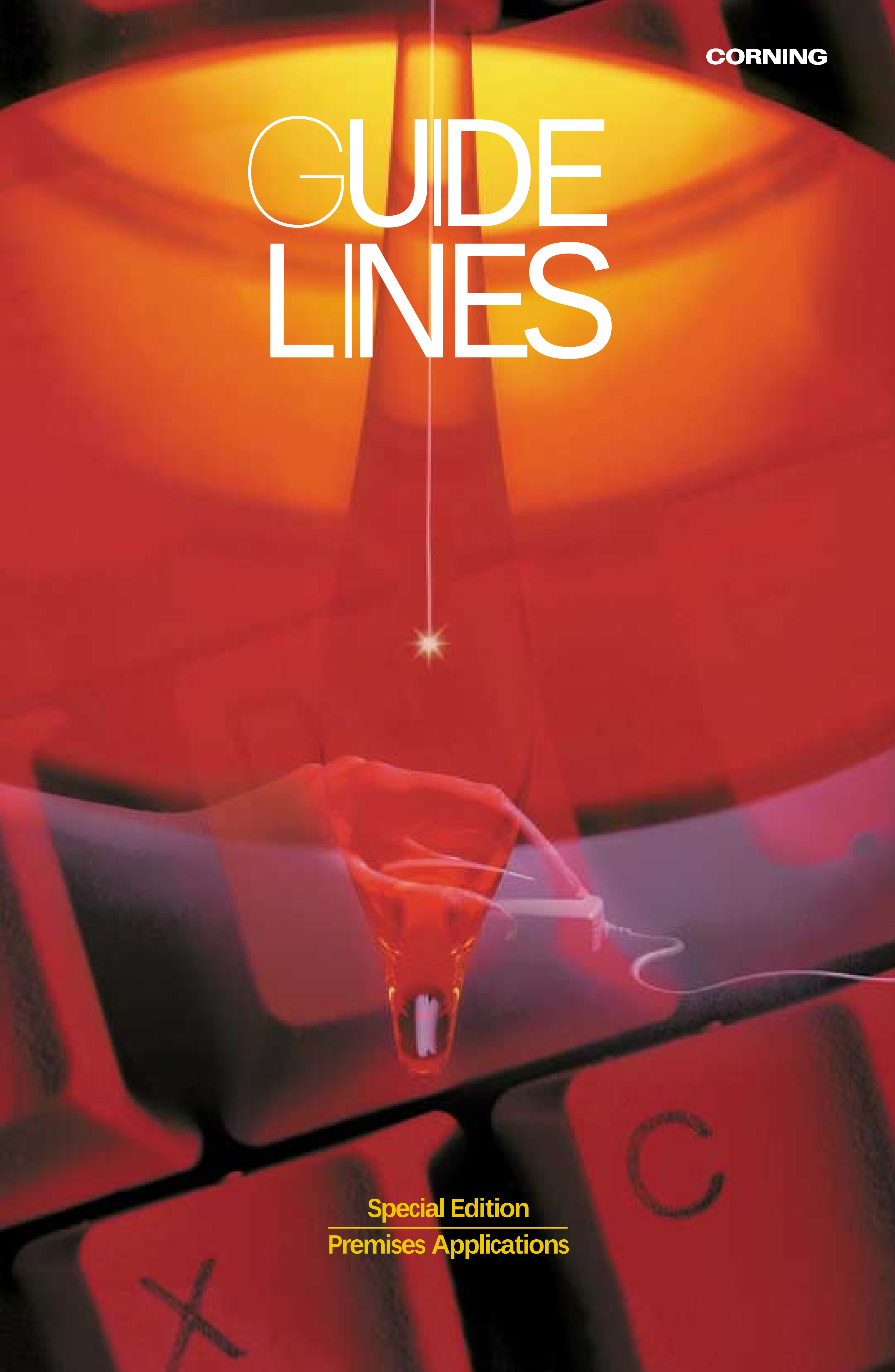
