Fiber in the Horizontal:

The better way to carry information

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Introduction

Optical fiber, long the transmission medium of choice for LAN backbones, is gaining market share for horizontal cabling applications. While copper is still the most popular horizontal cabling medium, an increasing number of MIS managers are choosing fiber for their desktop cable and an even larger number plan to install fiber in the next three to five years. Driving the decision to install fiber is the nation's growing commitment and dependence on high-speed LANs to support business requirements. In less than a decade, we have witnessed data rates nearly double every year as companies add more users to their networks and take advantage of more bandwidth intensive applications.

Network planners specify optical fiber cable for a number of reasons, but the most common are:

- **Fiber's error-free transmission over longer distances**. With longer link distances, network designers also have more flexibility in planning their networks, and are able to take advantage of new architectures.

- **Fiber's ability to support higher data rates**. Fiber's high bandwidth takes advantage of existing applications and emerging high-speed network interfaces and protocols such as Gigabit Ethernet.

- **Fiber's ease of handling, installing, and testing**. Fiber can now be installed and tested in the same or less time than copper networks.

- **Fiber's long term economic benefits**. Over the lifetime of the network, optical fiber is typically a more economically viable choice than copper. For example, fiber's superior reliability reduces operating costs by minimizing network outages. Similarly, fiber's higher bandwidth can produce considerable savings by eliminating the need to pull new cable when the network is upgraded to support higher bandwidth applications. Also, fiber's high bandwidth and long distance capability allow all hub electronics to be centrally located, rather than distributed in closets throughout a building. Centralization reduces the cost of cabling and electronics, and reduces administration and maintenance efforts by making moves, adds and changes easier.

Network engineers and technicians prefer optical fiber for the following reasons:

Fiber is immune to EMI/RFI signals. Optical fiber carries light rather than electricity, so it is not affected by electromagnetic interference from power (sub-kilohertz), radio (kilohertz to megahertz), or microwave (gigahertz) sources. Interfering signals from these sources can couple into copper cables creating sporadic problems that are difficult to troubleshoot and repair. Further, radiated emissions and susceptibility to external interference are almost entirely eliminated simply by the inherent design of optical cables.

Fiber is immune to crosstalk. Crosstalk occurs when unwanted signals are coupled between copper conductors. Signals cannot couple between fibers in a cable, thus eliminating crosstalk.

Fiber systems are easier to test. Even with higher data rates, fiber test requirements have not increased in complexity. For copper cabling, however, there are now more than 20 specified parameters (see attachment 2) for Gigabit Ethernet as opposed to two for optical fiber (attenuation and bandwidth).

Fiber provides greater reliability and equipment safety. Unlike copper facilities, all-dielectric fiber cabling systems do not conduct lightning strikes or electrical currents that can damage sensitive electronic transmission equipment.

Summary

Optical fiber provides users with higher reliability, superior performance and greater flexibility than copper-based systems. The construction of optical fiber makes it essentially immune to many of the factors that adversely impact copper, factors that often become more pronounced at higher data rates, thereby increasing network cost and complexity.

Standards, Equipment and Installation Considerations

Fiber standards

Fiber provides a uniform solution. The fiber cable specification encompasses the full spectrum of fiber-based LAN applications, including Token Ring, FDDI, 100BASE-FX, ATM, Fibre Channel and ESCON®, Ethernet, and Gigabit Ethernet. Each of these specifies multimode fiber with the common optical performance parameters detailed in ANSI/TIA/EIA-568. Further, by referencing fiber cable standards such as those developed by Insulated Cable Engineers Association (ICEA), the customer is assured of getting quality products.

Transmission equipment availability

There are numerous manufacturers that offer a full range of products which are readily available.

Installation considerations

Optical fiber cable is now an established medium, used extensively for building backbones and risers. Most installers have had considerable experience installing fiber in backbones -- experience that is easily transferred to installing the same type of fiber in the horizontal. Today, installing optic fiber cabling is less restrictive than installing high data rate copper cabling. Optical fiber cables are stronger, lighter, and smaller than comparative copper cable designs and there are few routing restrictions for optical fiber cables, particularly in areas with electrical power cables. Once installed, verifying the optical cabling performance can be accomplished with a simple power meter in a single step.

Understanding The Cost Of Fiber

Historically, the strongest argument against fiber, even for applications that require new cabling, has been higher initial cost. However, more stringent UTP requirements, coupled with advances in fiber technology and higher fiber production volumes, have narrowed the gap considerably. Moreover, when ongoing system-level cost factors such as network operation, management, and plant upgrades are considered, fiber is less expensive over the long haul. To understand a network's *total* installed lifetime costs, you should consider:

1) Cabling component costs, including the cable, wall outlets, patch panels, patch cords and connectors;
2) Labor costs to install and test the cabling system;
3) Electronics costs, such as hubs, concentrators and network interface cards;
4) Activation costs, including the labor and software needed to activate the network;
5) Downtime costs, including the impact of network outages on productivity;
6) Maintenance costs;
7) Network management costs, including the recurring cost of network changes;
8) Recabling costs associated with upgrading to higher bandwidth networks in the future.

