Network Cable Types and Specifications

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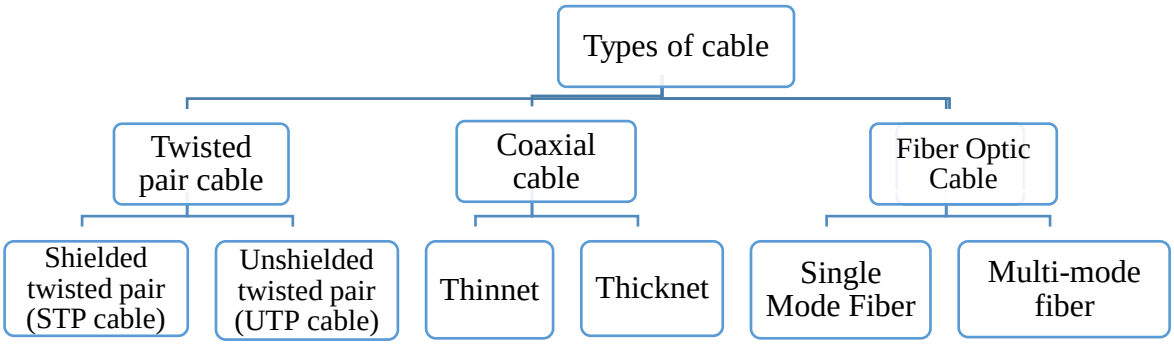
Introduction

Cable is the medium through which information usually moves from one network device to another. The type of cable chosen for a network is related to the network's topology, protocol, and size. Understanding the characteristics of different types of cable and how they relate to other aspects of a network is necessary for the development of a successful network. Network cables are used to connect and transfer data and information between computers, routers, switches and storage area networks. These cables are essentially the carrier or media through which data flows.

Even though there have been advances in wireless technologies, many computer networks in the 21st century rely on cables as the physical medium that devices use to transfer data. Several standard types of network cables exist, each designed for specific purposes. The most commonly used types of communications cables are dominated by what is referred to as “twisted pair cable”. In local area networks; typically, office environments, retail and commercial sites, copper communications cabling.

There are three types of network cables; coaxial, twisted-pair, and fiber-optic.



Coaxial cable

A coaxial cable consists of an inner conductor with an insulating layer surrounding it. That insulating layer is then covered by a conductive shielding or an outer insulating jacket. Electrical signals flow throughout the central conductor which is typically made of copper-clad steel (See fig. 1). Coaxial cabling is highly resistant to signal obstruction, in addition, it can support greater cable lengths between network devices than twisted pair cable, although it can be complex to install. Sometimes known as coax cable, is an electrical cable that transmits radio frequency (RF) signals from one point to another. The technology has been around since the early 20th century, with these cables mainly being used to connect satellite antenna facilities to homes and businesses thanks to their durability and ease of installation.

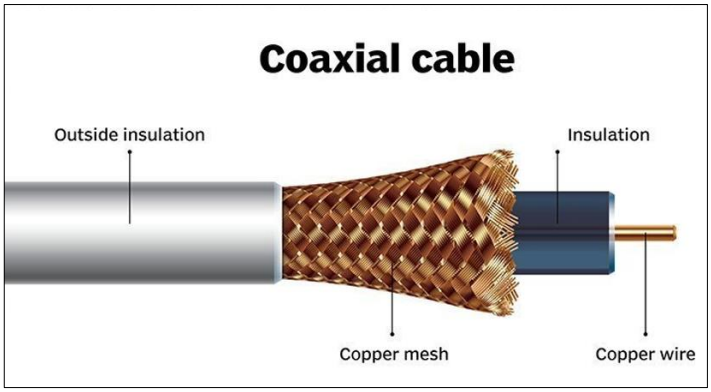


Figure 1: Coaxial cable

The center conductor layer is a thin conducting wire, either solid or braided copper. A dielectric layer, made up of an insulating material with very well-defined electrical characteristics, surrounds the wire. A shield layer then surrounds the dielectric layer with metal foil or braided copper mesh. The whole assembly is wrapped in an insulating jacket. The outer metal shield layer of the coaxial cable is typically grounded in the connectors at both ends to shield the signals and as a place for stray interference signals to dissipate.

Types of Coaxial Cable

Two main types of coaxial cable are used in computer networking: Thinnet and Thicknet coaxial cable .

1. Thick coaxial cable is also referred to as thicknet: 10Base5 refers to the specifications for thick coaxial cable carrying Ethernet signals. The 5 refers to the maximum segment length being 500 meters. Thick coaxial cable has an extra protective plastic cover that helps keep moisture away from the center conductor. This makes thick coaxial a great choice when running longer lengths in a linear bus network.
2. Thin coaxial cable is also referred to as thinnet: 10Base2 refers to the specifications for thin coaxial cable carrying Ethernet signals. The 2 refers to the approximate maximum segment length being 200 meters. Thin coaxial cable has been popular in school networks. One disadvantage of thick coaxial is that it does not bend easily and is difficult to install.

