Chapter 3

3.1 Introduction

The **Network Media** is the device that physically carries the data from computer to computer. The three major types of network media are:

- Copper Cable
- Fiber-Optic Cable
- Wireless

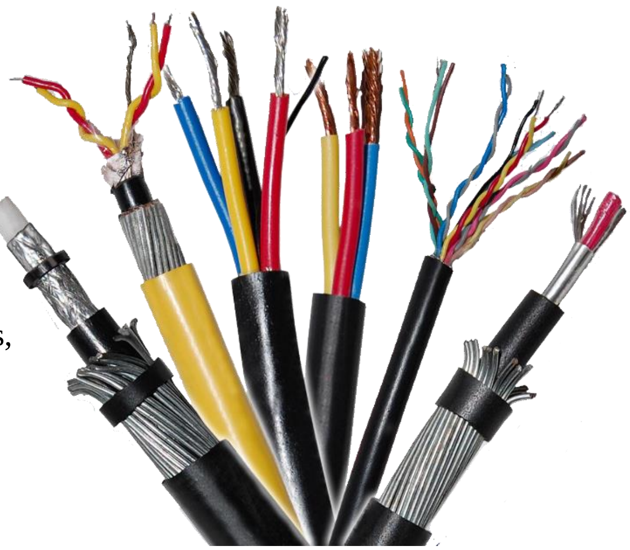
Each computer network can be built with many different media types. The **function of media** is to carry a flow of information through a LAN. Wireless LANs use the atmosphere, or space, as the medium. Other networking media confine network signals to a wire, cable, or fiber.

Each type of media has advantages and disadvantages. These are based on the following factors:

1. Cable Length
2. Cost
3. Ease of Installation
4. Susceptibility to Interference

3.2 Copper Cable

Copper cable is the most common type of network media used today. The data is carried over the copper cable in the form of electrical signals form computer to computer. The **disadvantage** of sending data over a copper wire is that the **further the signal travels, the weaker it becomes**. Copper is, however, **the easiest, quickest, and cheapest form of network media to install.**

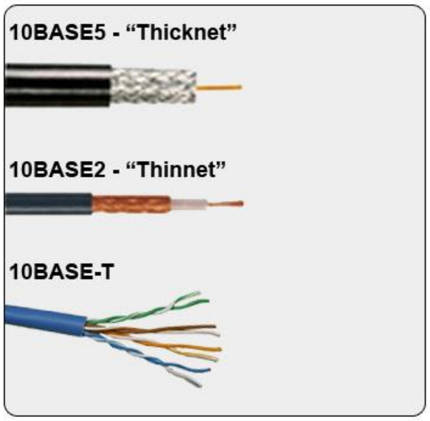


3.2.1 Cable Specification

Copper cables have different specifications and expectations. Important considerations related to performance are as follows:

- What speeds for data transmission can be achieved? The speed of bit transmission through the cable is extremely important. The speed of transmission is affected by the kind of conduit used.
- Will the transmissions be digital or analog? Digital or baseband transmission and analog or broadband transmission require different types of cable.
- How far can a signal travel before attenuation becomes a concern? If the signal is degraded, network devices might not be able to receive and interpret the signal. The distance the signal travels through the cable affects attenuation of the signal. Degradation is directly related to the distance the signal travels and the type of cable used.

The following Ethernet specifications relate to cable type:

