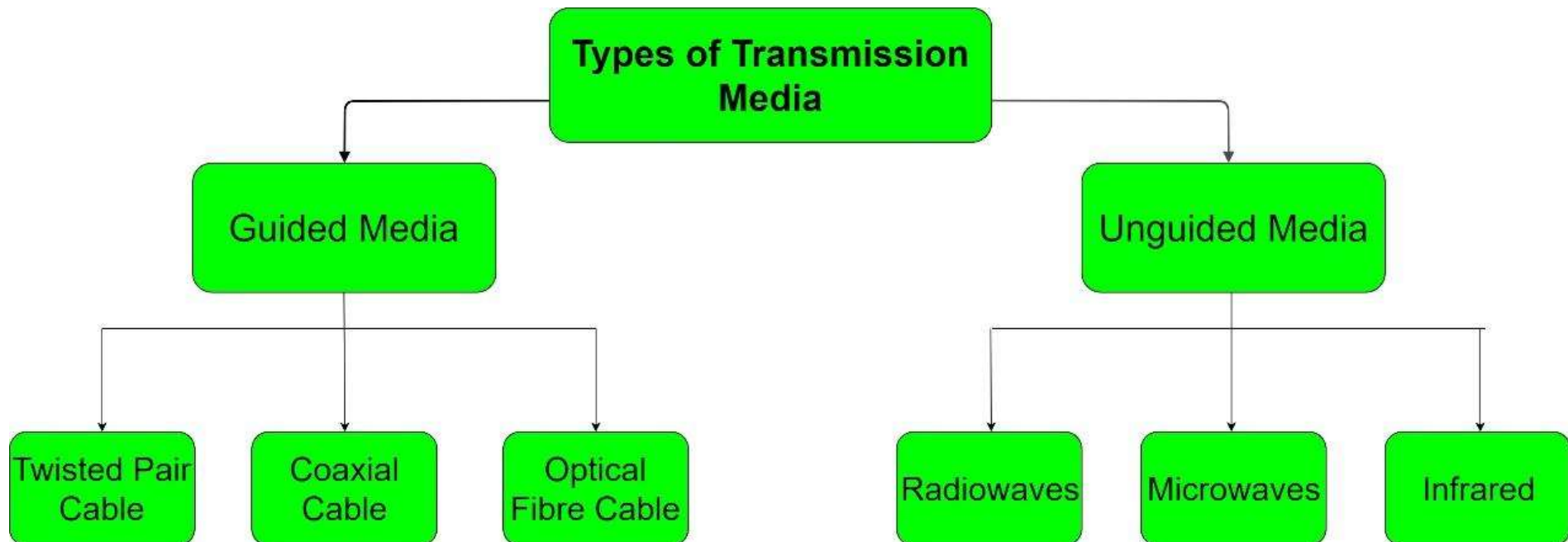


Communication Link?

Communication link : provides a way for information to move between physically separated components



Magnetic Media

- One of the most common ways to transport data from one computer to another is to write them onto magnetic tape or removable media.
- It is often more cost effective, especially for applications in which high bandwidth or cost per bit transported is the key factor.



Floppy disc.



Hard Disc



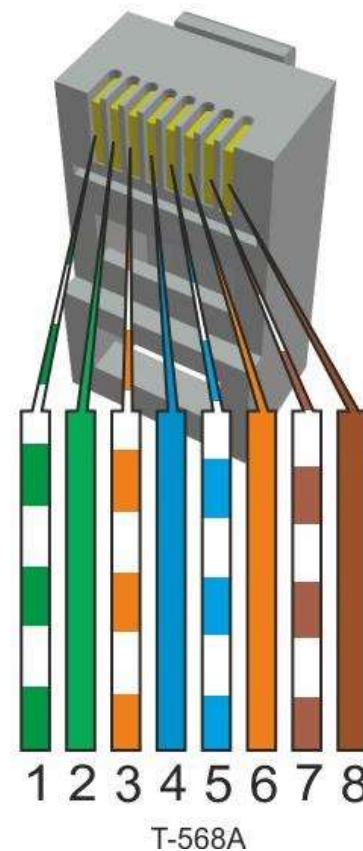
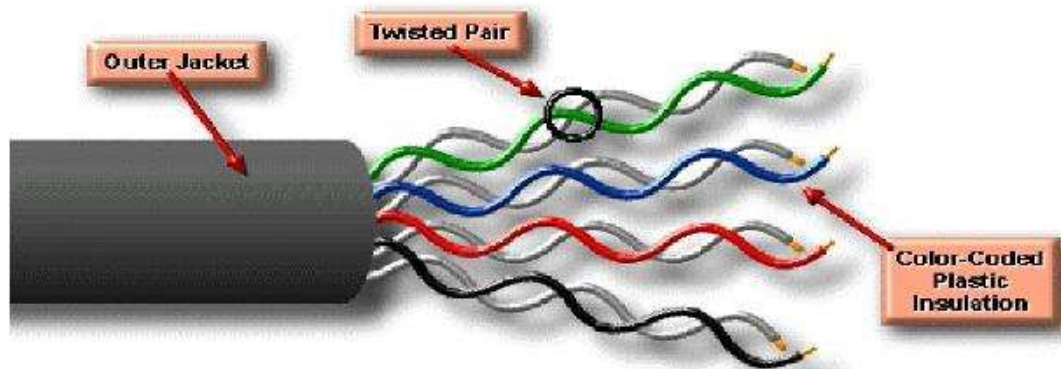
External hard Disc