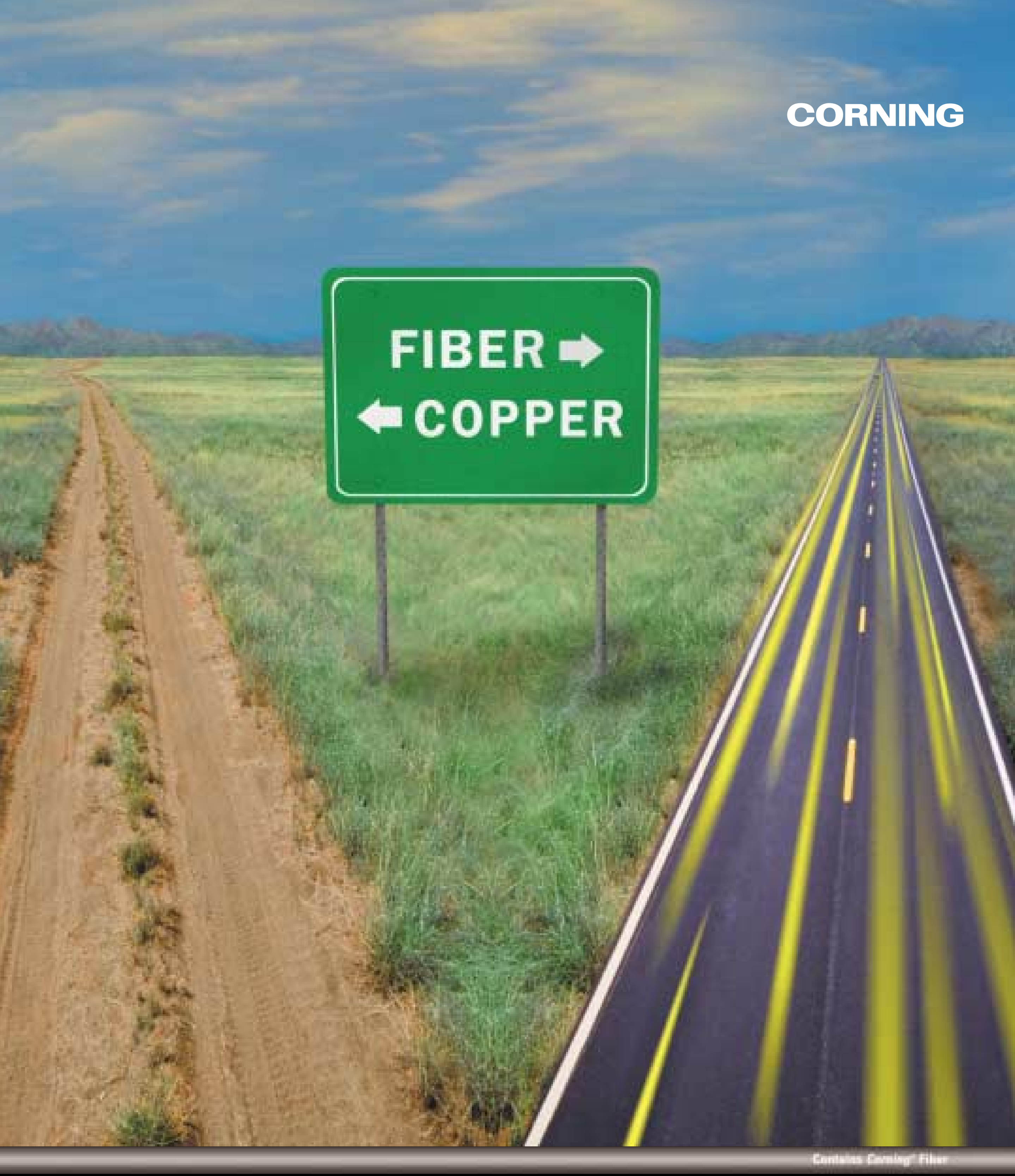