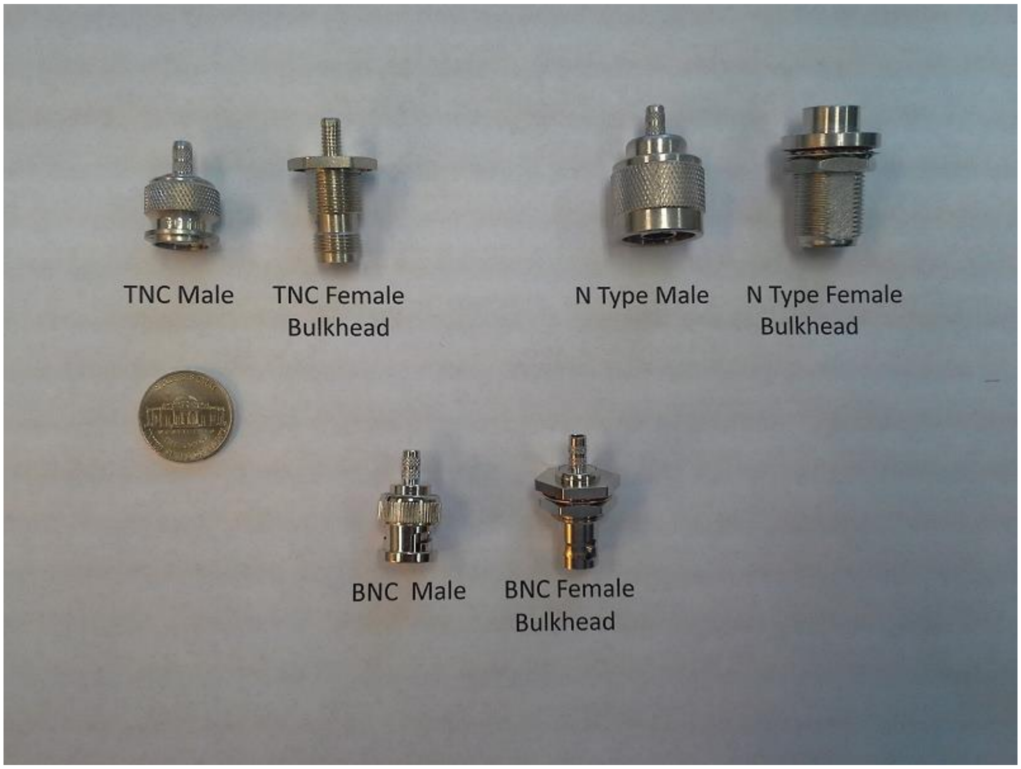


- 10BASE-T
- 10BASE5
- 10BASE2

10BASE-T refers to the speed of transmission at 10Mbps. The type of transmission is baseband, or digitally interpreted. The T stands for twisted pair.

10BASE5 refers to the speed of transmission at 10 Mbps. The type of transmission is baseband, or digitally interpreted. The 5 indicates that a signal can travel for approximately 500 meters before attenuation could disrupt the ability of the receiver to interpret the signal. 10BASE5 is often referred to as **Thicknet**.

10BASE2 refers to the speed of transmission at 10 Mbps. The type of transmission is baseband, or digitally interpreted. The 2, in 10BASE2, refers to the approximate maximum segment length being 200 meters before attenuation could disrupt the ability of the receiver to appropriately interpret the signal being received. The maximum segment length is actually 185 meters. 10BASE2 is often referred to as **Thinnet**.

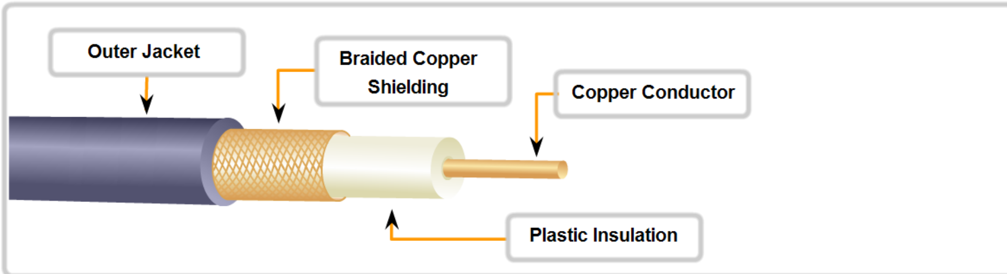


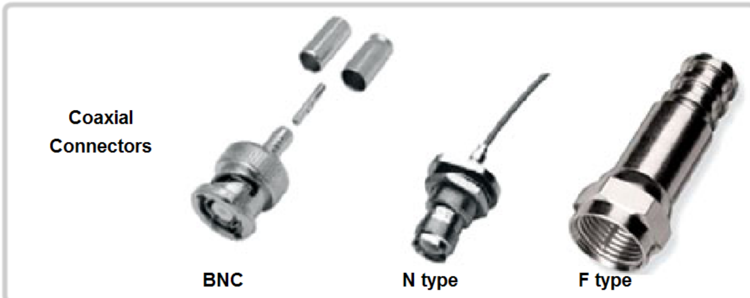
3.2.2 Coaxial Cables

Coaxial Cable consists of a copper conductor surrounded by a layer of flexible insulation. The center conductor can also be made of tin plated aluminum cable allowing for the cable to be manufactured inexpensively. Over this insulating material is a woven copper braid or metallic foil that acts as the second wire in the circuit and as a shield for the inner conductor. This second layer or shield also reduces the amount of outside electromagnetic interference. Covering this shield is the cable jacket. For LANs, coaxial cable offers **several advantages**. **It can be run longer distances than shielded twisted pair, STP, unshielded twisted pair, UTP, and screened twisted pair, ScTP, cable without the need for repeaters**. Coaxial cable is l**ess expensive than fiber-optic cable and the technology is well known**. It has been used for many years for many types of data communication such as cable television.

