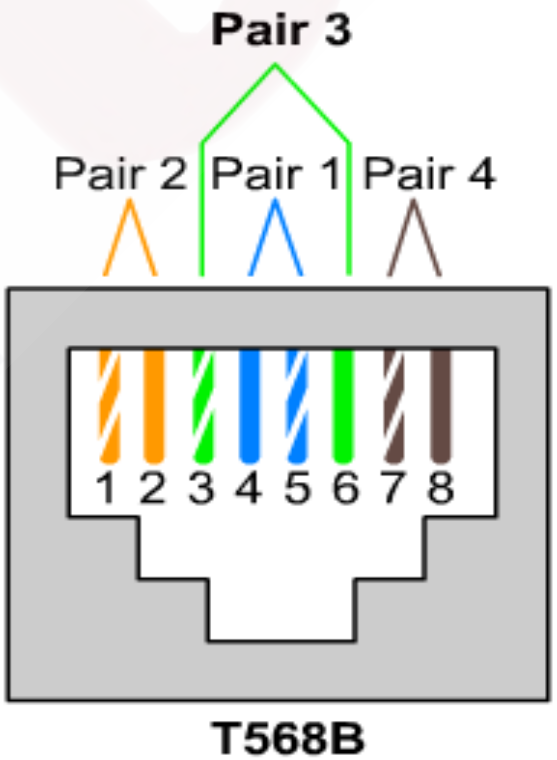




Remember…

A **straight-thru cable** has T568B on both ends. A **crossover** (or **cross-connect**) cable has T568B on one end and T568A on the other. A **console** cable had T568B on one end and reverse T568B on the other, which is why it is also called a **rollover** cable.





Straight-Thru or Crossover

Use straight-through cables for the following cabling:

- Switch to router
- Switch to PC or server
- Hub to PC or server

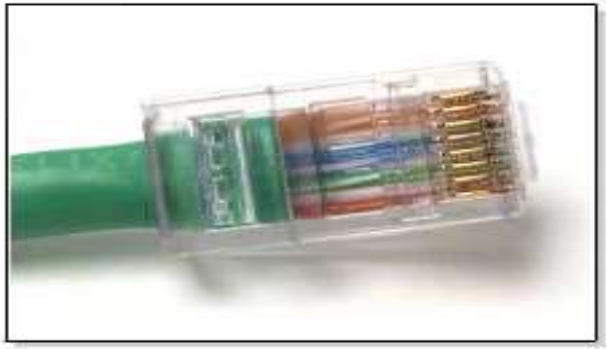
Use crossover cables for the following cabling:

- Switch to switch
- Switch to hub
- Hub to hub
- Router to router
- PC to PC
- Router to PC