Twisted pair

- 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.
- When electrical current flows through a wire, it creates a small, circular magnetic field around the wire (Ampere's Law).
- When two wires in an electrical circuit are placed close together, their magnetic fields are the exact opposite of each other. Thus, the two magnetic fields cancel each other out.
- Twisting the wires can enhance this *cancellation effect*.
- *Two types: Unshielded, and shielded.*

UTP (unshielded)

- is a medium that is composed of pairs of wires (4 pairs for network medium)
- UTP cable often is installed using a Registered Jack 45 (RJ-45) connector



Pin	Description	10base-T	100Base-T	1000Base-T
1	Transmit Data+ or BiDirectional	TX+	TX+	BI_DA+
2	Transmit Data- or BiDirectional	TX-	TX-	BI_DA-
3	Receive Data+ or BiDirectional	RX+	RX+	BI_DB+
4	Not connected or BiDirectional	n/c	n/c	BI_DC+
5	Not connected or BiDirectional	n/c	n/c	BI_DC-
6	Receive Data- or BiDirectional	RX-	RX-	BI_DB-
7	Not connected or BiDirectional	n/c	n/c	BI_DD+
8	Not connected or BiDirectional	n/c	n/c	BI_DD-

UTP

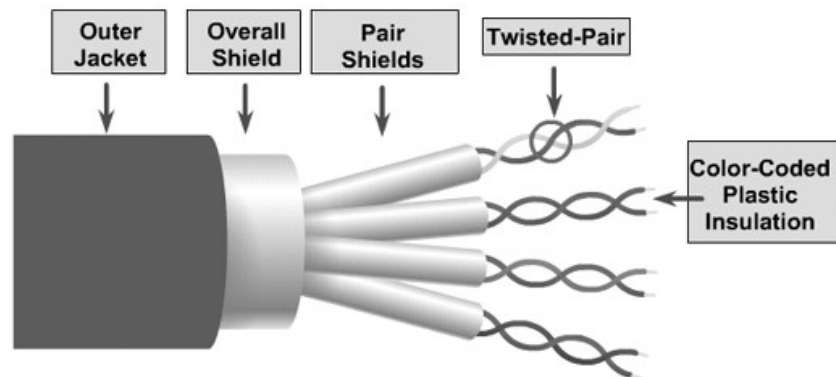
- Advantages: Smaller size (external diameter), easy to install and less expensive.
- Disadvantages: UTP cable is more prone to electrical noise and interference than other types of networking media, and the distance between signal boosts is shorter for UTP .
- The following summarizes the features of UTP cable:
 - Speed and throughput—10 to 1000 Mbps
 - Average cost per node—Least expensive
 - Media and connector size—Small
 - Maximum cable length—100 m (short)

UTP cabling

- **Category 1 (1 pair)**—Used for telephone communications. Not suitable for transmitting data.
- **Category 2 (2 pairs)**—Capable of transmitting data at speeds up to 4 megabits per second (Mbps).
- **Category 3 (4 pairs)**—Used in 10BASE-T networks, Can transmit data at speeds up to 10 Mbps.
- **Category 4 (4 pairs)**—Used in Token Ring networks, Can transmit data at speeds up to 16 Mbps.
- **Category 5 (4 pairs)**—Can transmit data at speeds up to 100 Mbps.
- **Category 5e (4 pairs)** —Used in networks running at speeds up to 1000 Mbps (1 gigabit per second [Gbps]).
- **Category 6 (4 pairs)**—Typically, Category 6 cable consists of four pairs of 24 American Wire Gauge (AWG) copper wires. Category 6 cable is currently the fastest standard for UTP.