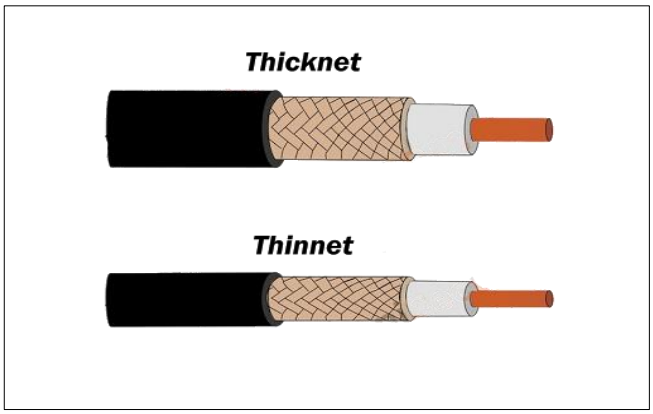


Figure 2: Types of coaxial cable

RG6 cables can carry signals at a longer distance and keep better signal quality than RG59 cables. Therefore, RG6 cables are usually used for high-frequency applications like TV connection, while RG59 cables is more suitable for low-frequency and short-distance transmission. RG 59 has a smaller conductor than RG 6, which means that it can't achieve the same signal quality as RG 6. The way its shielding is designed also means that it doesn't keep Gigahertz level signals inside the conductor very well. This is why RG 59 probably isn't a good choice for your TV or internet connection.

From these specifications, only a few were used in computer networks. The following table lists them.

Type	Ohms	AWG	Conductor	Description
RG-6	75	18	Solid copper	Used in cable network to provide cable Internet service and cable TV over long distances.
RG-8	50	10	Solid copper	Used in the earliest computer networks. This cable was used as the backbone cable in the bus topology. In Ethernet standards, this cable is documented as the 10base5 Thicknet cable.
RG-58	50	24	Several thin strands of copper	This cable is thinner, easier to handle and install than the RG-8 cable. This cable was used to connect a system with the backbone cable. In Ethernet standards, this cable is documented as the 10base2 Thinnet cable.
RG-59	75	20 - 22	Solid copper	Used in cable networks to provide short-distance service.

- Coaxial cable uses RG rating to measure the materials used in shielding and conducting cores.
- RG stands for the Radio Guide. Coaxial cable mainly uses radio frequencies in transmission.
- Impedance is the resistance that controls the signals. It is expressed in the ohms.
- AWG stands for American Wire Gauge. It is used to measure the size of the core. The larger the AWG size, the smaller the diameter of the core wir

Difference between RG59 and RG6

- RG59 and RG6 cables are commonly used in satellite television and cable modems. Older installations used the RG59 cable before the implantation of the RG6 cable. The RG59 cable is thinner at a 20 American Wire Gauge (AWG) and has a copper center conductor. This cable is more likely to be found in older buildings and is better for CCTV and analog video systems.

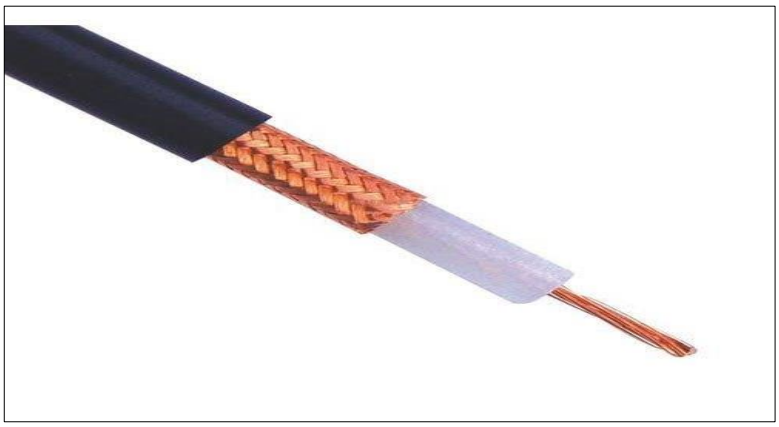


Figure 4: RG59 and RG6 cables

The RG6 cable is a larger 18 AWG cable and also has a copper center conductor. The RG6 cable is used with high-bandwidth and high-frequency hardware, where internet and satellite signals can run at a higher frequency compared to traditional analog video. What cable an individual may need will most of the time depend on the frequency. Above 50 MHz, and an individual should use an RG6 cable.

Figure 5: RG6 cable

Uses of coaxial cables

Typically, coaxial cable is used to carry voice, video, and data over the same wire ,In the home and small offices, short coaxial cables are used for cable television, home video equipment, amateur radio equipment and measuring devices. Historically, coaxial cables were also used as an early form of Ethernet, supporting speeds of up to 10 Mbps, but coax has supplanted by the use of twisted pair cabling. However, they remain widely in use for cable broadband internet. Coaxial cables are also used in automobiles, aircraft, military and medical equipment, as well as to connect satellite dishes, radio and television antennae to their respective receivers.

