What is Network Cabling?

Cable is the medium through which information usually moves from one network device to another. There are several types of cable which are commonly used with LANs. In some cases, a network will utilize only one type of cable, other networks will use a variety of cable types. 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.

The following sections discuss the types of cables used in networks and other related topics.

- Unshielded Twisted Pair (UTP) Cable
- Shielded Twisted Pair (STP) Cable
- Coaxial Cable
- Fiber Optic Cable
- Wireless LANs
- Cable Installation Guides

Unshielded Twisted Pair (UTP) Cable

Twisted pair cabling comes in two varieties: shielded and unshielded. Unshielded twisted pair (UTP) is the most popular and is generally the best option for school networks (See fig. 1).

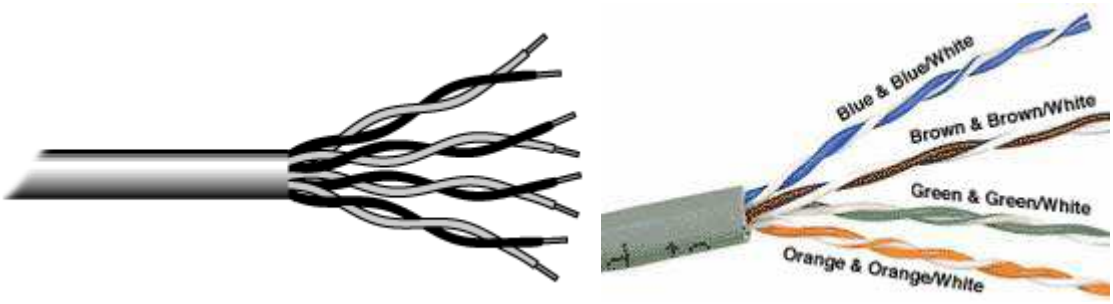
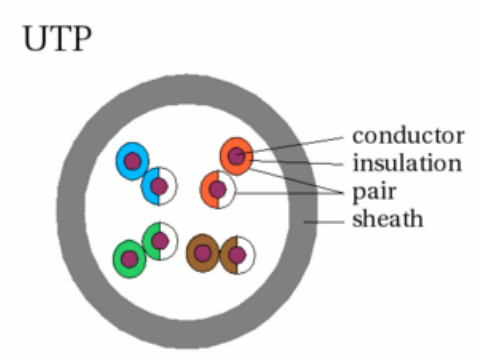


Fig.1. Unshielded twisted pair

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 five categories of wire.



Categories of Unshielded Twisted Pair

Type	Use
Category 1	Voice Only (Telephone Wire)
Category 2	Data to 4 Mbps (LocalTalk)
Category 3	Data to 10 Mbps (Ethernet)
Category 4	Data to 20 Mbps (16 Mbps Token Ring)
Category 5	Data to 100 Mbps (Fast Ethernet)
Category 5e	Data to both 100 Mbit/s and gigabit ethernet networks. (Gigabit Ethernet)
Category 6	10Gbit/sec(10Ge)

Shielded Twisted Pair (STP) Cable

A disadvantage of UTP is that it may be susceptible to radio and electrical frequency interference. Shielded twisted pair (STP) is suitable for environments with electrical interference; however, the extra shielding can make the cables quite bulky. Shielded twisted pair is often used on networks using Token Ring topology.