CORNING

GUIDE LINES

Special Edition

Premises Applications



Where Is Your LAN Headed?

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Editor's Note | Carolyn Case | SPECIAL EDITOR

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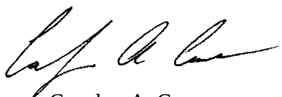
Winter 2000

Dear Networking Professional:

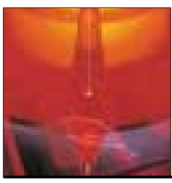
As product line manager of premises applications here at Corning, I'd like to welcome you to our first *GuideLines* issue totally dedicated to multimode optical fiber. I think you'll find this publication both beneficial and enlightening, especially in the area of recent developments within local area networks and fiber-to-the-desk. One topic that should be of special interest to our readers is the cost competitiveness of optical fiber throughout the entire local area network.

For more than a decade, *GuideLines* magazine, published by Corning Incorporated's Telecommunications Products Division, has been a valuable resource for communications network professionals. If you would like a complimentary subscription or if you would like more information on a particular article, please call 1-800-525-2524, ext. 4197.

Sincerely,



Carolyn A. Case
Product Line Manager - Premises



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STRAIGHT TALK

WITH PRESTON BUCK

CORNING INCORPORATED'S MARKET MANAGER OF PREMISES APPLICATIONS and a 'show me, I'm from Missouri' guy gives his opinion on the future of multimode fiber and local area networks.

Copper's stronghold in local area networks (LANs) continues although its demise has been predicted over the past few years. What's the real story?

Copper's progression is very interesting. Many years ago, it started out simply as coax. Then different types of coax evolved that were upgraded to new coax to be followed by twisted pair, shielded and unshielded. Now there are all the different categories — CAT 3, CAT 4, all the way to CAT 7.

Basically, it's the same product, copper! Only now with different coatings or a different separation or twist, it is packaged differently and marketed as a new product. The copper manufacturers have been able to improve the performance enough to meet the latest protocol requirements and sell each improvement as an "upgrade." This has worked so far, but now, with Gigabit Ethernet (GbE) being adopted in the riser and spreading to the desktop, things will change. The standard for GbE over copper took a year longer to develop than the GbE over fiber standard. I think this reflects the difficulty of using copper at the higher speeds and the realization that a lot of CAT 5 isn't installed properly and doesn't work at GbE. This is why there are so many additional tests that are required to run GbE over CAT 5. And while there finally is a standard for GbE over copper, most network planners are recommending CAT 5E or higher. Why is this? And what are the actual differences between CAT 5 and CAT 5E? The answer is that there are different testing requirements and installation practices, but the materials that go into the cable essentially are unchanged. The dielectric insulation is thicker and the number of twists has been changed, but the conductor size is unchanged. So network owners must pay for the cost of re-cabling with a more expensive CAT 5E or CAT 6 cable and have more testing requirements and more rigorous installation practices — all in the hope that they can run GbE over copper successfully.

Over the next five to ten years, I think that copper will continue to have a large percentage of the desktop links. The cheaper short-term cost almost ensures it. But with GbE, I hope the industry is beginning to realize that "upgrading" their copper cable isn't really buying them that much. The "upgrade" still is basically the same material in a slightly different configuration. Perhaps it's time to truly upgrade the network cabling to optical fiber and reap the benefits for years to come.

Taking this into consideration, how do network designers continue to justify the use of copper?

The demand for copper-to-the-desktop has always been strong because of its perceived low cost. So short term, it's cost. But that's the irony of the situation. Too many of those working in telecommunications today are focusing only on installation costs. They're not looking at the whole picture — the total cost of a network.

All network costs must be taken into consideration: installation, testing, maintenance and upgrades. Installation costs for fiber cables are very near the cost of CAT 5 and are less than the cost of CAT 6. The fiber electronics still are more expensive than copper electronics, but thanks to small form factor connectors, the costs continue to drop. Fast Ethernet fiber network interface cards (NICs) can be bought for around $140 versus more than $300 a couple of years ago and media converter prices have dropped to about half of what they were a couple of years ago. So the cost of a fiber network isn't that much more expensive than a copper network. And if your network has centralized cabling, the installation costs can actually be less than a copper network.

