Fibre Optics vs Copper Cabling – Understanding the Difference

White paper

Introduction

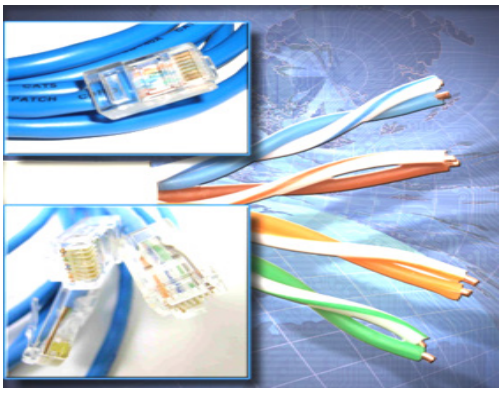
A common question is whether all cable lines are similar in nature. Those who have seen fibre and copper cable operations are familiar with the process similarity, but they don't understand the slight variations that exist between processing a crystalline structure like glass, or a flexible material like copper. A lot of people are unable to understand that copper cable and optical fibre cable cannot be created side-by-side on the same device. To demonstrate this more clearly, the physics involved in the cable should be considered.

Both copper and what is essentially glass, or fibre optics, have their advantages and unique characteristics. Copper has already existed in many places and it is cheap in network devices connection. However, with the dramatic reduction of cost of optical deployment, the future-proof fibre optic cable shows more advantages over copper and has a better prospect in the future market.

When we try to compare the fibre optic cable with copper cable, we may be thrown into trouble most of the time. Actually, it is too difficult to be impartial because the pros and cons between them are so clear. Apparently, fibre optic cable outweighs copper cable in the aspect of speed or bandwidth. It is much faster than copper cable, carries much higher bandwidth, has less interference and is lighter, stronger and more durable as well. Considering this situation, let's take a closer look at the advantages of fibre optic cable over copper cable through this white paper.

Copper Cabling, its Properties and Applications

Copper, being an excellent electrical conductor, is commonly used in electronics. Its properties make it an industry favourite. Copper wire is used as a medium for many types of transmissions.



Below are some of the copper properties:

- **Conductivity** - Because of its conductivity, copper is used as a primary medium for electricity transport. Metals similar to copper such as brass, cannot conduct electricity nearly as well. The only known metal to generate electricity better than copper is silver, which is far too expensive to use as a material in most circumstances.

- **Corrosion Resistance** - Copper is low in the reactivity series. This means that it doesn't tend to corrode and is resistant to corrosion. By avoiding rust, copper remains effective over time, making it valuable especially in areas that have high humidity. Like most metals, copper has a very high melting point—1,083 degrees centigrade.

- **Ductility** - Ductility allows copper wire to be put into a variety of forms. Ductile metals can be spun into extremely thin wire. Copper can be made thinner than the human hair. Copper that is 4 inches thick can be rolled to be 20 million times longer and can still be functional.

- **Malleability** - One of the copper wire's top qualities is its malleability. It can be bent, manipulated, stretched and shaped. All of this can be done without cracking or inhibiting the functionality of the wire. Even heat or cold does not prevent the copper wire from being malleable.

- **Tensile Strength** - Tensile strength, or the amount of force needed to pull an object apart, is relatively high for copper. It features a tensile strength of about 200-250N/mm2 which makes it a useful building material and a popular alloy

for building wire. This high tensile strength allows copper wire to resist creep, cracking, breaks, stretching and other forms of de-formation that would otherwise cause failure or service interruption.

Copper cable is the oldest, cheapest, and the most common form of transmission medium till date. It is 30% cheaper than optical fibre cable and does not require specialised personnel to install and test the equipment. It has lower installation costs and inexpensive copper networking hardware.

The most basic network is the star network comprising of:

- A switch
- UTP cable
- Some PCs

A switch connected by UTP cable to two PCs

Below are some business applications in communication related to copper cabling:

- Telecommunications Room
- Conference Room or Class Room
- Work Areas/Common Areas
- Education
- Professional Services
- Retail
- Healthcare/Pharmaceutical
- Datacentres
- Commercial/Manufacturing
- Multi-unit Residential
- Government/Military

During the manufacture of copper, copper conductors are considered to be the most robust components in many cable designs. In contrast, despite having a relatively high tensile strength, glass optical fibres are very small, and are sensitive to off axis and compressive stress.

Copper Has Dominance

Copper cabling has been used in the communications industry for more than 100 years, and it is still in use in many networks today. While there have been several advances in network technology in recent years, with fibre-optic networks and wireless networks becoming more popular, copper cables still dominate most networks because they are affordable, fast and reliable.

Since the telephone's advent over 100 years ago, the dominant way to "wire" the home involved the use of copper cabling. The copper phone wire is perfectly adequate for a voice signal, which is what it was intended for. All things considered, however, it offers very limited bandwidth. Still, so many are familiar with copper that they doubted any other medium would ever supplant it. Later, fibre optics came along.

Fibre optics refers to technology that transmits data through thin strands of a highly transparent material that usually is either glass or plastic.

Fibre optic communications were launched in the 1970s, though the first fibre optic telecommunications networks were not installed until the early 1980s. By the mid-1980s, fibre's bandwidth and distance capabilities made it significantly less expensive than other communication mediums, so it has replaced them.

In the mid-1990s, cable television discovered fibre could enhance performance reliability, as well as enable the offering of both phone and Internet service on the same fibre.