Coaxial Cable Connectors

There are many different types of coaxial cable connectors separated by two styles male and female connectors. Connector types include:

- BNC- Standing for Bayonet Neil-Concelman, this connector is used with television, video signal and radio below a frequency of 4GHz
- TNC- Standing for Threaded Neil-Concelman, this connector is a threaded version of the BNC connector and is used in cellphones. TNC connectors operate up to 12 GHz.
- SMA- Standing for Sub Miniature version A, this connector is used with cellphones, Wi-Fi antenna systems, microwave systems and radios. SMA connectors operate up to 18GHz.
- SMB- Standing for Subminiature version B, this connector may be used with telecommunications hardware.
- QMA- QMA connectors are a quick-locking variant of SMA connectors used with industrial and communications hardware.
- RCA- Standing for Radio Corporation of America, these are connectors used in audio and video. These are the grouped yellow, white and red cables used with older televisions. RCA connectors are also called A/V jacks.
- F connectors- Also called F-types, these are used in digital and cable televisions. These commonly use RG6 or RG 59 cables.

The most common type of connector used with coaxial cables is the Bayone-Neill-Concelman (BNC) connector (See fig. 3). Different types of adapters are available for BNC connectors, including a T-connector, barrel connector, and terminator. Connectors on the cable are the weakest points in any network. To help avoid problems with your network, always use the BNC connectors that crimp, rather screw, onto the cable.

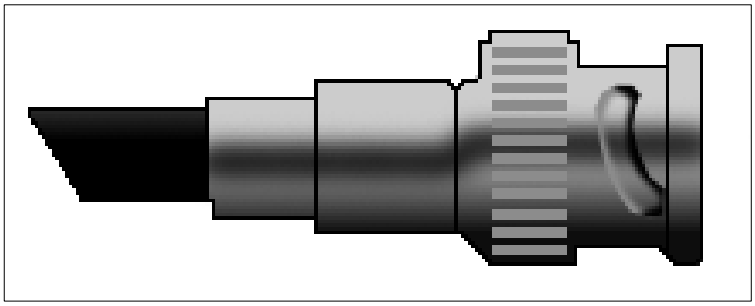


Figure 3: Bayone-Neill-Concelman (BNC) connector

Fiber Optic Cable

The use of fiber-optics was generally not available until 1970 when Corning Glass Works was able to produce a fiber with a loss of 20 dB/km. The applications of optical fiber communications have increased at a rapid rate, since the first commercial installation of a fiber-optic system in 1977. Telephone companies began early on, replacing their old copper wire systems with optical fiber lines. Today's telephone companies use optical fiber throughout their system as the backbone architecture and as the long-distance connection between city phone systems.

Fiber optic cables possess a center glass core surrounded by multiple layers of protective materials. It transmits light rather than electronic signals eliminating the problem of electrical interference. This makes it ideal for certain environments that contain a large amount of electrical interference.

Fiber optic cable has the ability to transmit signals over much longer distances than coaxial and twisted pair. It also has the capability to carry information at vastly greater speeds. This capacity broadens communication possibilities to include services such as video conferencing and interactive services.

This cable consists of a core, cladding, buffer, and jacket. The core is made from thin strands of glass or plastic that can carry data over a long distance. The core is wrapped in the cladding; the cladding is wrapped in the buffer, and the buffer is wrapped in the jacket.

- Core carries the data signals in the form of light.
- Cladding reflects light back to the core.
- Buffer protects the light from leaking.
- The jacket protects the cable from physical damage.

The center core of fiber cables is made from glass or plastic fibers (see fig 6). A plastic coating then cushions the fiber center, and kevlar fibers help to strengthen the cables and prevent breakage. The outer insulating jacket made of teflon or PVC.

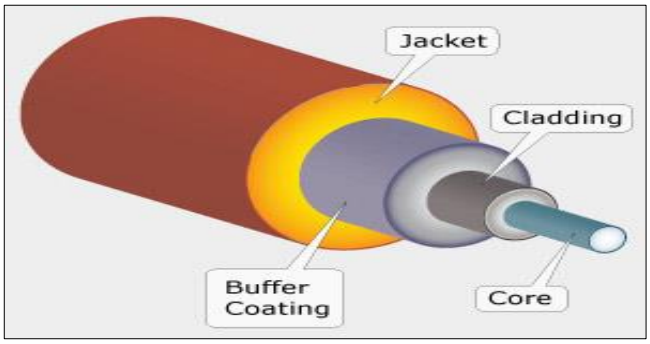


Figure 6: Fiber Optic Cable

Fiber optic uses light to send data. It reflects light from one endpoint to another. Based on how many beams of light are transmitted at a given time. Fiber optic cable is completely immune to EMI and RFI. This cable can transmit data over a long distance at the highest speed. It can transmit data up to 40 kilometres at the speed of 100Gbps.