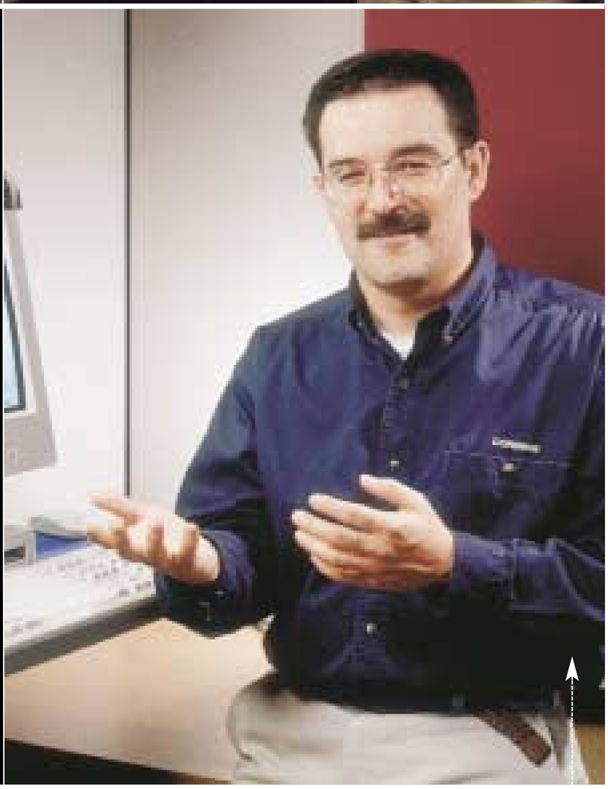
Testing fiber is easier and takes less time than copper. According to the TIA TSB-67 (Link Performance Test Standard), four tests are required for copper: wire map, length, attenuation and near-end crosstalk (NEXT). These tests are the bare minimum and aren't enough for GbE links. For GbE links, you need the following additional tests: delay skew, power sum NEXT, power sum ACR, far-end crosstalk and return loss. These tests cost time and money, especially the crosstalk test which should be performed at both ends of a link. In contrast, TIA 568A (Commercial Building Telecommunications Cabling Standard) requires that only the attenuation of a fiber link be measured. One simple test from one end of a fiber link is all you need.

Maintenance costs of the network also are important to consider. How much time and energy do you spend fixing the physical layer? A fiber network needs less maintenance than a copper network simply because glass is inert. It doesn't oxidize, corrode or have galvanic reactions. Consequently, a fiber network is more reliable. In talking to switch vendors, I'm told that smaller companies tend to install fiber-to-the-desktop (FTTD) within 20% to 40% of the costs of a copper network. Because engineers with numerous other responsibilities usually manage the networks, they're looking for a maintenance-free system that's dependable for the long term. They don't want to waste time babysitting a copper network. In talking to Corning networking personnel, they confirm this makes their job easier. And there are certain aspects to which an exact cost cannot be assigned, like network downtime. Where does it go down? For how long? In what business? How is productivity affected? As you can see, it can add up to more money than the installation costs.

Unfortunately, many organizations are trying to hold on to copper technology because they don't want to pay the perceived high initial investment required to upgrade to fiber. But how many times have they upgraded their copper network in the past five or ten years? When you examine the total cost of the network over a decade and include recabling three or four times, a copper network is more expensive. When you look at the cost of recabling a copper network in terms of materials, labor and downtime, fiber definitely offers a better long-term return on investment.

Is anything being done to address fiber installation costs?