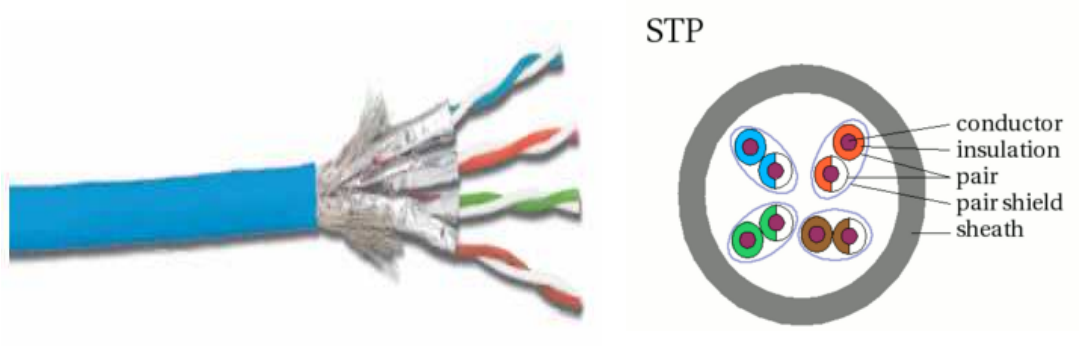


Fig. 2. STP Cable layout

Unshielded Twisted Pair Connector

The standard connector for unshielded twisted pair cabling is an RJ-45 connector. This is a plastic connector that looks like a large telephone-style connector (See fig. 3). A slot allows the RJ-45 to be inserted only one way. RJ stands for Registered Jack, implying that the connector follows a standard borrowed from the telephone industry. This standard designates which wire goes with each pin inside the connector.

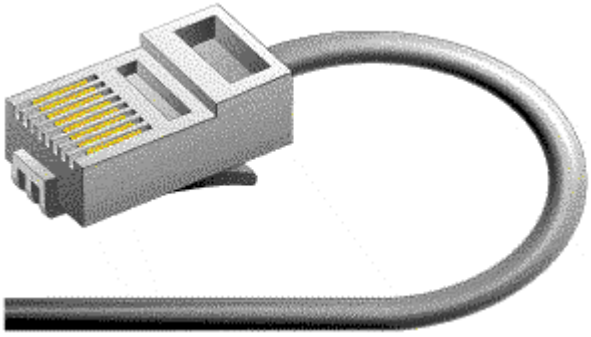


Fig. 3. RJ-45 connector

Ethernet Cable Pinouts:

There are two basic cables. A straight through cable, which is used to connect to a hub or switch, and a cross over cable used to operate in a peer-to-peer fashion without a hub/switch. Some interfaces can cross and un-cross a cable automatically as needed, really quite nice. The pinouts of jack given below (Fig. 4.).

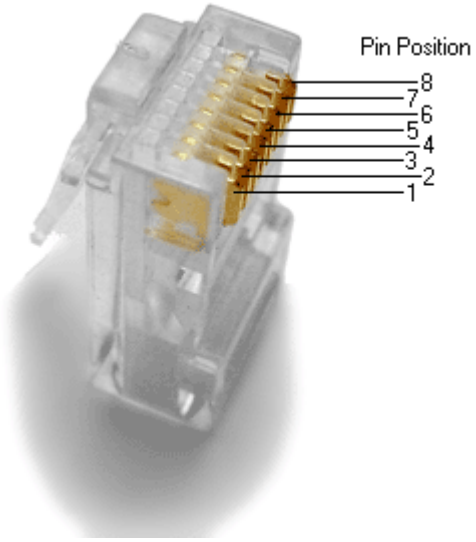
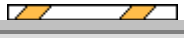
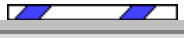
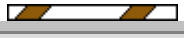
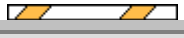
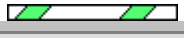
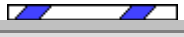
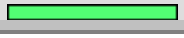
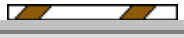


Fig. 4. Pins on plug face (jack is reversed)

Standard, Straight-Through Wiring (both ends are the same):

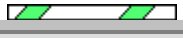
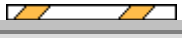
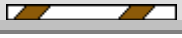
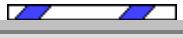
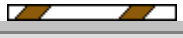
RJ45 Pin #	Wire Color (T568A)	Wire Diagram (T568A)	10Base-T Signal 100Base-TX Signal	1000Base-T Signal
1	White/Green		Transmit+	BI_DA+
2	Green		Transmit-	BI_DA-
3	White/Orange		Receive+	BI_DB+
4	Blue		Unused	BI_DC+
5	White/Blue		Unused	BI_DC-
6	Orange		Receive-	BI_DB-
7	White/Brown		Unused	BI_DD+
8	Brown		Unused	BI_DD-