STP (Shielded Twisted Pair)

- Combines the techniques of shielding, cancellation, and wire twisting.
- Each pair of wires is wrapped in a metallic foil. The four pairs of wires then are wrapped in an overall metallic braid or foil.
- Reduces electrical noise both within the cable (pair-to-pair coupling, or crosstalk) and from outside the cable (EMI and RFI)



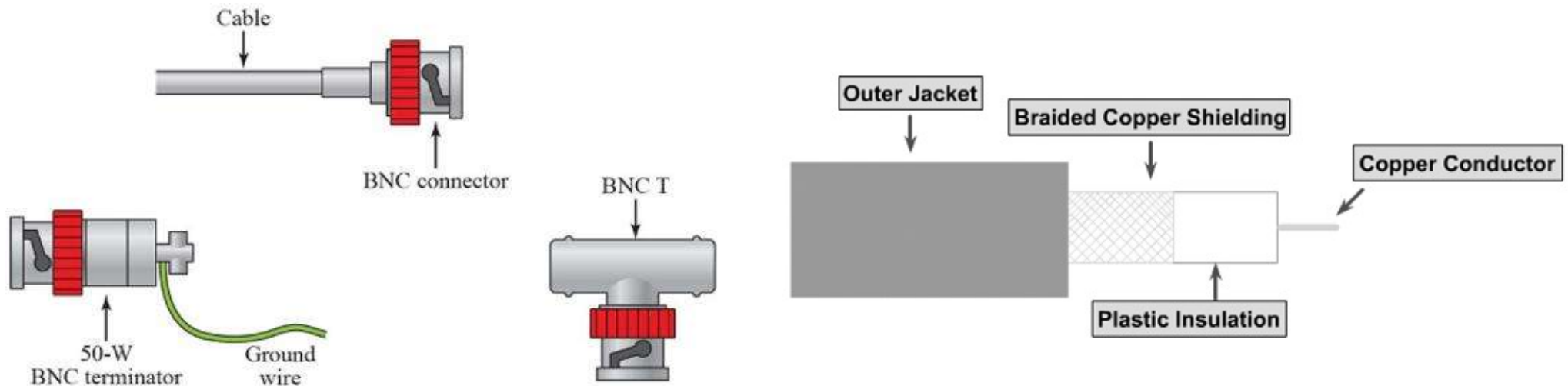
- Speed and throughput: 10-100 Mbps
- Cost per node: Moderately expensive
- Media and connector size: Medium to Large
- Maximum cable length: 100m (short)

STP comparison with UTP

- Although STP prevents interference better than UTP, it is more expensive and difficult to install.
- the metallic shielding must be grounded at both ends. If it is improperly grounded, the shield acts like an antenna and picks up unwanted signals.
- Because of its cost and difficulty with termination, STP is rarely used in Ethernet networks.
- The speed of both types of cable is usually satisfactory for local-area distances.

Coaxial Cable

- Coaxial cabling has a single copper conductor at its center. A plastic layer provides insulation between the center conductor and a braided metal shield.
- The metal shield helps to block any outside interference from fluorescent lights, motors, and other computers.
- The most common type of connector used the Bayonet Neill-Concelman (BNC) connector



Categories of Coax.