Yes, definitely. There's no longer the cost disparity between copper and fiber that there once was. The cost of a copper network is no longer half the cost of a fiber network. The gap between the two is closing fast. The cost of electronics is coming down. With the advent of new small form connector technology, end users are realiz-



CORNING HAS DEVELOPED A NEW SERIES of high-performance multimode fiber engineered specifically for laser-based LAN protocols.

ing higher connector densities and a decrease in cost.

Another major breakthrough is centralized architecture. This cabling design houses all of the data electronics in a single location with optical fiber cables providing direct connections to every workstation outlet in the network. Cost savings abound with this type of design. Without the need for numerous, expensive telecommunications closets, money is saved by reducing the amount of real estate and the need for as many active electronics. Maintenance costs plummet as well.

Copper, on the other hand, requires all of these closets because of the limited distance it can run, which basically is 100 meters. No matter which category of copper you buy, you still are limited to 100 meters. Every 100 meters, active electronics are needed to manage the signal, whether it's being repeated, trunked together or switched. With fiber, depending on what protocol is being used, the distance between active electronics can be as great as two kilometers — 20 times the distance of a copper network! The distance limitations of a copper network just don't apply to a fiber network. And don't forget that every piece of active electronics needs to have clean power, a good ground, conditioned air and uninteruptable power supply (UPS).

With centralized architecture, it's also less expensive and easier for one person to manage a network from one place versus having many people responsible for different floors and different switches. Troubleshooting is much cheaper and simpler. Because of a direct path with less active electronics, there's no process of elimination and the problem can be located right away. For example, George Washington University went to a centralized fiber network, which they call "fiber to the pillow." They had 20 technicians maintaining their old copper network. Now one technician maintains their current fiber network.

Additionally, centralized architecture design is flexible. It doesn't necessarily mean having to run everything to one switch. For example, if I were cabling a 15-story building, I might not have enough space in the riser to send 3000 fiber pairs down to a central switch. But if I used fiber to each desktop and combined three communication closets into one and connected that one directly to the central switch, that's a step in the right direction. I would realize the benefits of reduced costs for real estate and fewer electronics to buy and maintain service. Or, as another alternative, I could connect every five floors to one hub. So there are many approaches to using a centralized architecture, and they all offer cost savings.

Are there other factors to consider when comparing copper vs. fiber?

Certainly, network reliability is a big one. Category 5, unshielded twisted pair (UTP) cable is the most common grade of copper cable in use today and it's plagued with problems such as installation errors, substandard cable materials and substandard connectors.

Many installation mistakes are due to the fact that standards weren't formalized until 1995, although you could buy CAT 5 cable as early as 1993. According to Jim Serenbetz and Pete Lockhart, Anixter Inc. officials, in their white paper, "Category 5: How Did We Get Here and Where Do We Go Next," a lot of improperly installed cable exists in buildings today.

CORNING IS ALSO WORKING ON WAYS TO DRIVE THE COST OF ELECTRONICS DOWN, therefore helping to increase the acceptance of fiber-to-the-desk.

They mention in their paper that in 1994 the demand for Category 5 UTP led to shortages of a critical material, FEP, a form of Teflon used as a dielectric. Some cable manufacturers produced cables using less FEP on one of the twisted pairs, having mixed it with other materials that were compliant with the standard. The result was dramatic variance in electrical performance. Additionally, independent lab tests found that four out of ten connectors sold as Category 5-compliant failed to meet specifications and several others were borderline passes. All these problems add up to reducing the reliability of your network.

Fiber doesn't have any of these problems. Fiber-optic cable is relatively straightforward to install. There aren't any twists to count or three-eighths inches of insulation to remove. The jacketing materials are there to support and protect the fiber. They play no part in the transmission of the light and cannot affect the performance of your network. It's the same with the connectors. The function of a fiber connector is to bring the end-face of the fiber into contact with either another fiber or an active device. Unlike a copper connector, a fiber connector is not part of the transmission path. The current fiber connectors are easy to install and usually come with a tool kit that makes installing connectors much simpler and faster than in the past. Followed with a simple test for attenuation, a fiber-optic link is hard to beat.

