Network Connectivity

A Go-To Guide

GARLAND TECHNOLOGY

See every bit, byte, and packet®

Introduction

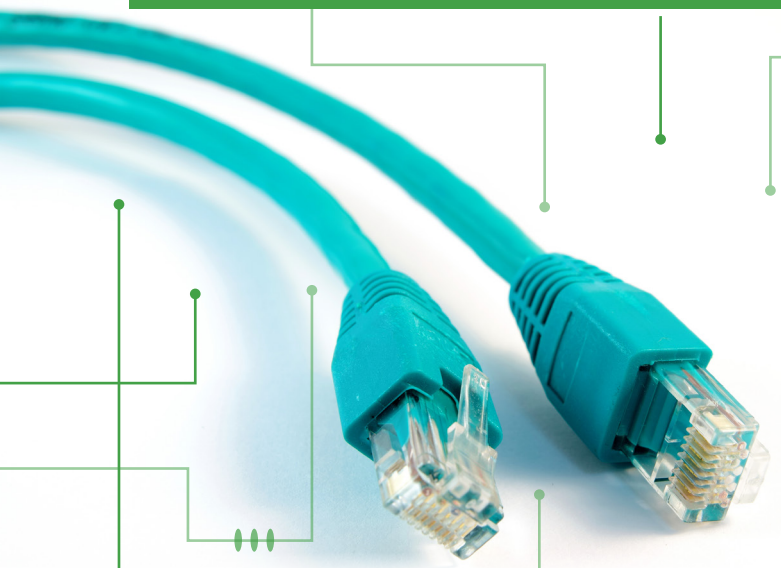
Ethernet has come a long way since Xerox patented it in 1975. It started off as a 2.94 Mbps connection of 100 workstations. Since then, Ethernet has transformed into complex, distributed networks of databases and servers connected from great distances.

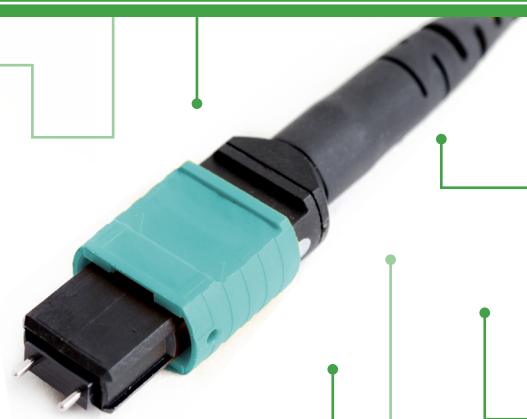
Now, companies have a dizzying array of connectivity possibilities available. Moreover, their needs have changed drastically since Ethernet's introduction. Businesses might need to build a new data center or upgrade an existing one. In either case, critical applications and other bandwidth-intensive solutions can cause headaches for IT professionals deciding which network connectivity path to choose.

They must decide between fiber or copper for particular network speeds. Then comes the choice between single-mode or multi-mode fiber, different micron options, various media options, choosing the right cable types and connectors.

This white paper is a comprehensive guide to the network connectivity information you need so you can focus on what's important to your firm—the communication between your databases, servers, and machines.

With the right connectivity, your hardware and software will function efficiently to keep your business running smoothly.





Copper or Fiber: What to Choose?

For years, IT professionals have debated at length over the merits and shortcomings of copper and fiber for increasing the bandwidth demands of today's data centers. Proponents of fiber point to its ability to support the fastest Ethernet standards—they claim it is the "cable of the future."

They shouldn't discount copper cabling manufacturers, though. They have continued to innovate, and copper cabling has evolved from Cat3 in the 1990s until the January 2014 draft of Cat8.

In light of the capabilities of fiber and copper, undecided IT professionals need more guidance to determine which method of connectivity to choose.

1G/10G Network Media Connectivity

Connector Name	Media	Network Speed	Mode	Wavelength	Distance*
TX	Copper – Twisted Pair	Up to 1000M	n/a	n/a	100 m
SX	Fiber Optic – Short Range	Up to 1G	Multi	850 nm	550 m
LX	Fiber Optic – Long Range	Up to 1G	Single	1310 nm	5 km
ZX	Fiber Optic – Long Range	Up to 1G	Single	1550 nm	70 km
SR	Fiber Optic – Short Range	Up to 10G	Multi	850 nm	137 m
LR	Fiber Optic – Long Range	Up to 10G	Single	1550 nm	5,000 m
ER	Fiber Optic – Extended Range	Up to 10G	Single	1550 nm	20,000 m

* Theoretical distance is defined as half a distance stated by the 802.3 standard.

Fiber: Optical Insertion Loss Considerations

The loss budget is the amount of loss that a Cable plant should have. It is calculated by adding the average losses of all the components used in the Cable plant to get the total estimated end-to-end loss. The loss budget has two uses, 1) during the design stage to ensure the cabling being designed will work with the links intended to be used over it and 2) after installation, comparing the calculated loss to test results to ensure the cable plant is installed properly.