- Speed and throughput: 10-100Mbps
- Cost: Inexpensive
- Media and connector size: Medium
- Maximum cable length: 500m

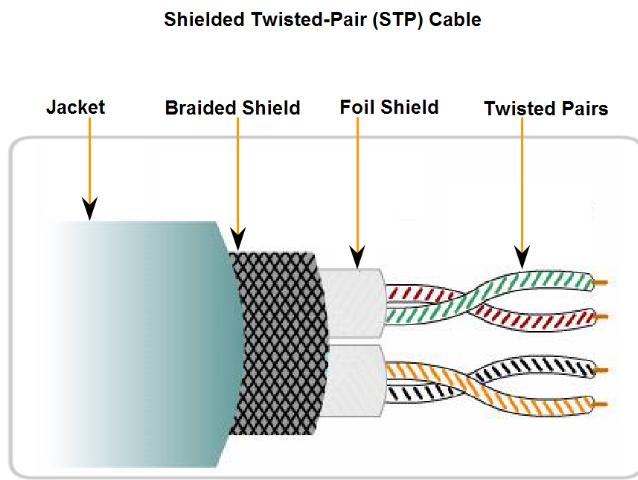
Coaxial Cable Design





3.2.3 STP Cable

In **Shielded Twisted Pair** STP each pair of wires is wrapped in a metallic foil. The two pairs of wires are wrapped in an overall metallic braid or foil. It is usually 150-ohm cable. As specified for use in Token Ring network installations, STP reduces electrical noise within the cable such as pair to pair coupling and crosstalk. STP also reduces electronic noise from outside the cable such as electromagnetic interference (EMI) and radio frequency interference (RFI). STP cable shares many of the advantages and disadvantages of UTP cable. STP provides more protection from all types of external interference. However, STP is more expensive and difficult to install than UTP.



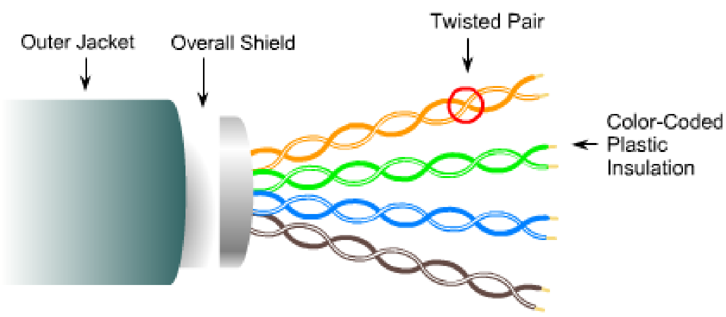
- Speed and throughput: 0-100Mbps
- Cost: Moderate
- Media and connector size: Medium to large
- Maximum cable length: 100m

3.2.4 Screened UTP (ScTP)

A new hybrid of UTP is Screened UTP (ScTP), which is also known as foil screened twisted pair (FTP). ScTP is essentially UTP wrapped in a metallic foil shield, or screen. ScTP, like UTP, is also 100 ohm cable. Many cable installers and manufacturers may use the term STP to describe ScTP cabling. It is important to understand that most references made to STP today actually refer to Four-Pair Shielded Cabling. It is highly unlikely that true STP cable will be used during a cable installation job.