All these things contribute to making your fiber network much more reliable. Incidentally, this is why all the transaction data from the New York Stock Exchange is transmitted on an all fiber network.

We've talked about cost and reliability. Is there anything else to consider?

Meeting the challenge of the future is a huge consideration. In the past decade, LAN data rates have more than doubled, which has led to the adoption of a new protocol, Gigabit Ethernet, the third generation of Ethernet technology. GbE offers 1000 Mbps speeds in LANs and upgrades easily from Ethernet, the current protocol most organizations are using. It's expected that GbE will be commonly used in both riser and backbone links within the next two years. Eventually it will migrate to the desktop as well. Apple already offers a GbE card as an option on their latest computer, the G3, and Phobos currently offers a GbE fiber NIC for desktops.

Supporting this, an Infonetics Research study released this spring stated that in all sizes of organizations, GbE is connecting servers, backbones and even desktops in numbers equal to asynchronous transfer mode (ATM) and will exceed ATM in 2000. And 68% of study respondents see it as a substitute for FDDI and ATM. So it looks like most networks will need to be able to support GbE.

How else is GbE different?

Traditionally, LAN applications used light emitting diodes (LEDs) for light sources. GbE, however, utilizes laser light sources such as 850-nm vertical cavity surface-emitting lasers (VCSELs) and 1300-nm Fabry-Perot lasers. This is an important distinction: while LEDs distribute their power throughout the entire index profile of the fiber, propogating hundreds of modes, lasers distribute power through roughly 5% at the center of the core and thus propagate fewer modes.

Will copper be able to handle GbE?

It's hard to say... . The standard for GbE over CAT 5 is out now. But by the end of 2000, many IT managers expect CAT 5 to be replaced because they don't know if their CAT 5 installations will handle GbE. They'll have to test for far-end cross-talk, return loss and delay skew problems they didn't have to worry about in the past. And unshielded twisted pair can be more costly to test than fiber. Most likely, copper in some form, will be able to handle GbE, though it will probably require recabling to a more expensive copper cable. Even then, the copper cable will still have a distance limitation of 100 meters.

What is Corning doing to meet the challenge of the future?

The GbE Standard (IEEE 802.32) formalized in June 1998 provides media specifications for both multimode and single-mode optical fiber. With single-mode networks being the more expensive option, Corning has developed a new series of multimode fiber — InfiniCor™ fiber. This high performance fiber is engineered specifically for laser-based LAN protocols such as GbE. InfiniCor fiber offers guaranteed GbE performance at established link lengths through associated cabler warranty programs and is compatible with existing multimode fiber and equipment. It's suitable for backbone, riser and horizontal applications. InfiniCor CL™ fiber, the next in the series of InfiniCor fibers, eliminates the need for a mode conditioning patch cord traditionally required for 1300-nm operation and is designed to support higher speeds. Basically we have a series of fiber that you can run any of the existing protocols on such as Ethernet, FDDI, etc. And when you want to start running GbE, you can do so over the same fiber. No recabling is required.

Corning also is working with the Fiber Optic LAN Section, the MTRJ Alliance and the VF-45 Action Group. These multi-vendor organizations are working on ways to drive the costs of electronics down, therefore helping to increase the acceptance of fiber-to-the-desk.

How do you personally feel about the future?

I bought my first computer in 1984, and I have always been fascinated by fiber-optic technology. To be able to take an image, break it into bits of light, send it down a glass pipe, and then reassemble it at the other end as a complete image is simply amazing to me. It's a great time for fiber, and I see the computer-networking industry continuing to grow by leaps and bounds. Right now, as in the past, we're unsure of how we'll utilize the colossal bandwidths we're now capable of with new protocols like GbE. However, I have no doubt that in the not too distant future we'll look back and think that even 10 Gbps is slow and can't meet our needs. But our fiber networks will still be there to support us. ■

For more information

FROM *CORNING INCORPORATED*

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Small Form Factor Connectors