Here's where you want to read the fine print, because there is not an industry standard of measurement for budget light loss. In the network TAP arena, each manufacturer measures and publishes their data based on their own standards and specifications. This is not unique to passive fiber network TAPs, it's just the example and environment that Garland Technology knows best. What can be even more confusing when comparing stats is you need to know where the measurement was taken; because some measurements are more accurate to real-word environments than others.

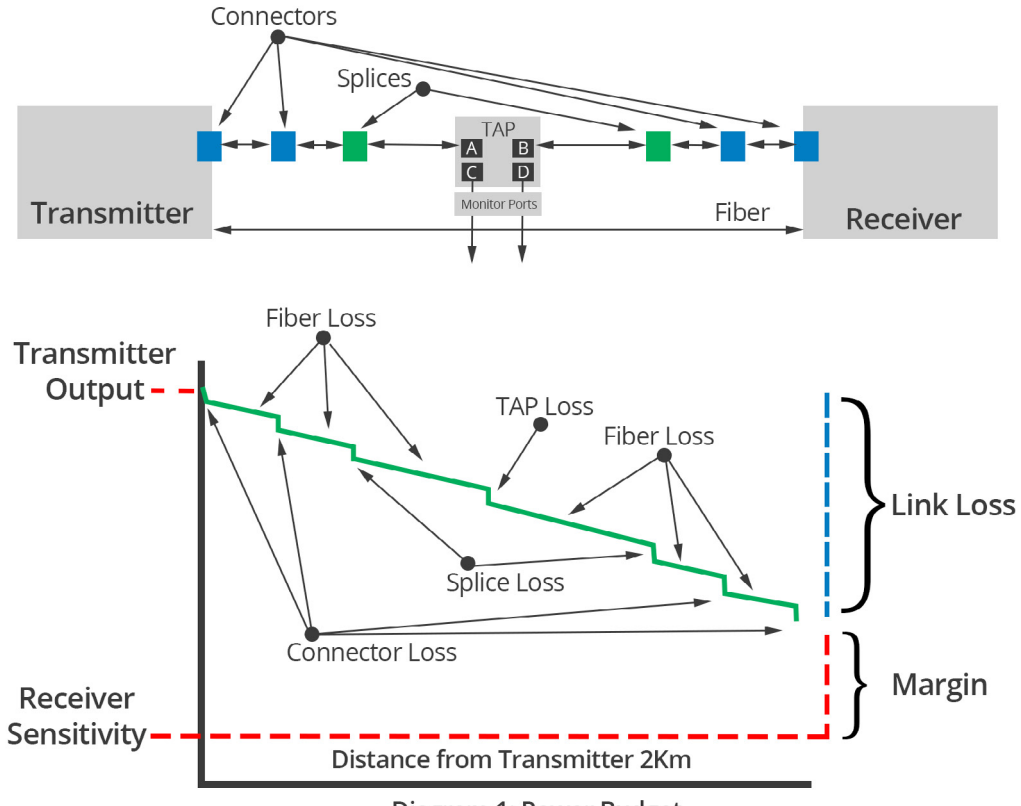


Diagram 1: Power Budget

3 Areas to Measure Fiber Optic Light Loss

First, let's understand that a fiber optic tap consists of the splitters; the splitters are terminated with LC or MTP® connectors and then connected to a coupler. The user connects their equipment to the couplers that exist on a TAP to complete the connection. Note that coming in the network port light traverses one mated pair then travels through the splitters and traverses one more mated pairs to exit the TAP on the other network port or the monitor port.

Loss measured through splitters. Loss numbers for TAPs have been published that are only – the loss through the splitter. This doesn't take into account the two mated pairs that exist in the system as mentioned above.

Loss number through splitters plus what is estimated the loss number will be through one mated pair. The idea here is that you have the hypothetical switch and router connected to one another with two fiber optic cables with a coupler in-between them. When you disconnect the coupler (one mated pair) and connect to the TAP you only introduced one additional mated pair and the fiber optic splitter loss.

Loss number through splitters plus what is estimated the loss number will be through two mated pairs. The idea here is that the switch and router are connected to one another without a coupler in between them (one continuous fiber). Therefore you have introduced two mated pairs and the fiber optic splitter.

> ***"Garland publishes the loss through our TAPs assuming you introduce one mated pair. Our light loss measurement standard is based on Option 2 found described above."***
> *Jerry Dillard, CTO/Co-Founder, Garland Technology*

Different Types of Fibers and Their Connectors: A Breakdown

If you're considering using fiber, there is still an array of choices before you. You'll have to decide on the mode, the thickness, the wavelengths, and the connectors.