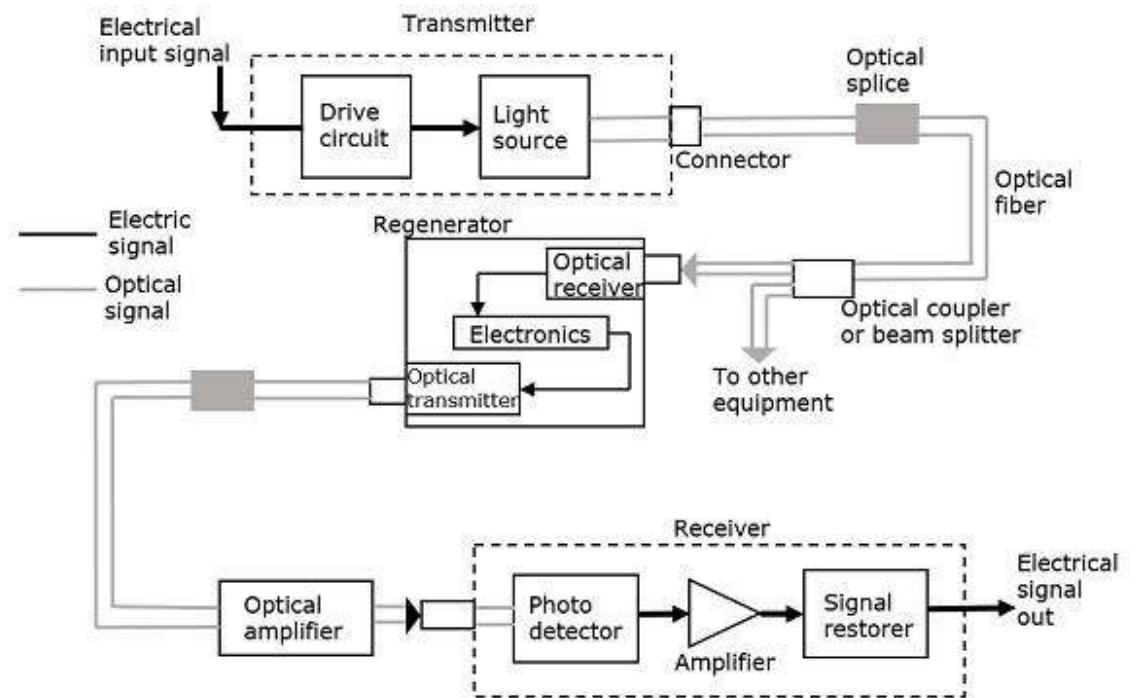
- Base band
- For digital transmission, a 50 ohm (Ω) coaxial cable is used. It defines a process of transmitting a single signal at a time with a very high speed. It is generally used for LAN's.
- Broadband
- Analog transmission on standard cable television 75 ohm (Ω) cabling is used by this. It defines a process of transmitting multiple signals simultaneously with very high speed. It covers a large area as compared to Baseband Coaxial Cable.

Advantages and Disadvantages

- It can be used for both analog and digital transmission.
- It offers higher bandwidth as compared to twisted pair cable and can span longer distances.
- Because of better shielding in coaxial cable, loss of signal or attenuation is less.
- Better shielding also offers good noise immunity.
- It is relatively inexpensive as compared to optical fibers.
- It has lower error rates as compared to twisted pair.
- It is not as easy to tap as twisted pair because copper wire is contained in plastic jacket.
- It is usually more expensive than twisted pair.

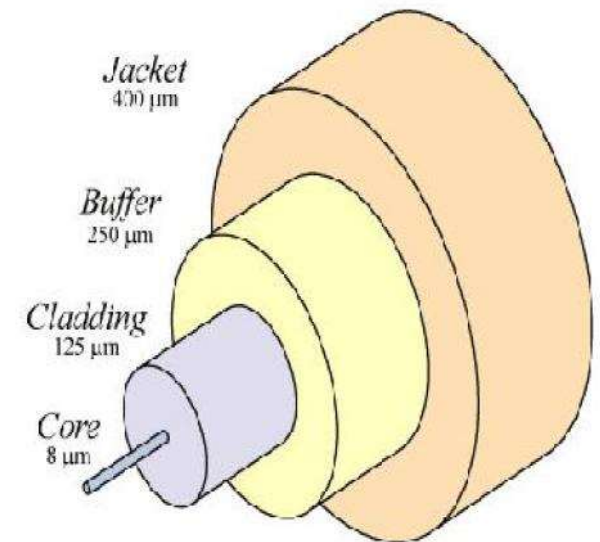
Fiber optics

- An optical transmission system has three key components:
- the light source,
- the transmission medium, and
- the detector