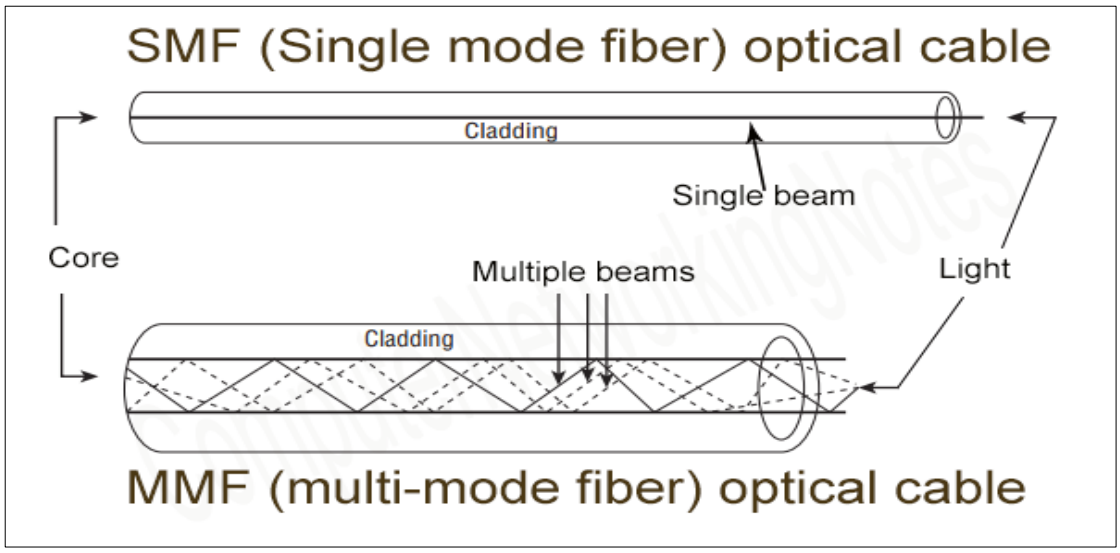


Figure 7: Sending data using light in Fiber optic

There are three types of fiber optic cable commonly used: single mode fiber (SMF), multimode fiber (MMF) and plastic optical fiber (POF).

1- SMF (Single-mode fiber) optical cable

Is a single stand of glass fiber with a diameter of 8.3 to 10 microns that has one mode of transmission, Single Mode Fiber with a relatively narrow diameter, through which only one mode will propagate typically 1310 or 1550nm. Carries higher bandwidth than multimode fiber, but requires a light source with a narrow spectral width. Single Modem fiber is used in many applications where data is sent at multi-frequency (WDM Wave-Division-Multiplexing) so only one cable is needed.

Single-mode fiber gives you a higher transmission rate and up to 50 times more distance than multimode, but it also costs more. Single-mode fiber has a much smaller core than multimode.

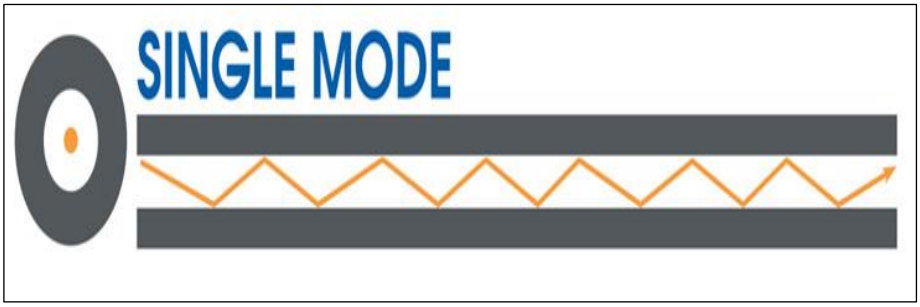


Figure 8: SMF (Single-mode fiber) optical cable

2- MMF (multi-mode fiber) optical cable

This cable carries multiple beams of light. Because of multiple beams, this cable carries much more data than the SMF cable. Multimode fiber gives you high bandwidth at high speeds (10 to 100MBS - Gigabit to 275m to 2km) over medium distances. Light waves are dispersed into numerous paths, or modes, as they travel through the cable's core typically 850 or 1300nm. However, in long cable runs (greater than 3000 feet [914.4 meters), multiple paths of light can cause signal distortion at the receiving end, resulting in an unclear and incomplete data transmission so designers now call for single mode fiber in new applications using Gigabit and beyond.

