Networking

Fiber Optic Cabling & Connections

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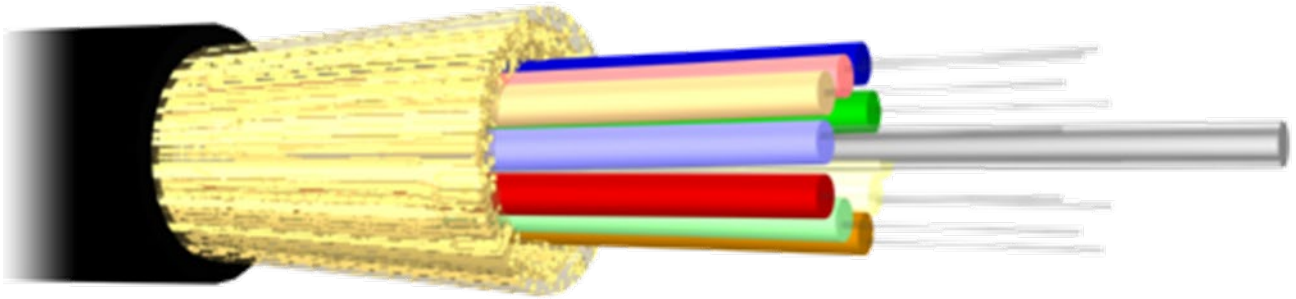
Fiber Optic Cabling & Connections

- Guiding Question: How do the different types of fiber optic cables, connectors, and transceivers impact network performance, and how do they support various communication needs?

- Students will:
  - Compare the characteristics of single-mode and multimode fiber, including speed, distance, and use cases.
  - Identify the different types of fiber optic connectors and describe their applications.
  - Explain the function of transceivers in connecting devices with fiber optic networks.
  - Differentiate between various transceivers by protocol (Ethernet vs. Fibre Channel) and form factor (SFP vs. QSFP).
  - Evaluate the impact of fiber optic components on network design, performance, and scalability.

Fiber Optic Media

The data is transferred by light impulses produced by a Light Emitting Diode (LED) or a Laser.

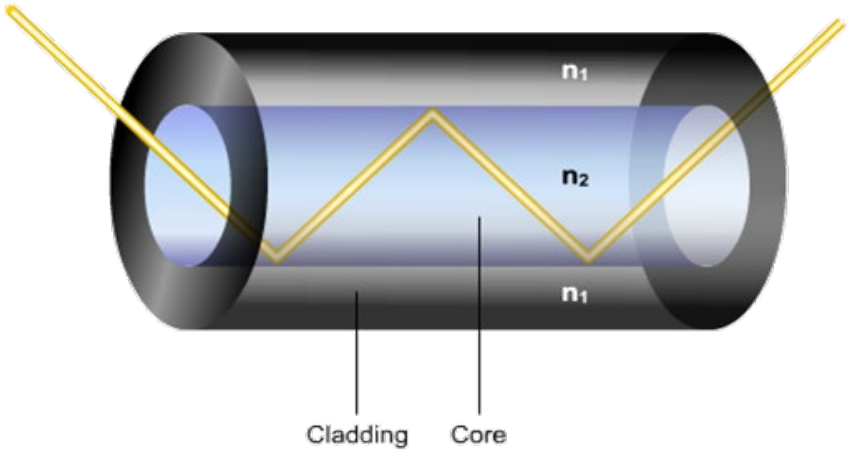


Warning: The laser light used with single-mode fiber optic has a longer wavelength than the eye can see. The laser is so strong that it can seriously damage eyes.

How Does Fiber Work?

Certain conditions must exist in the fiber cable for it to carry a digital light signal.

- Must NOT allow light ray to refract into cladding.
- Needs to have fiber reflect all of light into itself.
- When both conditions are met – light will bounce its way along the core.



Network Media Questions

- **CABLING TYPE:** What will carry the data signal?
- **SPEED:** How much data can be transmitted per second?
- **CONNECTOR:** What is the correct connector type for this media?
- **STANDARDS:** What is the naming scheme for this media?
- **DISTANCE:** How far can a signal travel through a particular type of media before degradation of the signal becomes a concern?