There are two modes for fibers: single and multi. Single-mode fiber (SMF) has a smaller core than multi-mode fiber (MMF). Moreover, SMF's laser wavelength is narrower. As a result, SMF has a higher bandwidth capability. It can also transmit data longer distances than MMF.

MMF has its advantages, though. Due to its bigger core and wider wavelengths, it gathers light better from the laser than SMF. This capability makes it cheaper than its single mode counterpart. While MMF isn't suitable for long distance transmission, it can transport many different kinds of optic signals.

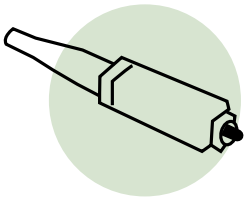
If you decide on MMF, your next selection is determining which optical mode suits your specific needs. You have four options:

	OM1	OM2	OM3	OM4
Thickness (µm)	62.5	50	50	50
Effective Modal Bandwidth (MHz*km) at 850nm	200	500	1500	3500
Effective Bit Rate	10Mbps	1Gbps	10Gbps	40Gbps to 100Gbps
Distance (at 10Gbps)	33m	82m	300m	400m

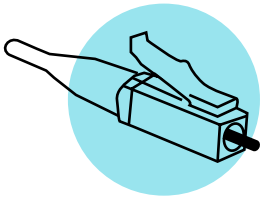
Although OM1 fiber was originally created to handle 10Mbps speeds, advancements in the legacy technology have made these fibers capable of handling up to 10Gbps. However, buying such high-end OM1 fiber would be very costly, leaving network architects to consider more modern cabling such as OM3 and OM4 for their bandwidth demands.

There are other MMF factors to keep in mind other than specific optical modes, one of which is wavelengths. Longer wavelengths in the infrared region and wavelengths between absorption bands influence fiber optic transmission wavelengths. The normal wavelengths for MMF are 850nm and 1300nm (or 1310nm). The 850nm wavelength is only used for short-reach applications because at this length, the waves attenuate. Today, 1350nm wavelengths are used for distances of up to 10km.

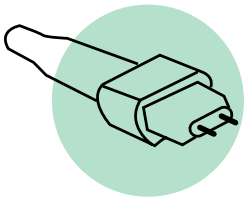
Fiber cabling also provides a variety of connectors. Three of the most popular connectors are SC, LC, and MPO:



The SC connector: With a reputation for excellent performance, this connector is incredibly easy to deploy because it latches with a simple push-pull motion.



The LC Connector: At half the size of an SC connector, cabling installers find LC connectors more effective with SMF for its space-saving abilities.



The MPO connector: If you have a multitude of cables to connect to the network, the MPO connector is the best option because it can connect twelve ribbons of fiber at once. The most reliable brand of MPO connectors is MTP®, manufactured by US Conec. In the fall of 2015, US Conec released the MTP-16™. Its ability to connect 16 ribbons means that it can transmit data faster. The MTP-16 will be a boon for companies who someday want to design 40G and 100G data centers to support mission-critical applications.

Cisco's Bi-Directional Technology - Easing the Transition to 40G

As much as IT professionals would love to overhaul their networks and migrate from 10G to 40G or even 100G, their employers lack the resources to do so.

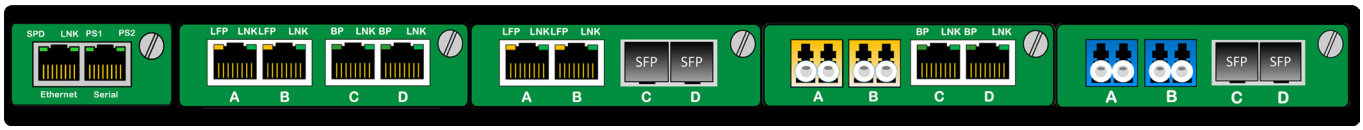
Cisco has attempted to address that issue with bidirectional 40G fiber connectivity (known as BiDi). BiDi allows data center engineers to reuse 10Gbps fiber infrastructure for 40Gbps connections. Implementing this technology postpones the need for a complete cabling overhaul. BiDi-enabled network test access points (TAPs) provide visibility into these faster networks so network administrators can see even the smallest amount of information as it travels over the cables.

Ensuring Network Visibility Regardless of Connectivity Type

To a large degree, it does matter quite a bit whether you choose copper or fiber, what kind of fiber, and the form of connector. Often though, network managers are forced to work in a mixed-media environment, meaning they need to convert their TX copper to fiber or vice versa.

“Media conversion” refers to the ability to convert fiber to copper or vice versa. If you wanted to convert a copper link to MMF, a media-converting TAP would let you continue to use your copper appliances.

Media conversion with TAPs is a cost-effective solution for data centers with mixed cabling and connectors. For instance, your single mode ER fiber link stretches about 10km. The network monitoring tool is two feet away. You can buy a transceiver to match the links, though it would be expensive. A network TAP allows a live connection to plug into one side and a monitoring tool into the other so you can see traffic, regardless of specifications.