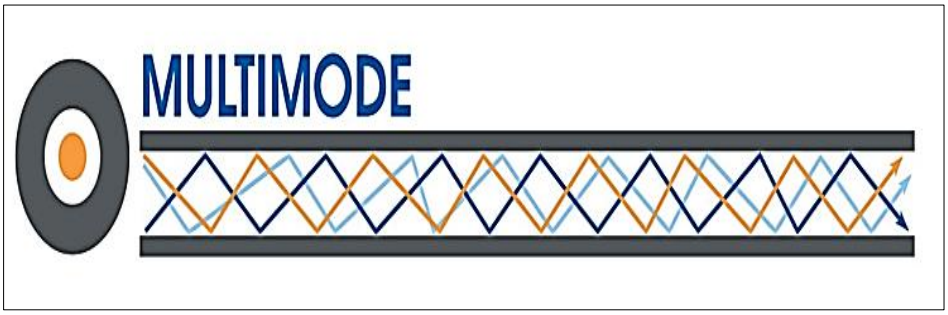


Figure 9: MMF (multi-mode fiber) optical cable

3- Plastic optical fiber (POF)

Plastic or polymer optical fiber is an optical fiber that is made out of polymer. Similar to glass optical fiber, POF transmits light (for illumination or data) through the core of the fiber. Its chief advantage over the glass product, other aspect being equal, is its robustness under bending and stretching. The cost of fiber optic cabling is comparable to copper cabling; however, it is more difficult to install and modify. 10BaseF refers to the specifications for fiber optic cable carrying Ethernet signals.

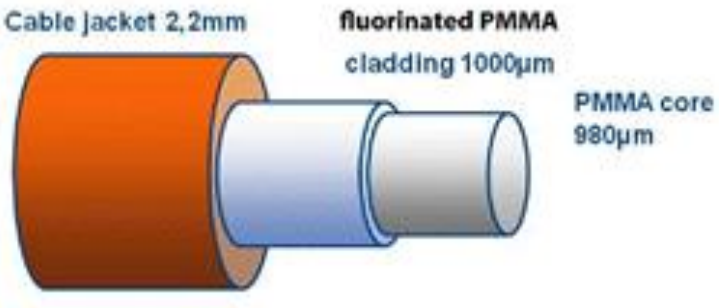


Figure 10: Plastic optical fiber (POF)

Fiber Optic Cable Connectors

Around a hundred different types of fiber-optic cable connectors are available in the market. Nevertheless, some types of fiber-optic cable connectors are commonly used, like MT, FC, ST, LC, and SC connectors. Most types of cable connectors are suitable for male connectors. The fiber-optic cable connectors are used by different methods like screw-on, bayonet, and snap-in. This cable connector type is used for transmission purposes, the fiber-optic cable connectors are available in duplex and simplex designs. The simplex cable connector can block one fiber, whereas the duplex cable connector can terminate two fibers simultaneously.

- ### MT-RJ Connectors

This is a duplex-style cable connector available in both male and female versions. They come with multiple bins for enhanced alignment and surround both fibers inside the polymer ferrule.

- ### SC Connectors

SC connectors are also referred to as snap-in connectors, highly used because of exceptional performance.

- ### ST Connectors

ST connectors are also known as spring-loaded connectors having a 2.5mm symmetrical ferrule and bayonet mount. ST connectors are very popular and highly used in the applications of multimode networking systems.

FC Connectors

When it comes to single-mode connectors, FC cable connectors are highly recommended.

Figure 10: Fiber Optic Cable Connectors

Brief over view of fiber optic cable advantages over copper

• Speed: Fiber optic networks operate at high speeds - up into the gigabits
• Bandwidth: large carrying capacity
• Distance: Signals can be transmitted further without needing to be "refreshed" or strengthened.
• Resistance: Greater resistance to electromagnetic noise such as radios, motors or other nearby cables.
• Maintenance: Fiber optic cables costs much less to maintain.

Twisted-pair cable

The twisted-pair cable was primarily developed for computer networks. This cable is also known as Ethernet cable. This cable consists of color-coded pairs of insulated copper wires. Every two wires are twisted around each other to form pair. Usually, there are four pairs. Each pair has one solid color and one stripped color wire. Solid colors are blue, brown, green, and orange. In stripped color, the solid color is mixed with the white color.