Fiber Optics: Construction

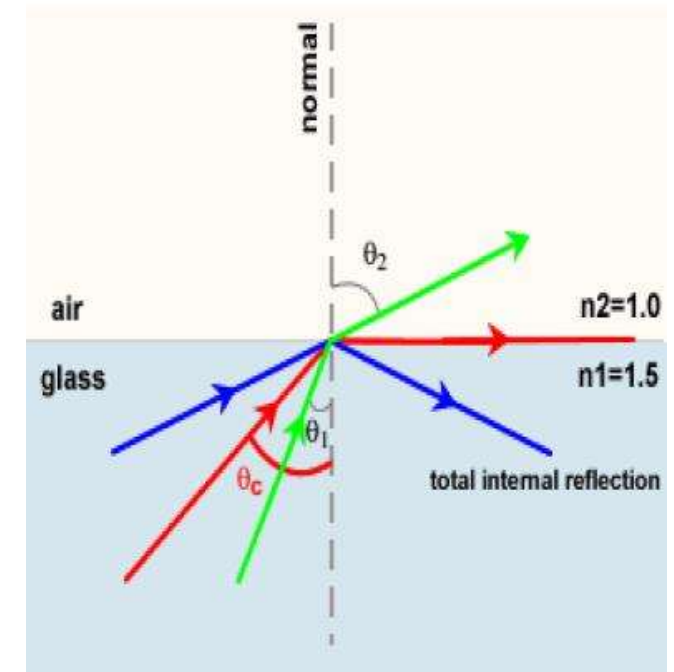
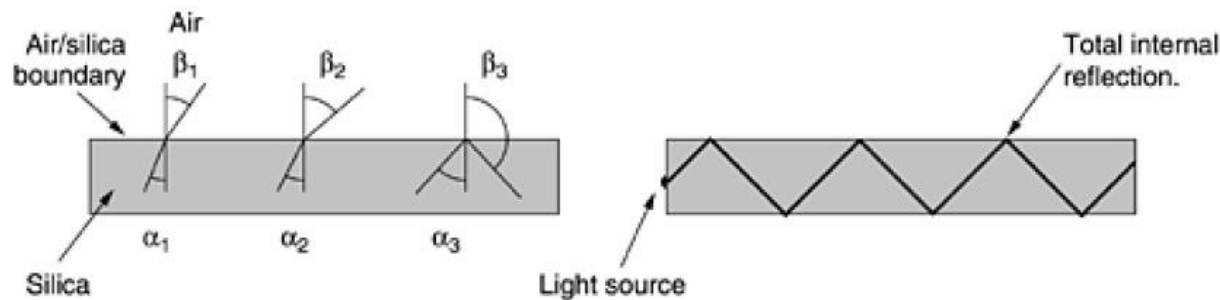
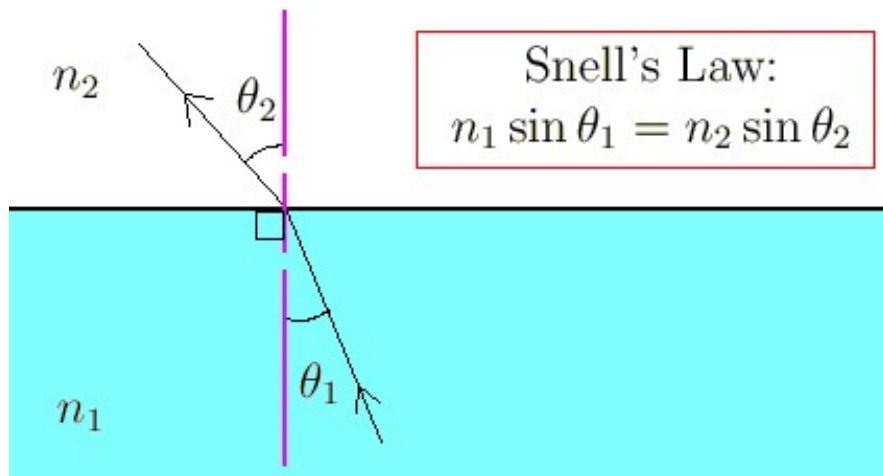
- **Core:** The core of a fiber cable is a cylinder of plastic that runs all along the fiber cable's length. The diameter of the core depends on the application used.
- **Cladding:** Cladding is an outer optical material that protects the core. The main function of the cladding is that it reflects the light back into the core.
- **Buffer:** The main function of the buffer is to protect the fiber from damage and thousands of optical fibers arranged in hundreds of optical cables.
- **Jacket:** These bundles are protected by the cable's outer covering that is called jacket.