Sources of Noise on Copper Media

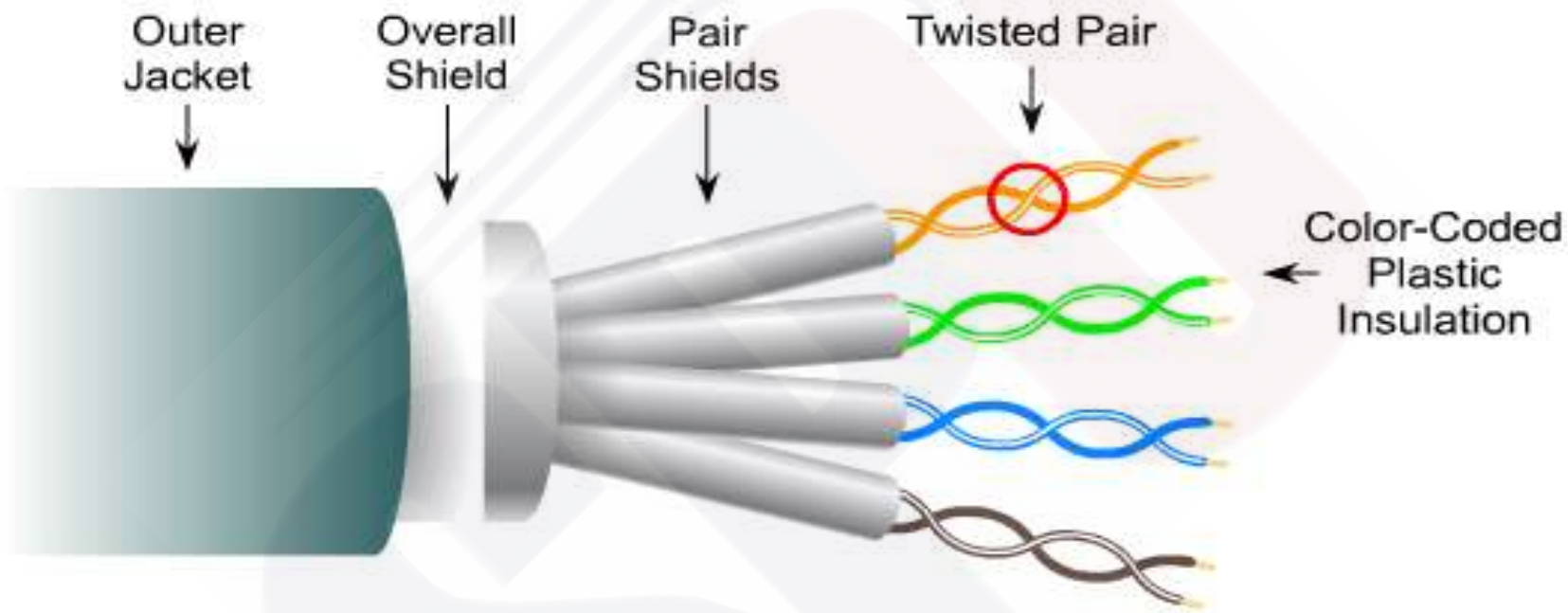
Noise is any electrical energy on the transmission cable that makes it difficult for a receiver to interpret the data sent from the transmitter. TIA/EIA-568-B certification of a cable now requires testing for a variety of types of noise.***Twisted-pair cable*** is designed to take advantage of the effects of crosstalk in order to minimize noise. In twisted-pair cable, a pair of wires is used to transmit one signal.The wire pair is twisted so that each wire experiences similar crosstalk. Because a noise signal on one wire will appear identically on the other wire, this noise be easily detected and filtered at receiver.Twisting one pair of wires in a cable also helps to reduce crosstalk of data or noise signals from adjacent wires.

Bad Connector - Wires are untwisted for too great a length.



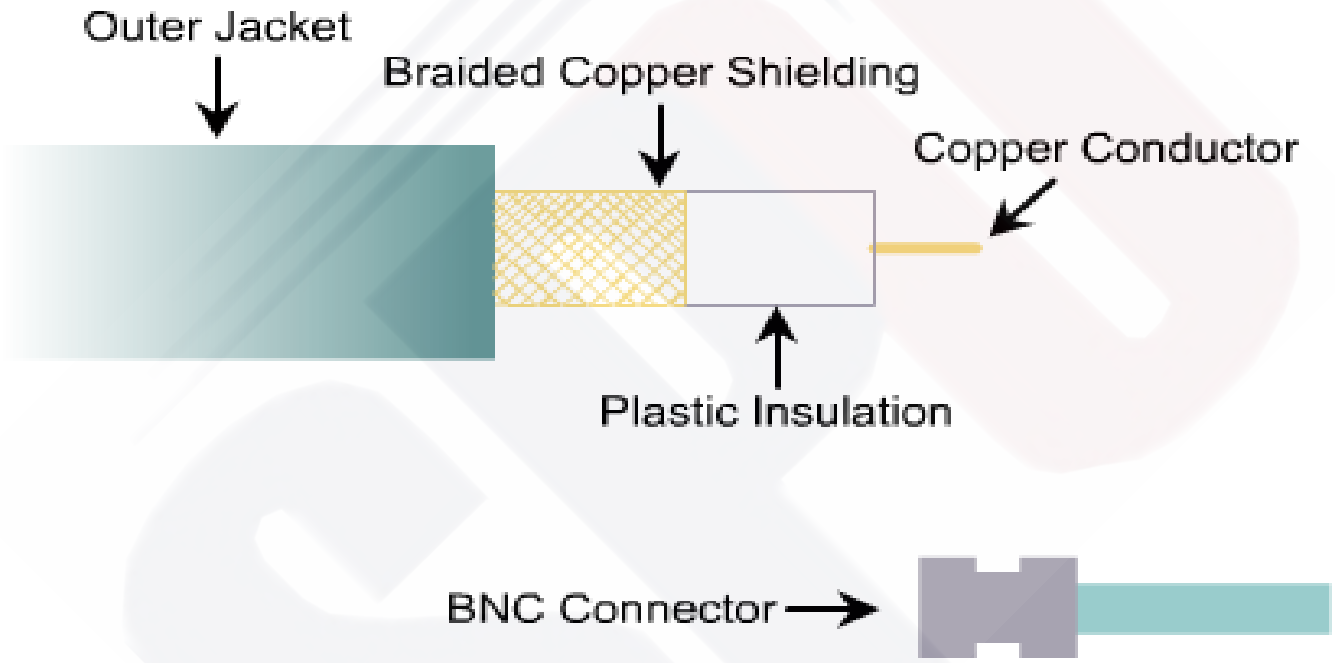
Good Connector - Wires are untwisted to the extent necessary to attach the connector.