Fiber systems have distinct advantages that reduce overall life-cycle costs. These savings can far exceed any remaining initial cost premium.

Cabling System Component Costs. The cost of fiber components is still marginally higher than that of category 5 UTP. However, more stringent requirements of category 5e, 6, and 7 cabling have caused the cost of copper-based systems to increase. Meanwhile, lower costs of fiber components (because of higher fiber component production volumes and introduction of small form factor connectors)**,** have caused the cost of copper and fiber cabling components to converge. Current estimates show optical fiber cabling to be within 10% of category 5e costs, at parity with category 6 costs and less expensive than category 7.

Installation and Testing Costs. Labor costs to terminate and test optical fiber cable and category 5 UTP cable are now comparable. Many new field-mountable fiber optic connector technologies make terminating optical cables easier and faster than before, and testing costs for category 5 UTP are significantly higher than for fiber.

Fiber's small size and light weight requires less space in cable trays, conduits and telecommunication closets. When recabling in existing space, fiber provides the unique option of using power conduit to run new data cable as long as National Electrical Code® guidelines are observed.

Open office cabling is another application where users are electing to install “zone” cabling in open office environments, specifically where open systems furniture is used. A multi-fiber cable can serve 6, 8 or even more users with no concern over interference between incompatible signals. Additionally, there is no concern about separation from power cables within the furniture or wiring columns. The increased patch cord length required with multi-user outlets also presents no problems for optical fiber.

Electronics Costs. Until recently, higher electronics costs, particularly for transceivers, have been a stumbling block for deploying fiber cable. These premiums have been reflected in the cost of system-level electronics such as hubs, concentrators and network cards. However, this scenario is changing. Already lower cost electronics are available, and new architectures are developing that allow users to install fewer electronics, thereby lowering the overall cost of their system.

Productivity Costs. While network managers are justifiably concerned with first-order costs such as cabling, components and installation, fiber's superior reliability minimizes data errors and requires less time and effort in troubleshooting and correcting cabling problems. The cost savings that result from increased productivity alone can more than offset the incremental cost associated with installing fiber.

Recabling Costs*.* Fiber's greatest cost advantage lies in its ability to support higher data rate networks without recabling, thereby extending the life of the network infrastructure. The inability of the installed base of pre-categorized copper facilities to handle new LAN implementations has led to the development of increasingly stringent cabling requirements resulting in the present category 3, 4, 5, 5e, 6 and 7 specifications.

Recommendations:

Recent advances are giving network managers new reasons to consider deploying all-fiber networks to future proof their networks. To learn more about the advances that are facilitating the deployment of optical fiber into the horizontal visit our web site at www.fols.org and the FOLS member companies.

Premise Fiber Technology Recommendations

Application	Baud Rate (Mbaud)	Cabling Scope and Technology Combinations					
		Horizontal Cabling < 100 meters		Building Cabling < 300 meters		Campus Backbone < 2000 meters	
		Media	Tx Tech	Media	Tx Tech	Media	Tx Tech
10BASE-F	20	mm	S	mm	S	mm	S
Token Ring	32	mm	S	mm	S	mm	S
100VG-AnyLAN	120	mm	S	mm	S	mm	LE
100BASE-F	125	mm	**S**	mm	**S**	mm	LE
1000BASE-SX	1250	mm	**SL**	mm	**SL**		
1000BASE-LX	1250	mm	**LL**	mm	**LL**	sm	LL
FDDI	125	mm	**S**	mm	**S**	mm	LE
Fibre Channel	133	mm	**S**	mm	**S**	mm	**LE**
	266	mm	SL/LE	mm	SL/LE	sm	LL
	531	mm	SL/**LE**	mm	SL/**LE**	sm	LL
	1062	mm	SL	**mm**	SL	sm	LL
Sonet-ATM	52	**mm**	**S**	**mm**	**S**	**mm**	**LE**
	155	mm	**S**/LE	mm	**S**/LE	mm	**SL**/LE
	622	mm	SL/LE	mm	SL/LE	sm	LL
	1244	**mm**	**SL**	**mm**	**SL**	sm	LL
	2488	**mm**	**SL**	**mm**	**SL**	sm	LL

Legend

mm = multimode optical fiber

sm = standard single-mode fiber

S = short λ (850 nm window) LED or short λ laser equivalent

SL = short λ (850 nm window) laser

LE = long λ (1300 nm window) LED

LL = long λ (1300 nm window) laser

Note: Multiple entries are ordered for readability and uniformity only