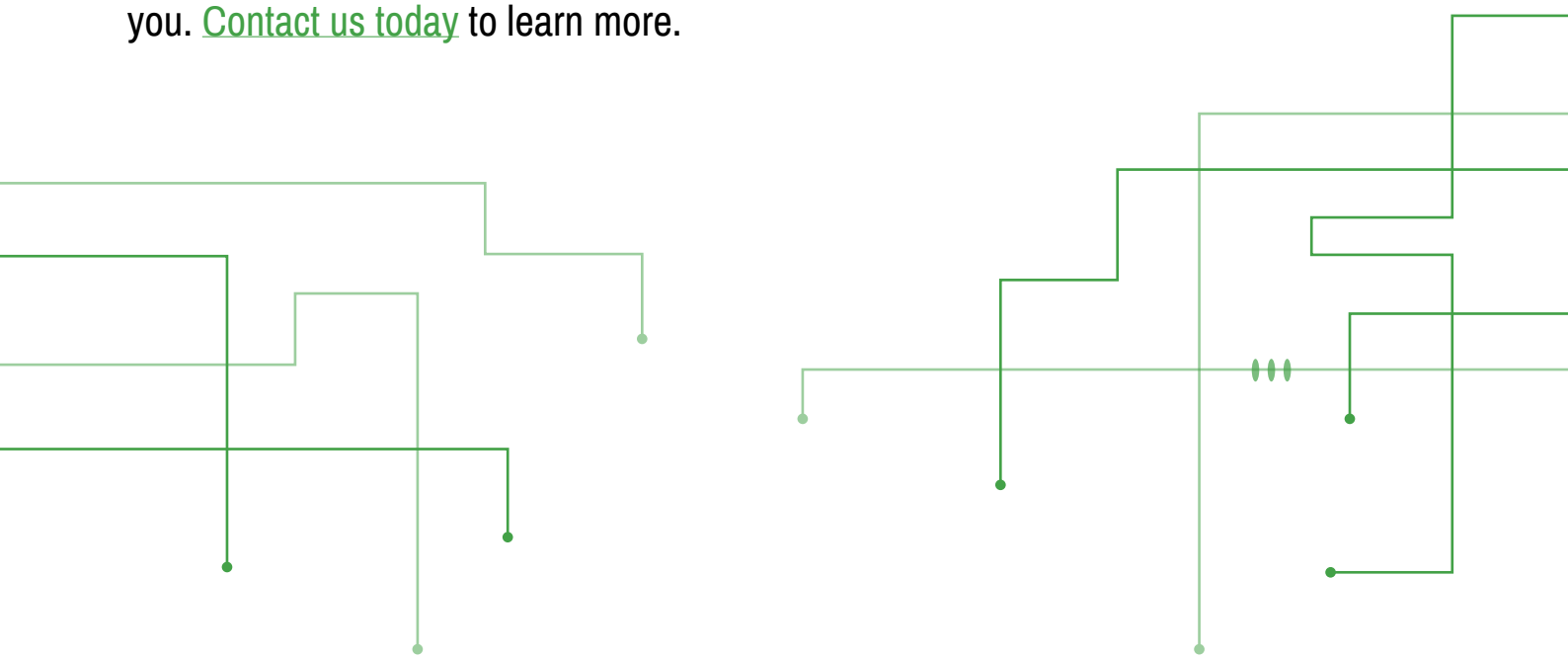
1U - 1G Chassis Supports Media Conversion: Fiber (SX, LX, ZX) to Copper (TX) and fiber short range (SX) to fiber long range (LX or ZX).

The most important thing about network visibility is to remember that you have to understand your data center environment. Being cognizant of your cabling infrastructure is half the battle. As well as implementing the appropriate monitoring and security tools to protect and defend your network and providing those tools every bit, byte and packet® of data to do their jobs.

Garland Technology's Design-IT™ Consultation: Your First Step into Total Network Visibility

At Garland Technology, our top priority is ensuring total network visibility. Our network designers are experienced IT professionals who work with you to determine your connectivity requirements, then tailor a solution that fits your needs. We work with the vendor of your choice without adding additional software that could cause a point of failure within your network.

Regardless of your connectivity situation, we will find a network visibility solution for you. Contact us today to learn more.



Garland Technology is all about connections – connecting your network to your appliance, connecting your data to your IT team, and reconnecting you to your core business. It's all about better network design. Choose from a full line of access products: a network TAP that supports aggregation, regeneration, bypass and breakout modes; packet brokering products; and cables and pluggables. We want to help you avoid introducing additional software, points of failure and bulk into your network. Garland's hardware solutions let you **see every bit, byte, and packet®** in your network.

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