UTP Categories - Copper Cable				
UTP Category	Data Rate	Max. Length	Cable Type	Application
CAT1	Up to 1Mbps	-	Twisted Pair	Old Telephone Cable
CAT2	Up to 4Mbps	-	Twisted Pair	Token Ring Networks
CAT3	Up to 10Mbps	100m	Twisted Pair	Token Rink & 10BASE-T Ethernet
CAT4	Up to 16Mbps	100m	Twisted Pair	Token Ring Networks
CAT5	Up to 100Mbps	100m	Twisted Pair	Ethernet, FastEthernet, Token Ring
CAT5e	Up to 1 Gbps	100m	Twisted Pair	Ethernet, FastEthernet, Gigabit Ethernet
CAT6	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT6a	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT7	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (100 meters)

UTP Categories

BNC connectors won't fit very well on *UTP cable*, so a **registered jack (RJ)** connector should be used. The connector used with UTP cable is called **RJ-11** for phones that use four wires; **RJ-45** has four pairs (eight wires), as shown in the below figure.

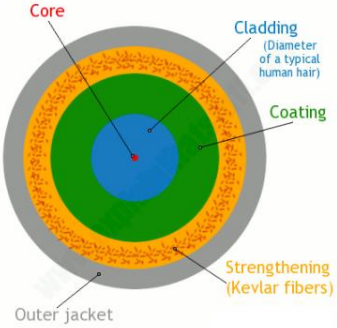
RJ-11 & RJ-45 Connectors

Fiber-Optic Cable

Optical fiber is a very thin strand of pure glass that acts as a waveguide for light over long distances. It uses a principle known as *total internal reflection*.

Fiber-Optic Cable

Fiber optic cable is actually composed of two layers of glass: The **core** which is thinner than hair *carries the actual light signal*, and the **cladding** is a *layer of glass surrounding the core*. Most fibers operate in duplex pairs: one fiber is used to transmit and the other is used to receive. But it is possible to send both signals over a single strand.



Fiber-Optic Cable Construction Layers

Because fiber-optic cable transmits digital signals using light impulses rather than electricity, it's **immune to EMI and RFI**. Fiber cable allows light impulses to be carried on either a glass or a plastic core. Glass can carry the signal a *greater distance*, but plastic *costs less*.

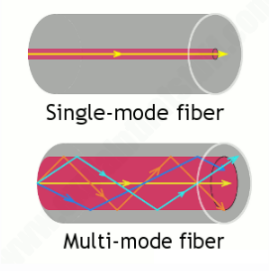
Here are the advantages:

- It's completely immune to EMI and RFI.
- It can transmit up to 40 kilometers (about 25 miles).
- It has high carrying capacity (very broad bandwidth, THz or Tbits/s)
- It has very low transmission losses (<0.2dB/km, cf1dB/km microwave, 10db/km twisted copper pair)
- It does not produce heat

And here are the disadvantages:

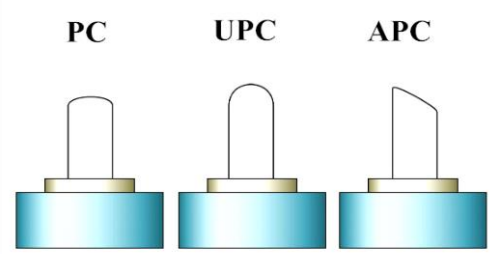
- It's difficult to install.
- It's more expensive than twisted-pair.
- Troubleshooting equipment is more expensive than twisted-pair test equipment.
- It's harder to troubleshoot.

There are two main types of fiber optic cables: **Single-Mode Fiber (SMF)** and **Multi-Mode Fiber (MMF)**. The difference is basically in the *size of the core*. **MMF** has a much wider core, allowing multiple modes (or "rays") of light to propagate. **SMF** has a very narrow core which allows only a single mode of light to propagate. Each type of fiber has different properties with its own advantages and disadvantages.



Single-Mode & Multi-Mode

Fiber optic cables have mainly 2 types of cable end interfaces. **Angled Physical Contact (APC)** and **Ultra Physical Contact (UPC)** (and there is also Physical Contact (PC) that is similar to UPC).

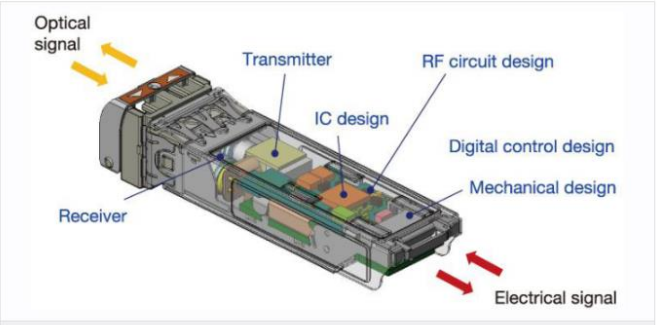


Fiber-optic Cable End Interfaces

A whole bunch of different types of *connectors* are available to use with fiber-optic cables, but the two most popular are the **straight tip (ST)** and the **subscriber (or square) connector (SC)**.