Straight-Through Cable Pinout for T568A

RJ45 Pin #	Wire Color (T568B)	Wire Diagram (T568B)	10Base-T Signal 100Base-TX Signal	1000Base-T Signal
1	White/Orange		Transmit+	BI_DA+
2	Orange		Transmit-	BI_DA-
3	White/Green		Receive+	BI_DB+
4	Blue		Unused	BI_DC+
5	White/Blue		Unused	BI_DC-
6	Green		Receive-	BI_DB-
7	White/Brown		Unused	BI_DD+
8	Brown		Unused	BI_DD-

Straight-Through Cable Pinout for T568B

Cross Over Cable (T568B):

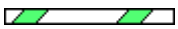
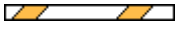
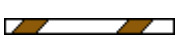
RJ45 Pin # (END 1)	Wire Color	Diagram End #1	RJ45 Pin # (END 2)	Wire Color	Diagram End #2
1	White/Orange		1	White/Green	
2	Orange		2	Green	
3	White/Green		3	White/Orange	
4	Blue		4	White/Brown	
5	White/Blue		5	Brown	
6	Green		6	Orange	
7	White/Brown		7	Blue	
8	Brown		8	White/Blue	

Cross Over Cable Pinouts

+Note: The cross over cable layout is suitable for 1000Base-T operation, all 4 pairs are crossed.

Power over Ethernet (PoE):

Power over Ethernet has been implemented in many variations before IEEE standardized 802.3af. 802.3af specifies the ability to supply an endpoint with 48V DC at up 350mA or 16.8W. The endpoint must be capable of receiving power on either the data pairs [Mode A] (often called phantom power) or the unused pairs [Mode B] in 100Base-TX. PoE can be used with any ethernet configuration, including 10Base-T, 100Base-TX and 1000Base-T. Power is only supplied when a valid PoE endpoint is detected by using a low voltage probe to look for the PoE signature on the endpoint. PoE power is typically supplied in one of two ways, either the host ethernet switch provides the power, or a "midspan" device is plugged in between the switch and endpoints which supplies the power. No special cabling is required.

RJ45 Pin #	Wire Color (T568A)	Wire Diagram (T568A)	10Base-T Signal 100Base-TX Signal	PoE
1	White/Green		Transmit+	Mode A +
2	Green		Transmit-	Mode A +
3	White/Orange		Receive+	Mode A -
4	Blue		Unused	Mode B +
5	White/Blue		Unused	Mode B +
6	Orange		Receive-	Mode A -
7	White/Brown		Unused	Mode B -
8	Brown		Unused	Mode B -

Power over Ethernet Power Delivery

Protocol Details:

	Frequency (MHz)	Symbol Encoding	Signal Rate (Mbaud)	Symbol Rate	Data Encoding	Data Bits per Symbol	Pairs per Channel	Pairs Used	Minimum Cable Category
10BaseT	10	Manchester	10	10	None	1	1	2	3
100BaseT4	12.5	Multi-level, 2T/Hz	25	25	8B6T	8/6	3	4	3
100BaseTX	31.25	MLT-3	125	125	4B5B	4/5	1	2	5
100BaseT2	12.5	PAM5x5 (2D-PAM5)	25	12.5	None	4 (2x2)	2	2	3
1000BaseT	31.25	4D-PAM5	125	31.25	None	8 (4x2)	4	4	5*

*Designed to work on MOST category 5 cable, category 5e specifications ensure 1000Base-T operation

How to wire Ethernet Cables:

1. Strip off about 2 inches of the cable sheath.
2. Untwist the pairs - don't untwist them beyond what you have exposed, the more untwisted cable you have the worse the problems you can run into.
3. Align the colored wires according to the diagrams above.
4. Trim all the wires to the same length, about 1/2" to 3/4" left exposed from the sheath.
5. Insert the wires into the RJ45 end - make sure each wire is fully inserted to the front of the RJ45 end and in the correct order. The sheath of the cable should extend into the RJ45 end by about 1/2" and will be held in place by the crimp.
6. Crimp the RJ45 end with the crimper tool
7. Verify the wires ended up the right order and that the wires extend to the front of the RJ45 end and make good contact with the metal contacts in the RJ45 end.
8. Cut the cable to length - make sure it is more than long enough for your needs. Remember, an end to end connection should not extend more than 100m (~328ft). Try to keep cables short, the longer the cable becomes the more it may affect performance, usually noticable as a gradual decrease in speed and increase in latency.
9. Repeat the above steps for the second RJ45 end.
10. If a cable tester is available, use it to verify the proper connectivity of the cable.