Shielded Twisted Pair (STP) Cable



- Speed and throughput: 10 - 100 Mbps
- Average $ per node: Moderately Expensive
- Media and connector size: Medium to Large
- Maximum cable length: 100m

Coaxial Cable

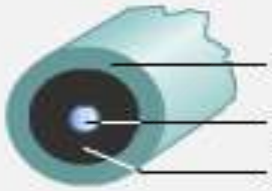


- Speed and throughput: 10 - 100 Mbps
- Average $ per node: Inexpensive
- Media and connector size: Medium
- Maximum cable length: 500m

Fiber Optic Cable

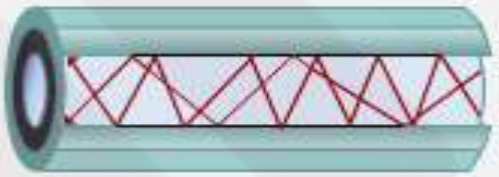
Single-mode

Requires very straight path

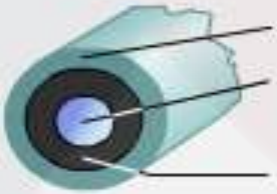


- Small core
- Less dispersion
- Suited for long distance applications (up to ~3km, 9,840 ft)
- Uses lasers as the light source often within campus backbones for distances of several thousand meters

Multimode



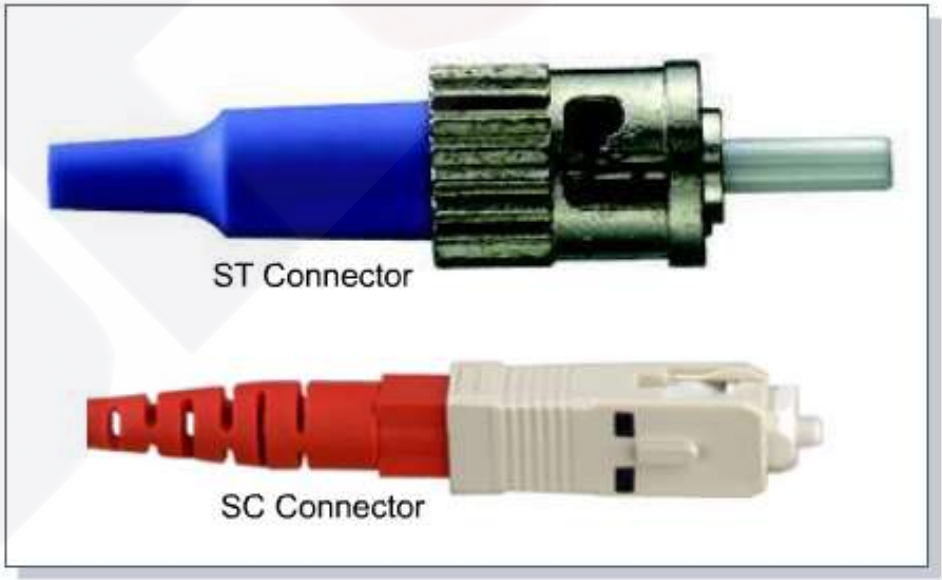
Multiple paths-sloppy



- Larger core than single-mode cable (50 or 62.5 microns or greater)
- Allows greater dipersion and therefore, loss of signal
- Used for long distance application, but shorter than single-mode (up to ~2km, 6,560 ft)
- Uses LEDs as the light source often within LANs or distances of a couple hundred meters within a campus network