Transceivers

A **transceiver (TRX)** is a device that can transmit and receive signals. Usually, a transceiver contains both a transmitter and a receiver, both of which share common circuitry. However, if the transmitter and receiver only share a common housing and nothing else, the device is called a **transmitter-receiver**. Transceivers are extremely important in the history of technology, as they have paved the way for many inventions such as two-way radios, mobile phones, and the internet.



Fiber Transceiver

Transceivers can be found in radio technology, telephony as well as Ethernet in which transceivers are called **Medium Attachment Units (MAUs)**.

The **small form-factor pluggable (SFP)** is a *compact, hot-pluggable* optical module transceiver used for both *telecommunication* and *data communications* applications.

Transceivers can be found in radio technology, telephony as well as Ethernet in which transceivers are called **Medium Attachment Units (MAUs)**.

The **small form-factor pluggable (SFP)** is a *compact, hot-pluggable* optical module transceiver used for both *telecommunication* and *data communications* applications.

Hot-pluggable optical module transceiver

The Quad Small Form-factor Pluggable (QSFP) is another *compact, hot-pluggable* transceiver used for *data communications* applications. It interfaces networking hardware (such as servers and switches) to a fiber optic cable or active or passive electrical copper connection.

Media Converters

Sometimes, you'll need to convert from one media type to another. Maybe you need to go from one mode of fiber to another mode, or in an even more extreme case, you need to go from fiber to Ethernet. If you're faced with situations like these, you'll need to be familiar with some of the more common media converters:

- **Single-Mode Fiber to Ethernet** - These devices accept a fiber connector and an Ethernet connector and convert the signal from Ethernet and single-mode fiber.

Single-Mode Fiber to Ethernet Converter

- **Multimode Fiber to Ethernet** - These devices accept a fiber connector and an Ethernet connector and convert the signal from Ethernet and multi-mode fiber.

Multimode Fiber to Ethernet Converter

- **Fiber to Coaxial** - These devices accept a fiber connector and a coaxial connector and convert digital signals from optical to coax.

Fiber to Coaxial Converter

- **Single-Mode to Multimode Fiber** - These devices accept a single-mode fiber connector and a multimode fiber connector and convert the signals between the two.

Single-Mode to Multimode Fiber Converter

Cable Properties

Transmission Speeds

Network administrators can control the speed of a network to meet the network's traffic demands based on the selected *cable or fiber type* and the *network topology*.

Admins usually permit or would like to have, transmission speeds of up to 10 Gbps or higher on the core areas of their networks that connect various network segments. In the distribution and access areas, where users connect to switches, it's typically 100 Mbps per connection, but transmission speeds are creeping up because the traffic demand is getting higher.

Distance

Decision factors used in choosing what type of cable to use often come down to the topology of a network and the distance between its components. Some network technologies can run much farther than others without communication errors, but all network communication technologies are prone to attenuation—the degradation of a signal due to the medium itself and the distance signals have to travel. Some cable types suffer from attenuation more than others. For instance, any network using twisted-pair cable should have a maximum segment length of only 328 feet (100 meters).

Duplex

All communications are either **half-duplex** or **full-duplex**. The difference is whether the communicating devices can "*talk*" and "*listen*" at the same time.

During **half-duplex** communication, a device can either send communication or receive communication, but not both at the same time. Think walkie-talkie—when you press the button on the walkie-talkie, you turn the speaker off and you can't hear anything the other side is saying.

In **full-duplex** communication, both devices can send and receive communication at the same time. This means that the effective throughput is doubled and communication is much more efficient. Full duplex is typical in most of today's switched networks. We'll discuss full and half-duplex in more detail in the section "The Current Ethernet Specifications."

Frequency

Each cable type has a specified maximum frequency that gives you the transmission bandwidth it can handle. Cat5e cable is tested to 100 MHz maximum frequency and can run 1 Gbps signals for relatively short distances. That's maxing it out, but it's still good for connecting desktop hosts at high speeds. On the other hand, Cat6 is a 250 MHz cable that can handle 1 Gbps data flow all day long with ease. Cat 6 has a lot more twists and thicker cables, so it's best used when connecting floors of a building.

Tips:

- Although a signal is measured as **bandwidth**, the capacity to carry the signal in a cable is measured as **frequency**.