Copper and Glass – A guide to Network Cables

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Introduction

For many medium and large sized networks the choice of cabling is the single most important, long-term investment made in the network. The choice of cabling must be a balance between cost and performance, all the while trying to predict future performance requirements. If the network cabling cannot support future requirements you may be forced to re-cable your entire network, which of course can be quite expensive.

In this article I will give you a high level overview of twisted pair cables, Coax cables, and Fibre optic cables. These are the most common types of network cables used in Ethernets. I will explain the advantages, disadvantages and limitations of each.

UTP and STP

By far the most common type of cabling for Ethernets are the twisted pair categories. An Unshielded Twisted Pair (UTP) cable, as shown in Figure A, consists of four pairs of 22 or 24 American Wire Gauge (AWG) copper wire. (The AWG number indicates the thickness of the wire, with higher numbers indicating a smaller diameter.) Each wire has a layer of plastic insulation around it, and the entire cable is wrapped in a protective plastic sheath. Each pair is twisted to provide protection against electromagnetic interference (EMI). To protect against crosstalk between the pairs, there are a different number of twists per metre in each pair. As a general rule, the more twists per metre the pair has, the more protection it has against these types of interference.

Figure A: A UTP

Shielded Twisted Pair (STP) cabling is the same as UTP cabling except that each pair is wrapped in a metallic foil, and the four pairs together are wrapped in a metallic foil. This metallic foil acts as a shield to electromagnetic fields, thus providing additional protection from interference.

Some of you might be wondering how this metallic foil protects against electromagnetic fields. I thought electromagnetic fields induced electric current in metals? Well, yes. They do. This is precisely why both ends of this metallic foil need to be properly grounded. If this grounding is not done properly you will have nothing more than a glorified radio antenna; but I suppose that would be one way to download free music!

For those that are interested, Figure B shows a very simple way to receive radio signals. Stay tuned for future articles on antennas of all sorts.

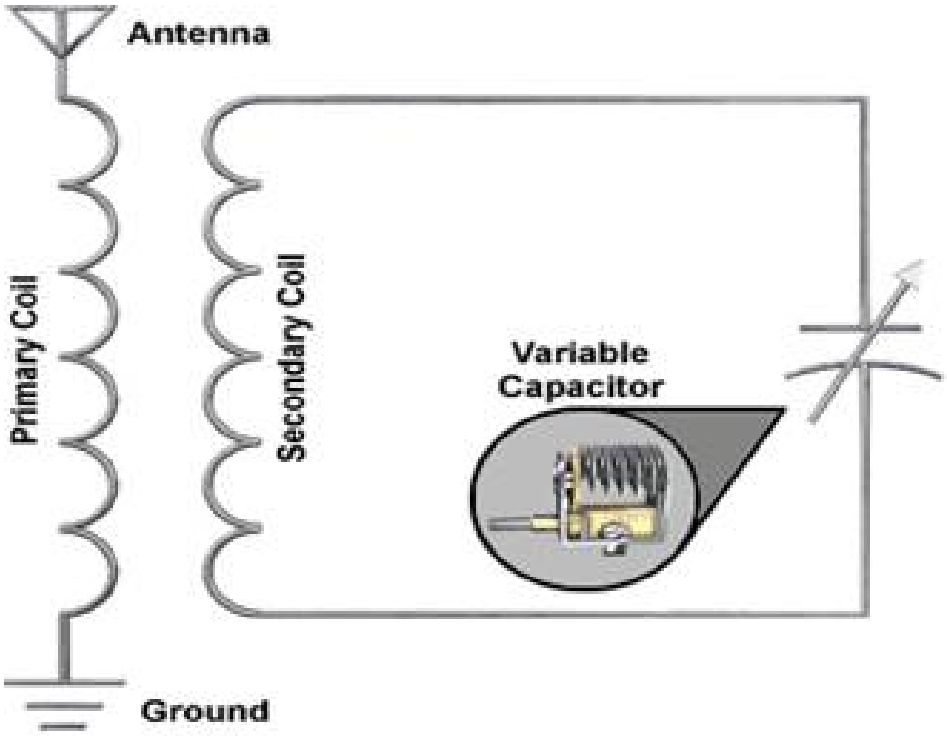

Figure B: Radio Tuning Circuit

All categories of twisted pair cabling have a maximum data transmission range of 100m but have varying maximum data transfer rates.