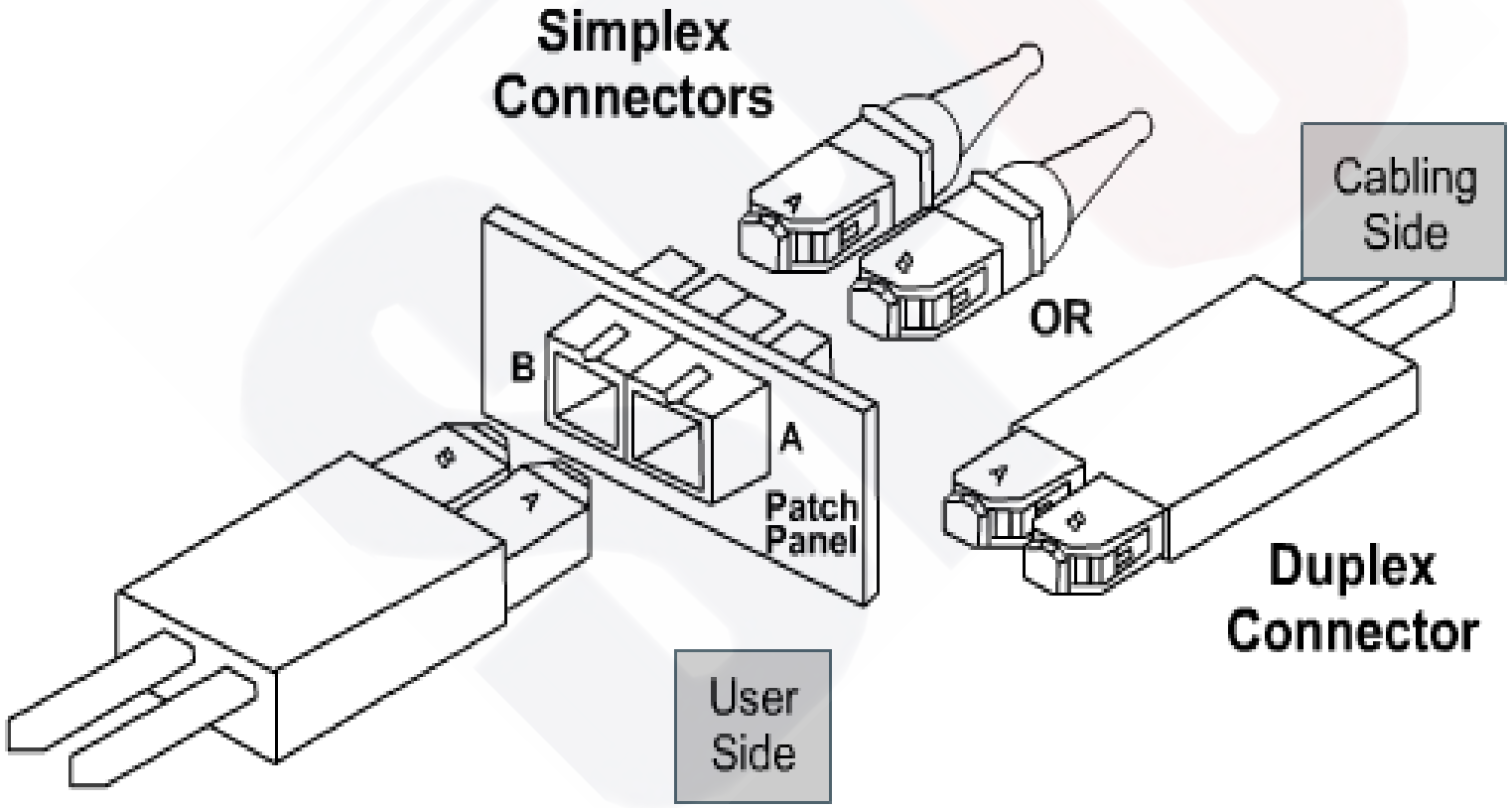
Fiber Optic Connectors

Connectors are attached to the fiber ends so that the fibers can be connected to the ports on the transmitter and receiver.
The type of connector most commonly used with multimode fiber is the Subscriber Connector (SC connector).On single-mode fiber, the Straight Tip (ST) connector is frequently used