Single Mode Fiber Cable (SMF)

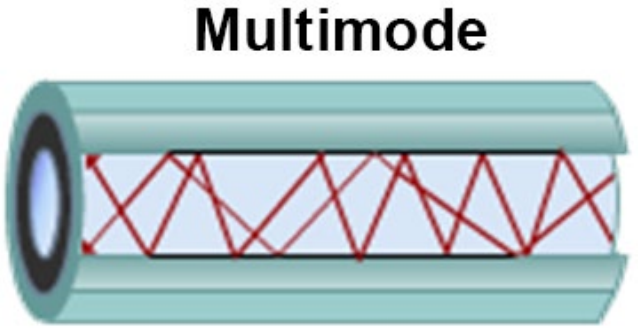
- **Mode** - Path inside core.
- Light rays can only enter the core if their angle is inside the diameter of the opening. This means once inside, there are limited number of optical paths to follow.
- Single Mode Fiber uses straight-line transmission of light rays which results in higher bandwidth
- Uses LASER as the transmitter.

Single Mode Fiber

- **Type:** Fiber with a core diameter ~8-10 micrometers.
- **Speed & IEEE Standard:**
  - 1 Gigabit per second : 1000Base-LX
  - 10 Gigabit per second: 10GBase-LX
- **Distance:** Up to 100 kms (may need signal boost)
- **Uses:** Long-distance telecommunications, high-speed data centers.

Multimode Fiber Cable (MMF)

- Can take many transmissions because the diameter of the fiber core is large enough so that there are many paths that light can take through the fiber.
- Uses LED as a light transmitter.

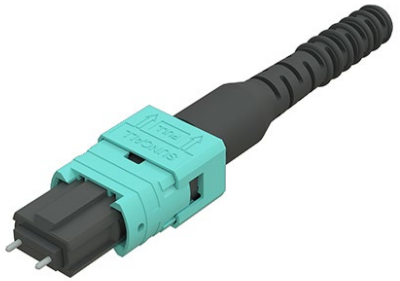


Multi-Mode Fiber

- **Type:** Fiber with a core diameter ~50 or 62.5 micrometers.
- **Speed & IEEE Standard:**
  - 1 Gigabit per second : 1000Base-SX
  - 10 Gigabit per second: 10GBase-SX
- **Distance:** High speeds up to 500 m or lower speeds up to 2 km
- **Uses:** Shorter distances, such as within buildings or data centers.

Fiber Optic Connectors

- **Subscriber Connector** (SC)
  - Push-pull design with a square-shaped connector.
- **Local Connector** (LC)
  - Small form-factor connector with a latch mechanism.
- **Straight Tip** (ST)
  - Bayonet-style connector with a spring-loaded mechanism.
- **Multi-Fiber Push On** (MPO)
  - Connects multiple fibers with a single connector; often used with arrays of 12, 24, or 48 fibers.



Advantages of Fiber

- Immune to Electromagnetic Interference (EMI).
- Low loss of signal.
- Longest maximum distance of all cable types.
- Lightweight: coaxial 1000ft =80lbs Fiber 1000 ft=9lbs
- Safety – Does not carry electricity, so no risk of spark or fire.
- Security – Does not radiate energy, so can't be "tapped" or picked up by antenna.

Disadvantages of Fiber

- Cost – Most expensive for both cable and the necessary devices that convert computer signals to and from light pulses.
- Installation – Difficult and expensive.
  - Need trained installers to terminate with connector.

- Noise can be caused by modal interference.
  - Variations in temperature, pressure, mechanical displacement, electric, magnetic and acoustic fields on fiber optic media.

Transceivers

- What if a network needs to mix copper and fiber cabling?
  - Copper carries an electrical signal while fiber carries a light signal - how do we make them work together?
- **Transceivers** - Convert electrical signals from Ethernet cables into light signals for transmission over fiber optic cable.
  - The network can then operate with different types of network media connected together.
- **Example:** Plug a fiber cable into a transceiver connector which then plugs into an ethernet transceiver port on a switch.

Transceiver Form Factors

Small Form-Factor Pluggable (SFP)

- Supports 1 fiber channel.
  - SFP = 5Gbps
  - SFP+ = 16 Gbps
  - SFP28 = 18 Gbps

Quad Small Form-Factor Pluggable (QSFP)

- Supports 4 fiber channels.
  - QSFP = 4 x 1.25 = 6 Gbps
  - QSFP+ = 4 x 10 = 40 Gbps
  - QSFP28 = 4 x 28 = 112 Gbps