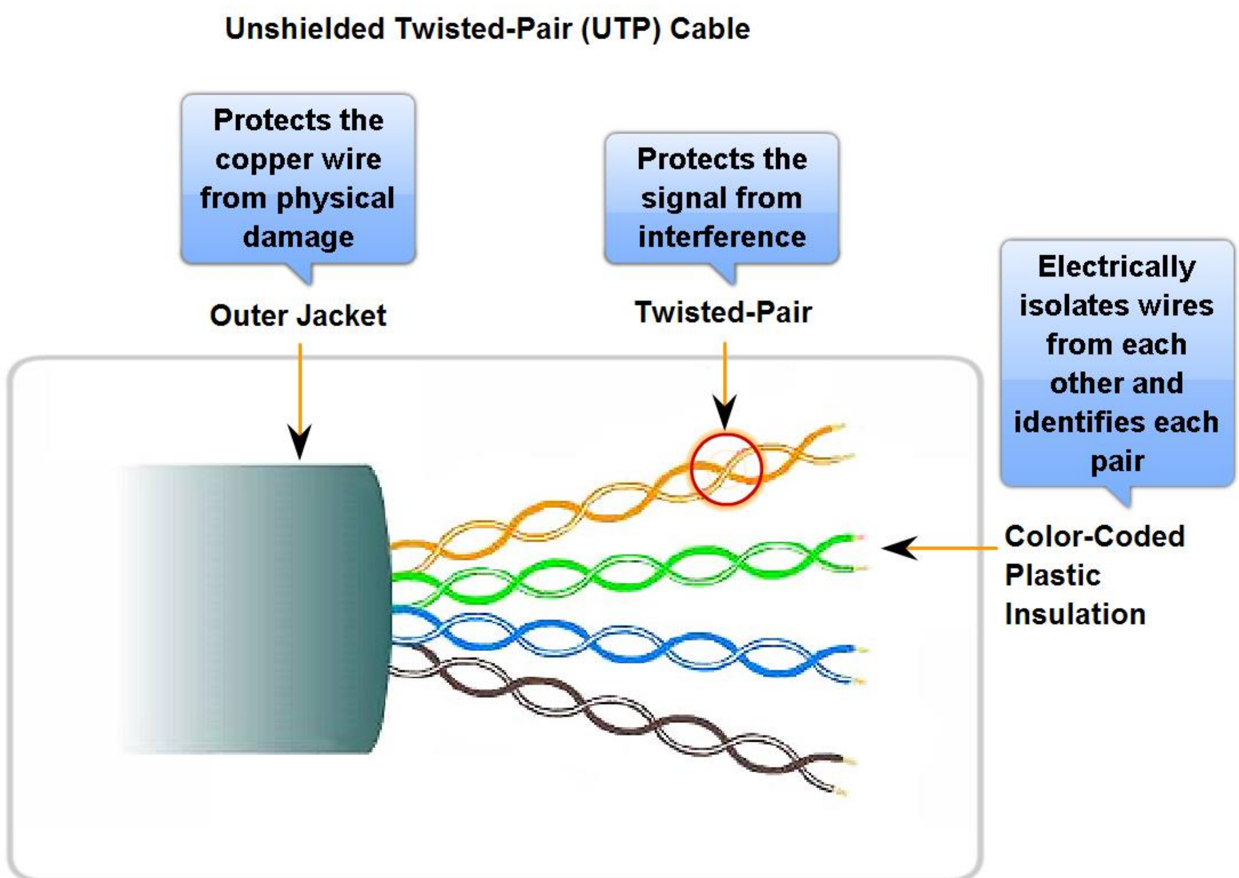
The shield prevents incoming electromagnetic waves from causing noise on data wires, and it also minimizes the outgoing radiated electromagnetic waves. These waves could cause noise in other devices. STP and ScTP cable cannot be run as far as other networking media, such as coaxial cable or optical fiber, without the signal being repeated. More insulation and shielding combine to considerably increase the size, weight, and cost of the cable.

- Speed and throughput: 0-100Mbps
- Cost: Moderately Expensive
- Media and connector size: Medium to large
- Maximum cable length: 100m