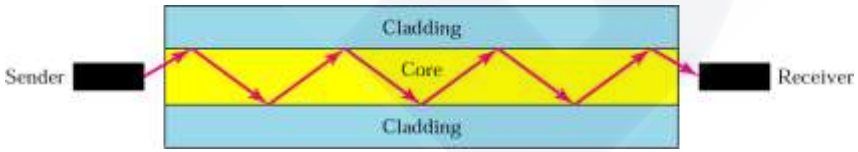
Fiber Optic Patch Panels

Fiber patch panels similar to the patch panels used with copper cable.

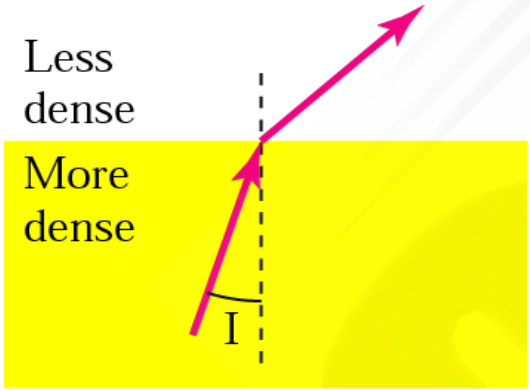


Fiber Media

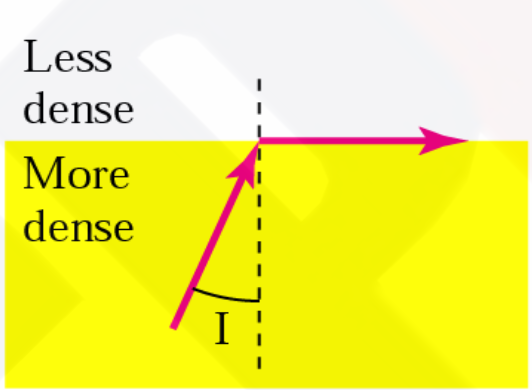
- Optical fibers use light to send information through the optical medium.
- It uses the principal of total internal reflection.
- Modulated light transmissions are used to transmit the signal.



Total Internal Reflection



I < critical angle,
refraction



I = critical angle,
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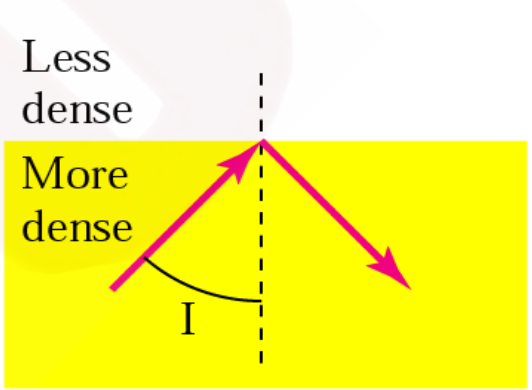