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 (See fig. 5). The metal shield helps to block any outside interference from fluorescent lights, motors, and other computers.

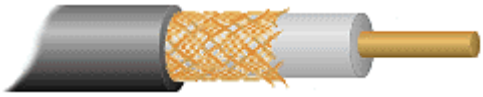


Fig. 5. Coaxial cable

Although coaxial cabling is difficult to install, it is highly resistant to signal interference. In addition, it can support greater cable lengths between network devices than twisted pair cable. The two types of coaxial cabling are thick coaxial and thin coaxial.

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. In actual fact the maximum segment length is 185 meters. Thin coaxial cable is popular in school networks, especially linear bus networks.

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. One disadvantage of thick coaxial is that it does not bend easily and is difficult to install.

Coaxial Cable Connectors

The most common type of connector used with coaxial cables is the Bayone-Neill-Concelman (BNC) connector (See fig. 6). 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 than screw, onto the cable.

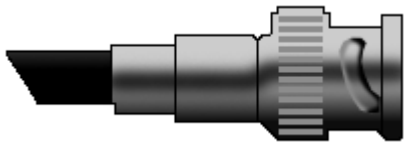


Fig. 6. BNC connector

Fiber Optic Cable

Fiber optic cabling consists of a center glass core surrounded by several layers of protective materials (See fig. 7). 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. It has also made it the standard for connecting networks between buildings, due to its immunity to the effects of moisture and lighting.

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. 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.

Fig.7. Fiber optic cable

Facts about fiber optic cables:

- Outer insulating jacket is made of Teflon or PVC.
- Kevlar fiber helps to strengthen the cable and prevent breakage.
- A plastic coating is used to cushion the fiber center.
- Center (core) is made of glass or plastic fibers.

Fig. 8. Raw Fiber Optic

Fiber Optic Connector

The most common connector used with fiber optic cable is an ST connector. It is barrel shaped, similar to a BNC connector. A newer connector, the SC, is becoming more popular. It has a squared face and is easier to connect in a confined space.

Wireless LANs

Not all networks are connected with cabling; some networks are wireless. Wireless LANs use high frequency radio signals, infrared light beams, or lasers to communicate between the workstations and the file server or hubs. Each workstation and file server on a wireless network has some sort of transceiver/antenna to send and receive the data. Information is relayed between transceivers as if they were physically connected. For longer distance, wireless communications can also take place through cellular telephone technology, microwave transmission, or by satellite.

Wireless networks are great for allowing laptop computers or remote computers to connect to the LAN. Wireless networks are also beneficial in older buildings where it may be difficult or impossible to install cables.

The two most common types of infrared communications used in schools are line-of-sight and scattered broadcast. Line-of-sight communication means that there must be an unblocked direct line between the workstation and the transceiver. If a person walks within the line-of-sight while there is a transmission, the information would need to be sent again. This kind of obstruction can slow down the wireless network.

Scattered infrared communication is a broadcast of infrared transmissions sent out in multiple directions that bounces off walls and ceilings until it eventually hits the receiver. Networking communications with laser are virtually the same as line-of-sight infrared networks.

Wireless LANs have several disadvantages. They provide poor security, and are susceptible to interference from lights and electronic devices. They are also slower than LANs using cabling.

Installing Cable - Some Guidelines

When running cable, it is best to follow a few simple rules:

- Always use more cable than you need. Leave plenty of slack.
- Test every part of a network as you install it. Even if it is brand new, it may have problems that will be difficult to isolate later.
- Stay at least 3 feet away from fluorescent light boxes and other sources of electrical interference.
- If it is necessary to run cable across the floor, cover the cable with cable protectors.
- Label both ends of each cable.
- Use cable ties (not tape) to keep cables in the same location together. ,

Reference:

1. http://ioc.unesco.org/Oceanteacher/OceanTeacher2/02_InfTchSciCmm/01_CmpTch/00_compsys/04_networks/
2. http://en.wikipedia.org/wiki/Twisted_pair
3. http://www.ertyu.org/steven_nikkel/ethernetcables.html