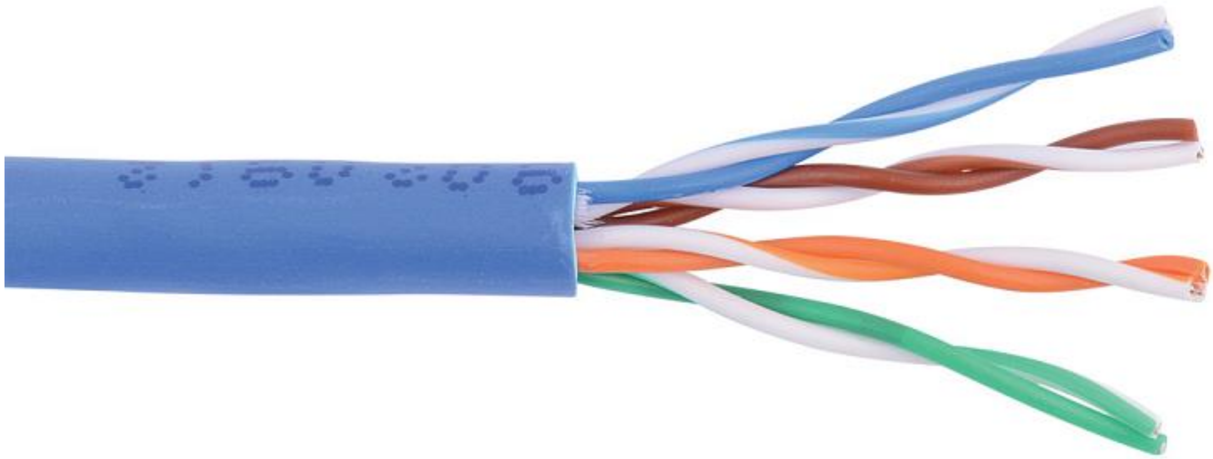


3.2.5 UTP Cable Unshielded Twisted Pair

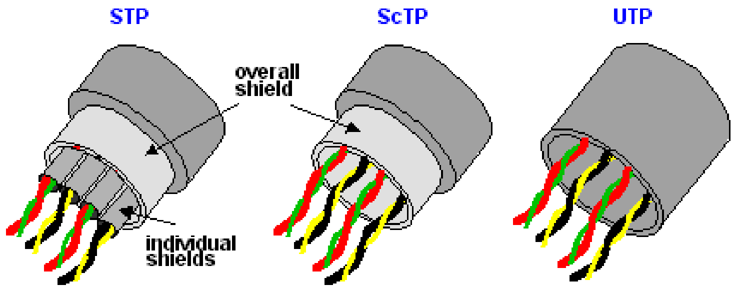
UTP is a four-pair wire medium used in a variety of networks. Each of the eight copper wires in the UTP cable is covered by insulating material. In addition, each pair of wires is twisted around each other. This type of cable relies on the cancellation effect produced by the twisted wire pairs to limit signal degradation caused by EMI and RFI. To further reduce crosstalk between the pairs in UTP cable, the number of twists in the wire pairs varies. Like STP cable, UTP cable must follow precise specifications as to how many twists or braids are permitted per foot of cable.



- Speed and throughput: 10-100-1000Mbps*
- Cost: Least Expensive
- Media and connector size: Small
- Maximum cable length: 100m * (Depending on the quality/category of cable)



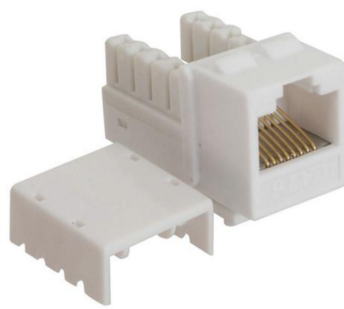
UTP cable has many advantages. It is easy to install and is less expensive than other types of networking media. In fact, UTP costs less per meter than any other type of LAN cabling.