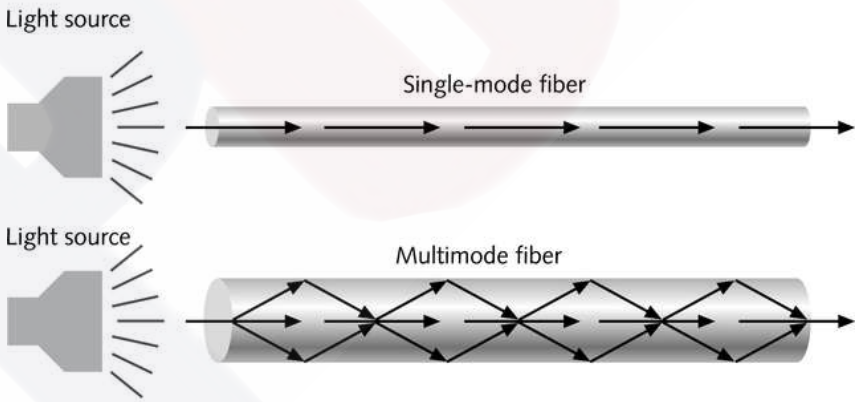
I > critical angle,
reflection

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

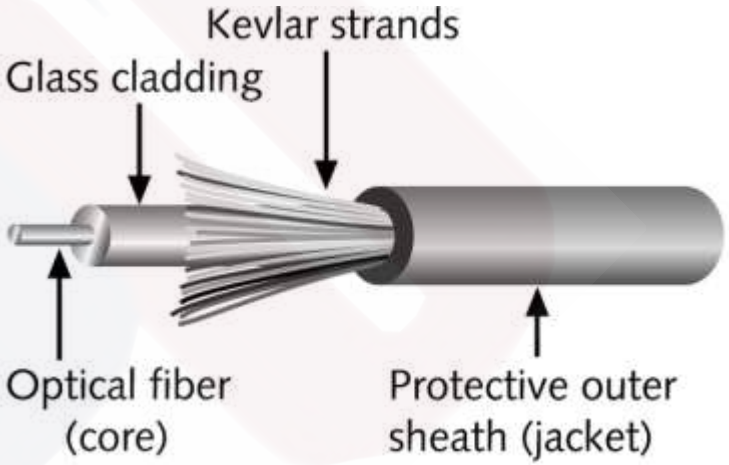


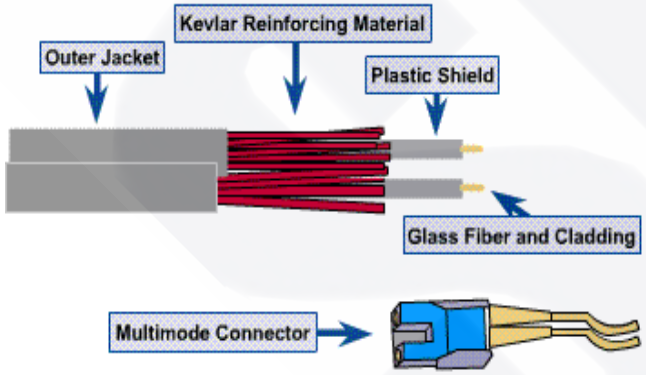
Fiber Media

- 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





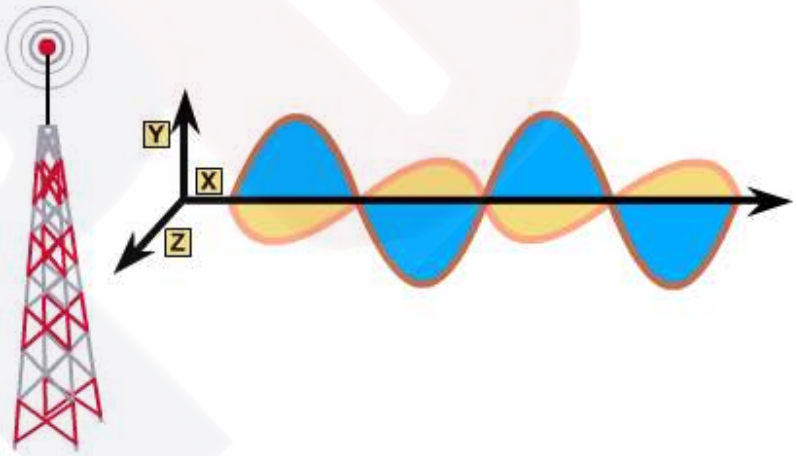
- Speed and throughput: 100+ Mbps
- Cost per node: Most Expensive
- Media and connector size: Small
- Single mode, maximum cable length: Up to 3000m
- Multimode mode, maximum cable length: Up to 2000m
- Single mode: One stream of laser-generated light
- Multimode: Multiple streams of LED-generated light

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.



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