- Cat1 and Cat2 cables are obsolete. They were once used for telephones, and very early networks.
- Cat3 cables became popular in the late 1980s, as they were inexpensive and provided a maximum data transfer rate of 10Mbps.
- Cat4 are not seen very often. They were used in earlier token ring network topologies and have a maximum data transfer rate of 16Mbps.
- Cat5 cables are currently the most common type of cabling you will see in Ethernets. The maximum data transfer rate of Cat5 cables is 100Mbps.
- Cat5e cables are also quite common. They have slightly more enhanced specifications which allow a maximum data transfer rate of 1Gbps.
- Cat6, Cat7, and Cat8, cables are not yet very common. However, as gigabyte Ethernets become more popular you will likely see these categories of cables become more popular as they offer even better performance.

You will notice that as the category number increases so does the maximum data transfer rate. This is accomplished, in large part, by the copper wire pairs within the cables having more twists per metre. As said earlier, more twists per metre provide more protection against interference and therefore allows a greater spectral bandwidth to be transmitted over the cable.

Straight through and Crossover Cables

There are two general configurations for twisted pair cables. A straight through configuration means that both ends of the cable have the same pin configuration. That is, whatever pin number a wire is connected to at one end of the cable it will be connected to that same pin number at the other end of the cable. This configuration is used to connect two different kinds of equipment.

A crossover configuration means that the two ends of the cable have opposite pin configurations. Crossover configurations are used to connect two of the same kinds of equipment. You should be aware that a lot of newer devices are smart enough to know whether you are using a straight through or a crossover cable. So before you go out and buy a new cable, you should check to see if your device is one of these smart devices.

Plenum Cables

It should be noted here that all of the cables mentioned in this article are available in a plenum version. It is required to use plenum cables when running cable through ducts, suspended ceilings, or any other area which acts as an air passage. This is because normal cabling can be toxic in the event of a fire; plenum cables have a special coating which makes the cable non-toxic.

Coax Cables

Coax cables can also be found in many networks. There are two types of coax cables commonly used in Ethernets. They are 10Base2 and 10Base5, or alternatively thinnet and thicknet. Coax cable consists of a solid copper wire surrounded with insulation. Around this insulation is a copper shield and an outer plastic insulator. Just as in STP cables the copper shield must be grounded at both ends in order to protect against EMI. The difference between thinnet and thicknet is that the solid copper wire has a diameter of 0.35cm in thinnet and a diameter of 1cm in thicknet.

Both types provide a maximum data transfer rate of 100Mbps. The advantages of using coax cabling can be found in the maximum data transmission range. Thinnet has a maximum data transmission range of 185m, while thicknet has a maximum data transmission range of 500m. This is the reason that coax cables are often used as a backbone in network bus topologies.

A typical coax cable is shown here in Figure C.

Figure C: A Coax Cable

A major disadvantage of coax cabling is that the thickness of coax cables, especially thicknet cables, makes them very difficult to install and therefore they are more costly than the twisted pair cables. However, if your network is large the extra money spent on coax cabling may be offset by the money saved by not having to purchase repeaters needed to span long distances.

Fibre Optic Cables

Fibre optic cables are definitely cool. They provide a transmission length of 10km or more for single mode fibre, or 2km or more for multi mode fibre. Fibre optic cables can also provide maximum data transfer rates of more than 100Gbps.

Fibre optic cable, as shown in Figure D, consists of a glass core with a surrounding cladding. There is also a protective coating, strengthening fibres, and an outer coating. Data is transmitted via light through the glass core. Since data is not transferred with electric signals, fibre optic cables are not affected by EMI. Another advantage of fibre optic cables is that the cable is not affected by water. The performance of coax cables and twisted pair cables can be significantly degraded if water penetrates the cable. This makes fibre optic cables ideal for spanning long distances outside.

Figure D: Fibre Optic Cables

The major disadvantage of fibre optic cables is the cost. It is far more expensive to use fibre optic cable than any other cable discussed in this article. Fibre optic cables can also be quite fragile. The inner glass core can be broken if the cable is pulled too hard, or bent around a sharp corner. In many networks that use fibre optic cabling, cables are often replaced because they have been broken, thus adding additional costs.

Conclusion

As I mentioned in the introduction of this article, the choice of cabling in a network is a balance of cost and performance. The biggest reason twisted pair cabling has become so pervasive is because of the very low cost and relatively high maximum data transfer rates.

As the cost of fibre optic cable decreases, you will no doubt see this as the cabling of choice in more and more networks. In future articles I will give examples of the different types of fibre optic cables, and some of the more unique challenges that come along with this technology.