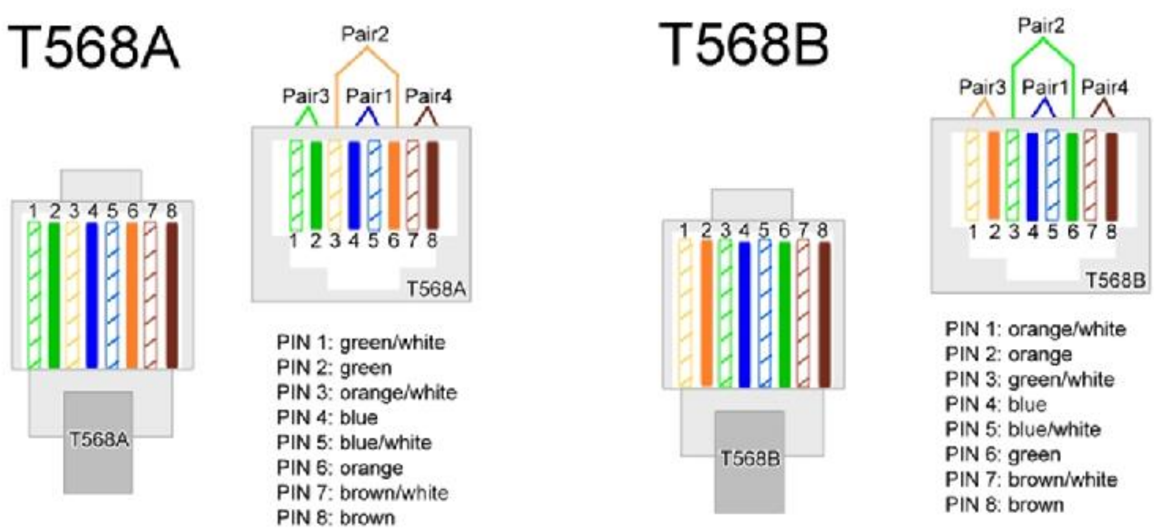
3.2.6 UTP Implementation

EIA/TIA specifies an RJ-45 connector for UTP cable. The letters RJ stand for registered jack and the number 45 refers to a specific wiring sequence. The RJ-45 transparent end connector shows eight colored wires. Four of the wires, T1 through T4, carry the voltage and are called tip. The other four wires, R1 through R4, are grounded and are called ring. Tip and ring are terms that originated in the early days of the telephone. Today, these terms refer to the positive and the negative wire in a pair. The wires in the first pair in a cable or a connector are designated as T1 and R1. The second pair is T2 and R2, the third is T3 and R3, and the fourth is T4 and R4. The RJ-45 connector is the male component, which is crimped on the end of the cable. When a male connector is viewed from the front, the pin locations are numbered from 8 on the left to 1 on the right as seen in the following figure.

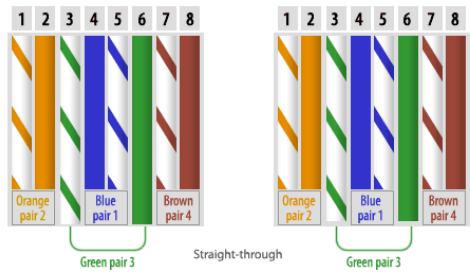
The jack is the female component in a network device, wall outlet, or patch panel as seen in the following figure.



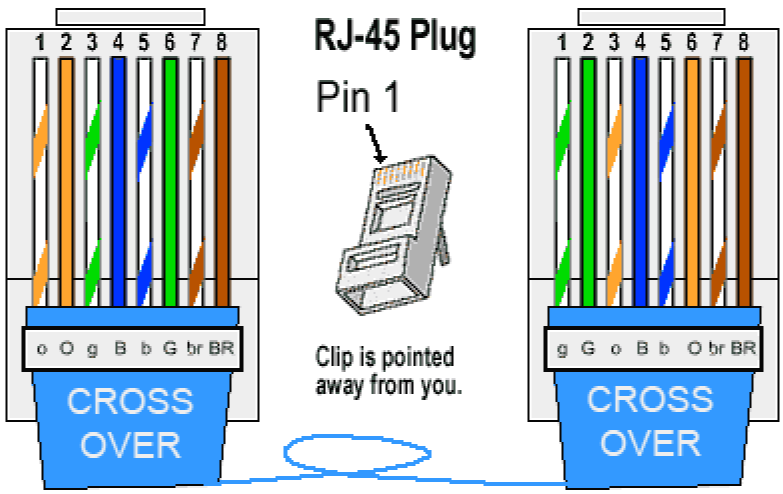
For electricity to run between the connector and the jack, the order of the wires must follow **T568A** or **T568B** color code found in the EIA/TIA-568-B.1 standard, as shown in Figure.



If the two RJ-45 connectors of a cable are held side by side in the same orientation, the colored wires will be seen in each. If the order of the colored wires is the same at each end, then the cable is a Straight-Through, as seen in the next figure.



In a Crossover Cable, the RJ-45 connectors on both ends show that some of the wires are connected to different pins on each side of the cable. The following figure shows that pins 1 and 2 on one connector connect to pins 3 and 6 on the other.



Use straight-through cables for the following connections:

- Switch to Router
- Switch to PC or Server
- Hub to PC or Server

Use crossover cables for the following connections:

The next figure illustrates how a variety of cable types may be required in a given network. The category of UTP cable required is based on the type of Ethernet that is chosen.

- Switch to Switch
- Switch to Hub
- Hub to Hub
- Router to Router
- PC to PC
- Router to PC

Twisting provide:

1- **protection against crosstalk, noise generated by adjacent pairs &**
2- **cancellation of the magnetic field.**

Based on connection layout, 3 types of UTP are existed:

Straight UTP Cable

Side1 : WO	O	WG	B	WB	G	WBr	Br
Side2 : WO	O	WG	B	WB	G	WBr	Br

Cross-Over UTP Cable

Side1 : WO	O	WG	B	WB	G	WBr	Br
Side2 : WG	G	WO	B	WB	O	WBr	Br

Roll-Over UTP Cable (Console UTP Cable)

Side1 : WO	O	WG	B	WB	G	WBr	Br
Side2 : Br	WBr	G	WB	B	WG	O	WO

Types of Cable

- UTP & STP (CAT 5 & 6)