Fibre Optics or Copper Cabling: Which connection is better?

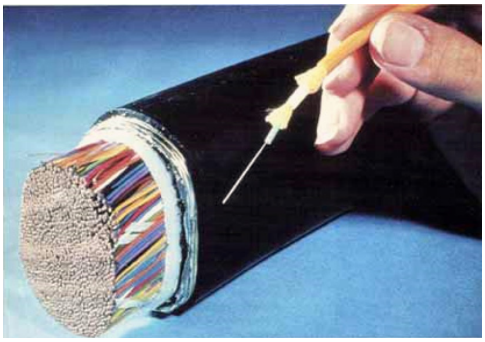
Assessing which type of network cable is optimal for a particular company requires consideration of several factors.

While traditional copper wire transmits data by electrical impulses, fibre optic cable is made from fine hair-like glass fibres, which carry light impulses transmitted by an LED or laser. This infrared light bounces along the insides of the fibres at blistering speeds and when the signal reaches the other end of the fibres, an optical receiver then converts it back into data.

One of the most beneficial advantages of fibre optics is the extremely wide bandwidth, which allows for increased information carrying capacity. The practical bandwidth of fibre optic cables far exceeds that of copper cable assemblies.

Using optical fibres also helps to minimise attenuation in your system. As a signal travels along a transmission medium, either copper or fibre, the signal will naturally lose strength. In a copper wire, the attenuation increases as the frequency of the information signal increases. However, the attenuation in an optical fibre is virtually flat up until very high frequencies.

A single optical fibre can hold as much information as this large cable containing thousands of copper wires.



Copper does offer advantages for those in rural areas. It already exists (it has been used, as noted, to wire telephones, so copper already found its place in the household) and is less expensive when used to connect network devices. Those in rural areas where no fibre optics have been run may find copper the most cost effective, because they don't have to pay to run new cabling.
Still, fibre optic cable offers many advantages over copper:

Fibre optic is light weight and has small diameter: Fibre is thinner, lighter and more durable than the equivalent copper cable. Its small size makes it easier to install and takes up less room in conduits and service ducts.

Fibre optic transmission is faster and has higher bandwidth: Fibre optic versus copper wire transmission can be boiled down to the speed of photons versus the speed of electrons. Photons travel at the speed of light, whereas electrons (as used in copper wire) occurring in nature travel at less than one percent of the speed of light. And while fibre optic cables don't travel at the speed of light, they come very close — only about 31 percent slower. So, as you can see, there's a huge inherent speed difference. Although copper is perfectly adequate for a voice signal, it has very limited bandwidth – while fibre provides standardised performance up to 10 Gbps and beyond.

Fibre optic transmission results in less attenuation: When traveling over a long distance, fibre optic cables experience less signal loss than copper cabling, known as low attenuation. One source estimates that fibre loses only three percent signal strength going over 100 meters (approximately 320 feet) in distance. By contrast, copper loses 94 percent over the same distance.

Repeaters or boosters can improve those rates, but in its native state, fibre beats out copper when it comes to avoiding signal loss.

Fibre optic cables are impervious to electromagnetic interference: Copper wires, if not properly installed, will produce electromagnetic currents that can interfere with other wires and wreak havoc on a network. An added benefit of fibre optic cables is that they are not a fire hazard. Fibre optic cables, unlike copper cables, do not conduct electricity. Fibre optic cables are safe from lightning strikes or electrical interference.

Fibre optic cables do not break as easily: This means that you will not have to worry about replacing them as frequently as copper wires.

	Optical fiber	Copper wire
Safety	✔	✖
Weight	✔	✖
RF effects	✔	✖
Data bandwidth	✔	✖
Durability	✔	✔
Cost	✖	✔

Table of Comparison

A few years ago, the overall price of fibre cable was nearly twice that of copper, but now the price between fibre and copper has narrowed and fibre components and hardware have steadily decreased.

Conclusion

Optical fibre is generally chosen for systems requiring higher bandwidth or spanning longer distances than copper can accommodate. While the difference between copper and fibre optic cables is already akin to the difference between the telegraph and the telephone, the future will see fibre optic technology improve exponentially.

Fibre optic systems are already being used in the backbone applications of most major companies because of their reliability and upgradability and in the near future, a technique known as wavelength multiplexing will increase their capacity even more, by allowing multiple channels to run on a single fibre strand. The development of better quality glass will also allow signals to travel even further without experiencing degradation. All up, it is fairly safe to assume that, just as digital telephony has done in the past, so fibre optic technology will put yet another nail in the coffin of the traditional copper wire.

The advent of optical cable with its ever-reducing cost, increased bandwidth, extremely high speed and long transmission distance, excellent reliability and perfect security, has replaced copper in every aspect of network transmission and reception. Fibre optic cable has become one of the most popular mediums for both innovative cabling installations and upgrades, including backbone, horizontal, and even desktop applications. And with the steadily lowering cost and intrinsic improvements made seemingly daily in fibre optic connectivity, fibre construction will become more convenient and cost-effective. It's only a matter of time before fibre optics completely replaces copper cable in both long and short-haul networking.

When comparing traditional copper cable with fibre optic cable, it is hard to be impartial, because the facts speak so clearly for themselves. Fibre optic cable is superior to copper cable in almost every way imaginable. It is much faster than copper cable, carries much higher bandwidth, has less interference and is lighter, stronger and more durable as well. While copper has been a reliable medium in the past, fibre optic cable is undoubtedly the future.

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