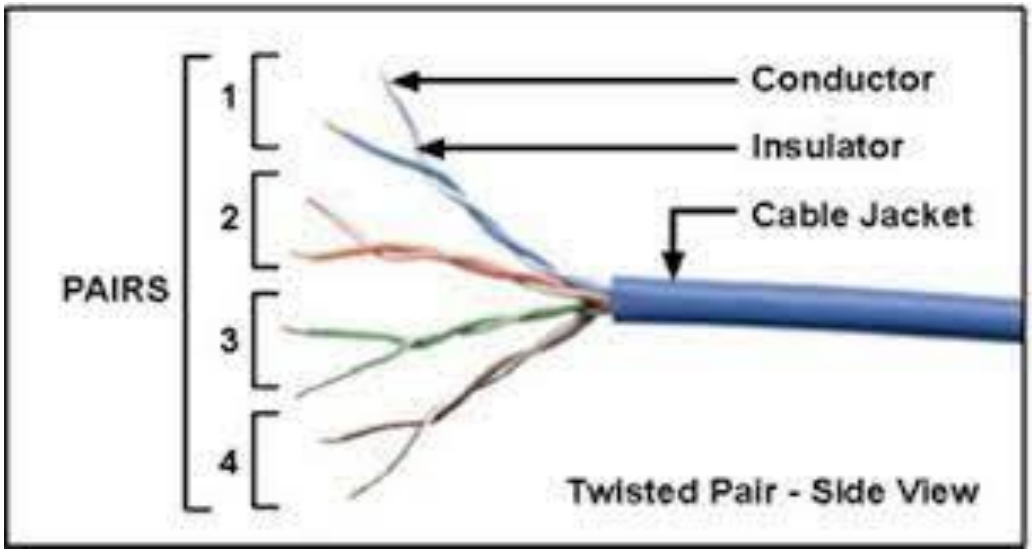


Figure 12: Twisted-pair cable

Types of Twisted Pair Cables

For additional noise immunity, twisted pair cabling may be shielded. Cable with shielding is known as **shielded twisted pair (STP cable)** and without as **unshielded twisted** pair (UTP cable).

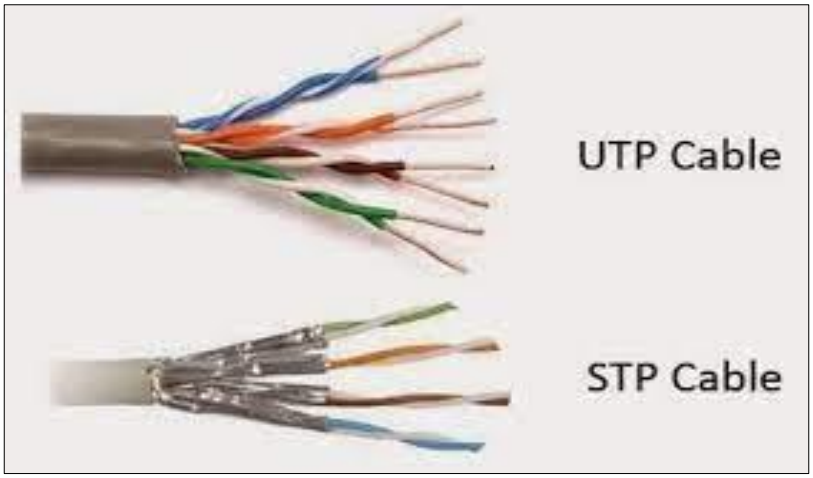


Figure 13: shielded twisted pair and unshielded twisted pair cable

1- Shielded Twisted Pair (STP) Cable

A shielded twisted pair is a type of twisted pair cable that contains an extra wrapping foil or copper braid jacket to protect the cable from defects like cuts, losing bandwidth, noise, and signal to the interference. It is a cable that is usually used underground, and therefore it is costly than UTP. It supports the higher data transmission rates across the long distance. We can also say it is a cable with metal sheath or coating that surround each pair of the insulated conductor to protect the wire from external users and prevent electromagnetic noise from penetrating.

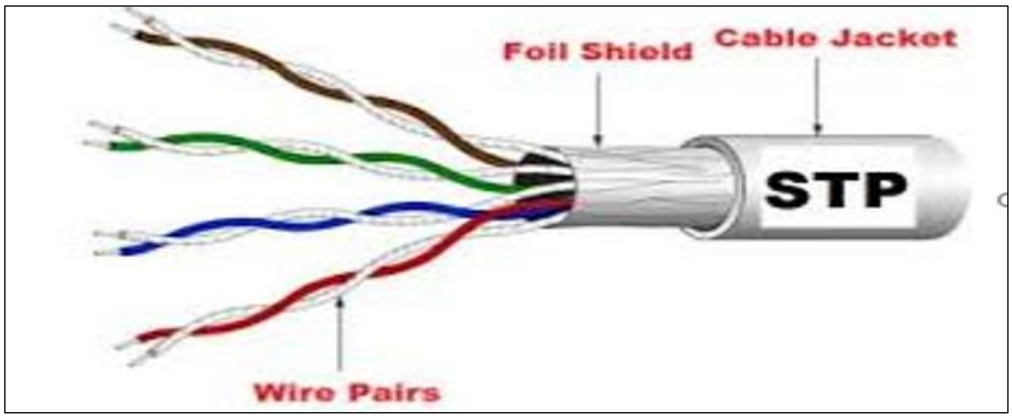


Figure 14: Shielded Twisted Pair (STP) Cable

There are a variety of different types of STP cables, such as a foil twisted pair (FTP) and a shielded foil twisted pair (S/FTP).