- Coax
- Fiber

UTP Cables

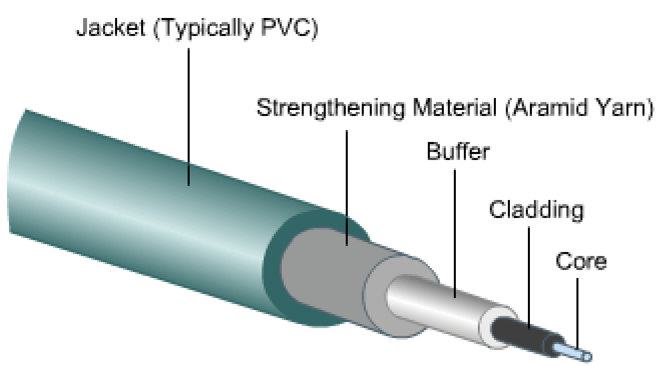
- Straight for different devices
- Cross Over for similar devices
- Roll Over for configuration of routers

Connectors

- BNC : Coax
- RJ-45 : UTP & STP
- RJ-11 : Phone , VSAT
- Type F : Fiber

3.3 Fiber-Optic

Fiber-Optic cable uses glass strands to transmit data at the speed of light. The data is carried over these glass strands in the form of light beams. These beams of light can carry signals a much greater distance at a much higher speed than copper cable. These signals are not as subject to degradation or electronic interference as is the case with copper.



The part of an optical fiber through which light rays travel is called the core of the fiber. Light rays can only enter the core if their angle is inside the numerical aperture of the fiber. Likewise, once the rays have entered the core of the fiber, there are a limited number of optical paths that a light ray can follow through the fiber. These optical paths are called modes. If the diameter of the core of the fiber is large enough so that there are many paths that light can take through the fiber, the fiber is called "multimode" fiber. Single-mode fiber has a much smaller core that only allows light rays to travel along one mode inside the fiber.

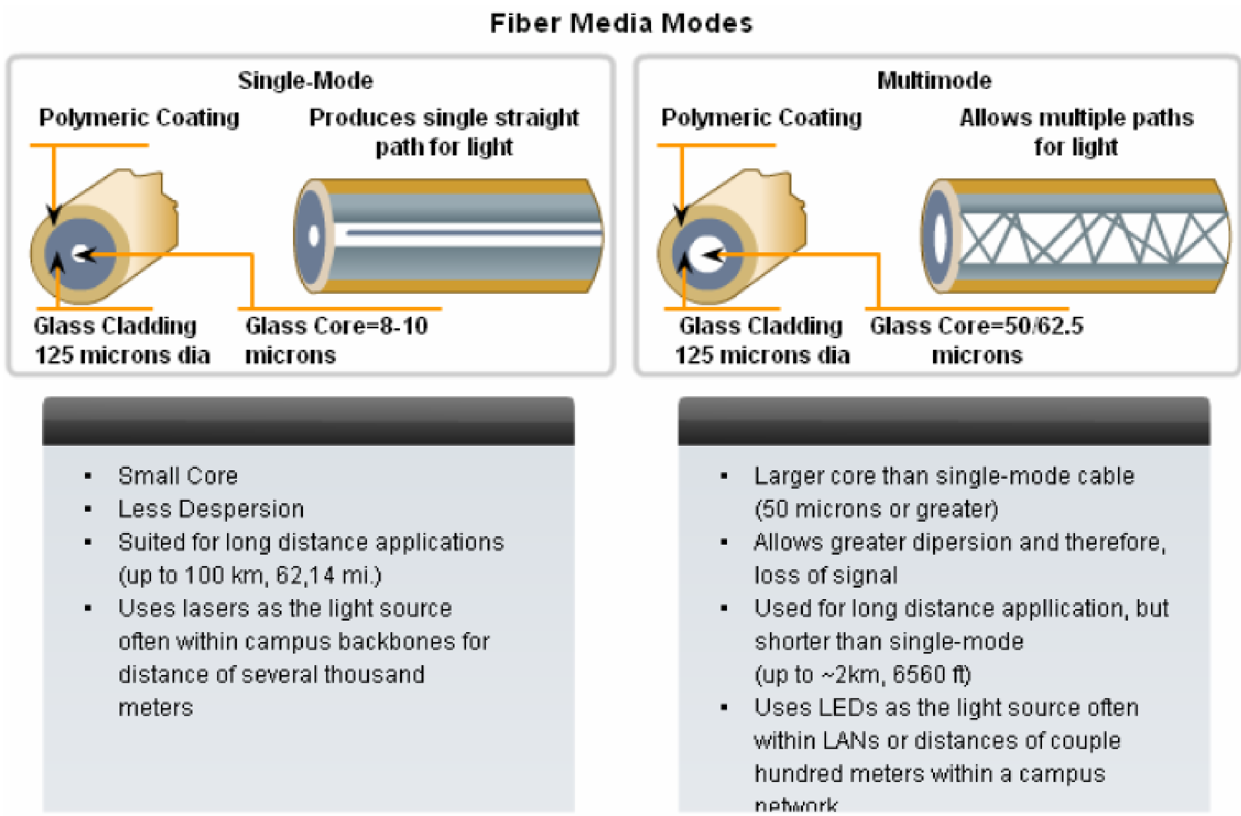
Every fiber-optic cable used for networking consists of two glass fibers encased in separate sheaths. One fiber carries transmitted data from device A to device B. The second fiber carries data from device B to device A. The fibers are similar to two one-way streets going in opposite directions. This provides a full-duplex communication link. Copper twisted-pair uses a wire pair to transmit and a wire pair to receive. Fiber-optic circuits use one fiber strand to transmit and one to receive. Typically, these two fiber cables will be in a single outer jacket until they reach the point at which connectors are attached.