Fiber Optics: Working Principle

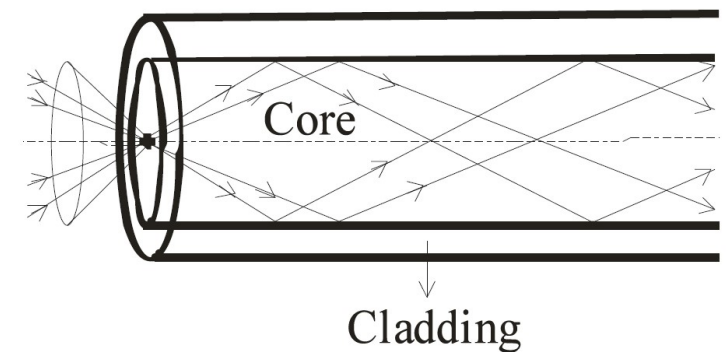
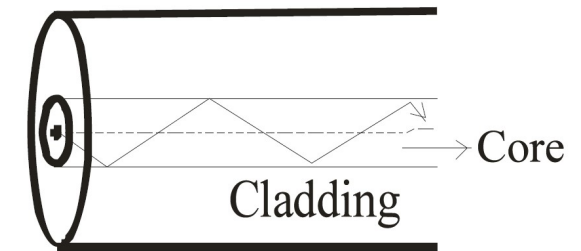
- A hair-thin Fiber consist of two concentric layers of high-purity silica glass the core and the cladding, which are enclosed by a protective sheath.
- Core and cladding have different refractive indices, with the core having a refractive index, n_1 , which is slightly higher than that of the cladding, n_2 .
- When light enters the fiber made of material with higher refractive index than the cladding surrounding it, it stays inside the material due to total internal reflection and is thus transmitted forward.
- **Index of refraction:** Index of refraction is a measurement of speed of light in material.

Snell's Law: Law of Refraction, Critical Angle, total internal Reflection



Fiber Optics: Modes

- Mode is the one which describes the nature of propagation of electromagnetic waves (light) in a wave guide (Fiber).
- Single mode fiber: In a fiber, if only one mode is transmitted through it, then it is said to be a single mode fiber.
- If more than one mode is transmitted through optical fiber, then it is said to be a multimode fiber.
- The larger core radii of multimode fibers make it easier to launch optical power into the fiber and facilitate the end to end connection of similar powers.



Types of Fibers

- **Step-index fiber** – The refractive index of the core is uniform throughout and undergoes an abrupt change (or step) at the cladding boundary.
- **Graded-index fiber** – The core refractive index is made to vary as a function of the radial distance from the center of the fiber.
- Further divided into:
 - **Single-mode fiber** – These are excited with laser.
 - **Multi-mode fiber** – These are excited with LED.

Item	LED	Semiconductor laser
Data rate	Low	High
Fiber type	Multimode	Multimode or single mode
Distance	Short	Long
Lifetime	Long life	Short life
Temperature sensitivity	Minor	Substantial
Cost	Low cost	Expensive

Fiber Optics: Advantages and Disadvantages

- **Advantages:**

- The transmission bandwidth of the fiber optic cables is higher than the metal cables.
- The amount of data transmission is higher in fiber optic cables.
- The power loss is very low and hence helpful in long-distance transmissions.
- Fiber optic cables provide high security and cannot be tapped.
- Fiber optic cables are the most secure way for data transmission.
- Fiber optic cables are immune to electromagnetic interference.
- These are not affected by electrical noise.

- **Disadvantages:**

- Though fiber optic cables last longer, the installation cost is high.
- The number of repeaters are to be increased with distance.
- They are fragile if not enclosed in a plastic sheath. Hence, more protection is needed than copper ones

Media Type	Maximum Segment Length	Speed	Cost	Advantages	Disadvantages
UTP	100 m	10 Mbps to 1000 Mbps	Least expensive	Easy to install; widely available and widely used	Susceptible to interference; can cover only a limited distance
STP	100 m	10 Mbps to 100 Mbps	More expensive than UTP	Reduced crosstalk; more resistant to EMI than Thinnet or UTP	Difficult to work with; can cover only a limited distance
Coaxial	500 m (Thicknet) 185 m (Thinnet)	10 Mbps to 100 Mbps	Relatively inexpensive, but more costly than UTP	Less susceptible to EMI interference than other types of copper media	Difficult to work with (Thicknet); limited bandwidth; limited application (Thinnet); damage to cable can bring down entire network
Fiber-Optic	10 km and farther (single-mode) 2 km and farther (multimode)	100 Mbps to 100 Gbps (single mode) 100 Mbps to 9.92 Gbps (multimode)	Expensive	Cannot be tapped, so security is better; Difficult to terminate can be used over great distances; is not susceptible to EMI; has a higher data rate than coaxial and twisted-pair cable	