1. **FTP:** There are also STP cables that use a lighter, foil shield. However, note that bend radius and pulling tension must be monitored during installation to prevent these shielded cables from tearing.
2. **S/FTP:** To avoid the possibility of tearing, there are also STP cabling systems that use a thick braided shield to make the cable sturdier. Essentially, the individual pairs of wires inside the cable are twisted and shielded to provide the best protection against cross-talk and electromagnetic interference.

Advantages of the STP cable

- It has lower noise and attenuation than UTP.
- It is shielded with a plastic cover that protects the STP cable from a harsh environment and increases the data transmission rate.
- It reduces the chances of crosstalk and protects from external interference.
- A modular connection helps to terminate the connection of the STP cable.

Disadvantages of the STP cable

- It is the most expensive wire from UTP cables.
- It requires more maintenance to reduce the loss of data signals.
- There is no segment improvement in length despite its thick and heavier connection.
- It is used only as a grounded wire.

2- Unshielded Twisted Pair (UTP) Cable

UTP is an unshielded twisted pair cable used in computer and telecommunications mediums. Its frequency range is suitable for transmitting both data and voice via a UTP cable. Therefore, it is widely used in the telephone, computers, etc. It is a pair of insulated copper wires twisted together to reduce noise generated by external interference. It is a wire with no additional shielding, like aluminum foil, to protect its data from the exterior. Unshielded twisted pair (UTP) is the most popular and is generally the best option for school networks.

Figure 15: Unshielded Twisted Pair (UTP) Cable

The quality of UTP may vary from telephone-grade wire to extremely high-speed cable. The cable has four pairs of wires inside the jacket. Each pair is twisted with a different number of twists per inch to help eliminate interference from adjacent pairs and other electrical devices. The tighter the twisting, the higher the supported transmission rate and the greater the cost per foot. The EIA/TIA (Electronic Industry Association/Telecommunication Industry Association) has established standards of UTP and rated eight categories of wire.as shown in the table below

Category/name of the cable	Maximum supported speed	Bandwidth/support signals rate	Ethernet standard	Description
Cat 1	1Mbps	1MHz	Not used for data	This cable contains only two pairs (4 wires). This cable was used in the telephone network for voice transmission.
Cat 2	4Mbps	4MHz	Token Ring	This cable and all further cables have a minimum of 8 wires (4 pairs). This cable was used in the token-ring network.
Cat 3	10Mbps	16MHz	10BASE-T Ethernet	This is the first Ethernet cable that was used in LAN networks.
Cat 4	20Mbps	20MHz	Token Ring	This cable was used in advanced Token-ring networks.
Cat 5	100Mbps	100MHz	100BASE-T Ethernet	This cable was used in advanced (fast) LAN networks.
Cat 5e	1000Mbps	100MHz	1000BASE-T Ethernet	This cable/category is the minimum requirement for all modern LAN networks.
Cat 6	10Gbps	250MHz	10GBASE-T Ethernet	This cable uses a plastic core to prevent cross-talk between twisted-pair. It also uses a fire-resistant plastic sheath.
Cat 6a	10Gbps	500MHz	10GBASE-T Ethernet	This cable reduces attenuation and cross-talk. This cable also Potentially removes the length limit. This is the recommended cable for all modern Ethernet LAN networks.
Cat 7	10Gbps	600MHz	Not drafted yet	This cable sets a base for further development. This cable uses multiple twisted-pair and shields each pair by its plastic sheath.

- Cat 1, 2, 3, 4, 5 are outdate and not used in any modern LAN network.
- Cat 5e, 6, 6a are the commonly used twisted-pair cables.
- Cat 7 is still a new technology and not commonly used.

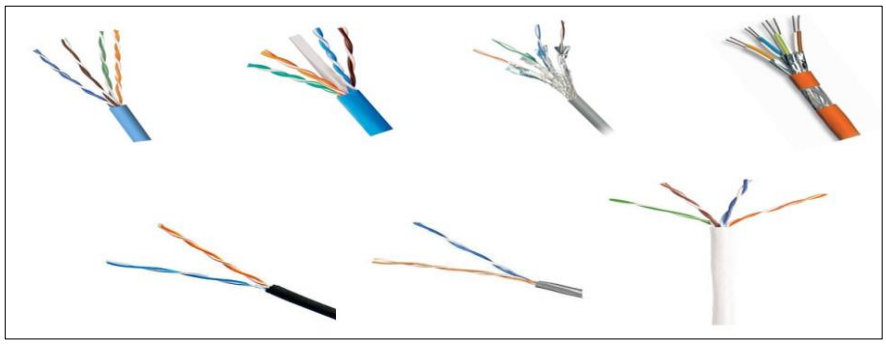


Figure 16: Types of category cable

Advantages of the UTP:

- It is a less costly and less expensive unshielded wire from another network medium.
- It is designed to reduce crosstalk, RFI, and EMI.
- Its size is small, and hence the installation of the UTP is easier.
- It is mostly useful for short-distance network connections like home and small organizations.
- It is the most commonly used networking cable in the market. It is considered as faster copper-based data transmission cable.
- It is suitable for transmitting both data and voice via UTP cable.