Until the connectors are attached, there is no need for shielding, because no light escapes when it is inside a fiber. This means there are no crosstalk issues with fiber. It is very common to see multiple fiber pairs encased in the same cable. This allows a single cable to be run between data closets, floors, or buildings. One cable can contain 2 to 48 or more separate fibers. With copper, one UTP cable would have to be pulled for each circuit. Fiber can carry many more bits per second and carry them farther than copper can.

3.3.1 Single-Mode and Multi-Mode

Fiber Single-mode fiber consists of the same parts as multimode. The outer jacket of single-mode fiber is usually yellow. The major difference between multimode and single-mode fiber is that single-mode allows only one mode of light to propagate through the smaller, fiber-optic core. The single-mode core is eight to ten microns in diameter. Nine-micron cores are the most common. A 9/125 marking on the jacket of the single-mode fiber indicates that the core fiber has a diameter of 9 microns and the surrounding cladding is 125 microns in diameter. An infrared laser is used as the light source in single-mode fiber. The ray of light it generates enters the core at a 90-degree angle. As a result, the data carrying light ray pulses in single-mode fiber are essentially transmitted in a straight line right down the middle of the core. This greatly increases both the speed and the distance that data can be transmitted. Because of its design, single-mode fiber is capable of higher rates of data transmission (bandwidth) and greater cable run distances than multimode fiber. Single-mode fiber can carry LAN data up to 3000 meters. Although this distance is considered a standard, newer technologies have increased this distance and will be discussed in a later module.

Multimode is only capable of carrying up to 2000 meters. Lasers and single-mode fibers are more expensive than LEDs and multimode fiber. Because of these characteristics, single-mode fiber is often used for inter-building connectivity.



3.3.2 Other Optical Components

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). On single-mode fiber, the Straight Tip (ST) connector is frequently used.

In addition to the transmitters, receivers, connectors, and fibers that are always required on an optical network, repeaters and fiber patch panels are often seen. Repeaters are optical amplifiers that receive attenuating light pulses traveling long distances and restore them to their original shapes, strengths, and timings. The restored signals can then be sent on along the journey to the receiver at the far end of the fiber. Fiber patch panels similar to the patch panels used with copper cable. These panels increase the flexibility of an optical network by allowing quick changes to the connection of devices like switches or routers with various available fiber runs, or cable links.

3.4 Wireless Media

The extraordinary convenience of wireless communications has placed an increased emphasis on wireless networks in recent years. Technology is expanding rapidly and will continue to expand into the near future, offering more and better options for wireless networks. Presently, you can subdivide wireless networking technology into three basic types corresponding to three basic networking scenarios:

- Local Area Networks (LANs). Occasionally, you will see a fully wireless LAN, but more typically, one or more wireless machines will function as members of a cable-based LAN. A LAN with both wireless and cable-based components is called a hybrid.
- Extended Local Networks. A wireless connection serves as a backbone between two LANs. For instance, a company with office networks in two nearby but separate buildings could connect those networks using a wireless bridge.
- Mobile Computing. A mobile machine connects to the home network using cellular or satellite technology. The main advantage that wireless networks have over copper and fiber optic is that you don't have to run and connect cables to the computers.

The three major types of wireless networks today are:

- Infrared (IR)
- Microwave
- Radio Frequency (RF)