Disadvantage of the UTP:

- It can only be used in length segment up to 100 meters.
- It has limited bandwidth for transmitting the data.
- It does not provide a secure connection for data transmitting over the network.

Difference between UTP and STP

UTP	STP
It is an unshielded twisted pair.	It is a shielded twisted pair.
UTP cable is a twisted pair cable with wires that are twisted together.	It is enclosed within a foil or mesh shield.
The price of UTP is lower as compared to the STP.	The price of STP is much costlier than UTP.
It does not require a grounding cable.	It requires a grounding cable.
In UTP, the electromagnetic interference is more than the STP while transferring the signal to the transmission media.	It reduces electromagnetic interference while transferring the signal to the transmission media.
UTP has high crosstalk.	STP has low crosstalk.
Transferring speed of the data signal is slow as compared to the STP.	Transferring speed of the data signal is high as compared to the UTP.
Installation of UTP cables is easy as they are lighter, small in size, and flexible.	Installation of STP cable is quite difficult as compared to the UTP. Its size is heavy, bigger, and stiffer.
It does not require much maintenance.	It requires more maintenance.
UTP cables are noisier.	STP cables are less noisy.
However, the UTP cable is used to establish the connection within a short distance, like a home or small industry.	Generally, it is used to establish the connection for enterprises over a long distance.

Similarities between STP and UTP cables

- Both STP and UTP can transmit data at 10Mbps, 100Mbps, 1Gbps, and 10Gbps.
- Both cables use the same RJ-45 (registered jack) modular connectors.
- Both cables can accommodate a maximum of 1024 nodes in each segment.

Types of Twisted Pair Cable Connectors

There are mainly two types of cable connectors used for twisted pair connection in voice and data communication installation.

- **RJ11 Connectors**

- RJ11 connectors typically have only 6 positions and 4 or 2 contacts. They are not internationally standardized, but used to be a very popular choice for both commercial and residential telephone applications due to their simplicity and small forms.

- **RJ45 Connectors**

  RJ45 connectors normally have 8 positions and 8 contacts. Therefore, RJ45 connectors are larger than RJ11 connectors in forms. An RJ45 connector is usually used for data transmission in scenarios such as monitoring projects and general cabling in the equipment room.

Due to the different structure of RJ45 and RJ11 connectors, the wiring sequence standard and applications are also different. It is not recommended to use RJ11 plugs for RJ45 jacks as it may cause damages on the devices.

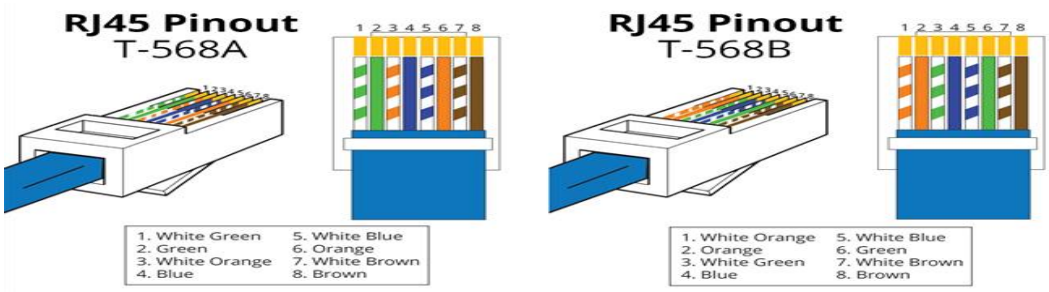


Figure 17: Types of category cable

Difference between Twisted pair cable, Co-axial cable and Optical fiber cable.

Co-axial cable	Twist pair cable	Fiber optic cable
Transmission of signals takes place in the electrical structure over the conflicting metallic wires.	Transmission of signal takes place in the electrical structure over the inner conductor of the cable.	Signal transmission place in an optical structure over glass fibre.
Noise immunity is low. Hence more distortion.	Higher noise immunity than the twisted pair cable because of the presence of a shielding conductor.	Higher noise immunity as the light rays is unaffected by the electrical noise.
It can be affected due to the external magnetic field.	It can be less affected due to the external magnetic field.	It is not affected by the external magnetic field.
A short circuit between the two conductors is possible.	A short circuit between the two conductors is possible.	A short circuit is not possible.
It is cheapest	It is moderately expensive.	It is expensive.
It can support low data rates.	It can be relatively high data rates.	It is very high data rates.
Power loss due to conduction and radiation	Power loss due to conduction	Power loss due to absorption, scattering dispersion and bending.
Node capacity per segment is 2.	Node capacity per segment is 30 to 100.	Node capacity per segment is 2.
Attenuation is very high.	Attenuation is low.	Attenuation is very low.
Installation is easy.	Installation is relatively easy.	Installation is complicated.

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