ENABLE COST-EFFECTIVE FIBER-TO-THE-DESK NETWORK SOLUTIONS

The biggest obstacle to full-scale deployment of fiber-to-the-desk (FTTD) network cabling designs has been the cost of electronics and connectors. Connectors alone comprise roughly 35 percent of total optical fiber cabling costs ("Fiber Fights Back," *Data Communications*, May 1999). Also, the bulk of fiber connectors, such as the ST and SC models, are twice the size of copper connectors and have made port density impossible, keeping overall network costs relatively high. Thus, an impediment to bringing down the cost of FTTD installations using conventional connectors has been the cost and size of those connectors.

Now a new family of fiber connectors, known as small form factor connectors, is helping break down the barriers to lower costs in fiber networks. Compared to traditional fiber connectors, small form factor connectors are smaller, cheaper and easier to install. They do not require that the fibers be polished and glued. Their compact design increases port density on network hubs and switches, which reduces electronics costs and helps cut back on expensive telecommunications closet space. Installing fiber brings down the cost of ownership of a network by reducing recabling costs and downtime characteristic of a copper network. The overall result is that fiber is the smarter long-term solution offering users affordable, end-to-end, passive to active fiber solutions for a local area network (LAN) with higher bandwidth, security and flexibility.

Although several small form factor connector designs have been considered by the Telecommunications Industry Association for standardization in the Commercial-Building Cabling Standard, support for a single design has proved elusive. However, the proposed revision of the Telecommunications Industry Association Commercial-Building Cabling Standard (TIA-568B) currently allows small form factor connectors at all locations other than the wall outlet, provided an intermatability standard exists and the connector can meet the performance requirements specified in Annex A. As a result, two small form factor connector designs featured in this article have emerged, establishing themselves in the industry as well as making the costs associated with a FTTD network competitive with copper. These two connectors are the MT-RJ and the VF-45.

The MT-RJ Connector

The MT-RJ connector (see Figure 1)— the result of work among a consortium of manufacturers including Siecor, AMP Inc., Alcoa-Fujikura Ltd., Hewlett-Packard and US Conec — employs the familiar RJ latching system found in copper systems. That is, the connector snaps in place like an RJ-45 phone jack. Two metal guide pins on the male end mate with a corresponding set of holes in the receptacle to ensure proper alignment. One-half the size of an SC connector and with half as many components, the MT-RJ terminates two multimode or single-mode fiber strands, which are contained in a single ferrule. Conventional duplex connectors align the fibers by threading each through its own ferrule, adding bulk and complexity.

The VF-45 Connector

The VF-45 connector (see Figure 2) is the result of work among 3M, Honeywell Micro Switch and Infineon Technologies. Other companies that make compatible networking equipment include BATM Advanced Communications, Gemflex Networks Ltd., Phobos Corporation, RACORE Technology Corporation, Infineon Technologies and Sumitomo Electric Lightwave Corporation. Both the VF-45 and the MT-RJ employ the RJ top-latching system. The VF-45 uses V-grooves rather than one or two ferrules to align the two fibers. V-groove technology provides tight tolerances in the opto-electronic devices used in the system while eliminating ferrules altogether. Being precision-made parts, the ferrules can be the most expensive part of the connector.

Fiber Alignment

How fiber alignment is achieved is a significant differentiating factor in small form factor connectors. The alignment process is largely dependent on the placement of fibers within the connectors. The VF-45 is a so-called "large pitch" connector, with the fiber strands spaced far apart: 4.5 mm. As a result, each fiber is aligned independently and directly with its mated fiber. The MT-RJ is a "small pitch" connector; the fibers, contained in a single ferrule, are only 0.75 mm apart. Using one ferrule means both fibers are installed at the same time.

The Benefits of Using Small Factor Connectors

With all small form factor connectors, port density is doubled, bringing it on par with copper. Doubling ports does not double the cost of electronics, because most of the cost is for required components regardless of the number of ports. Therefore,

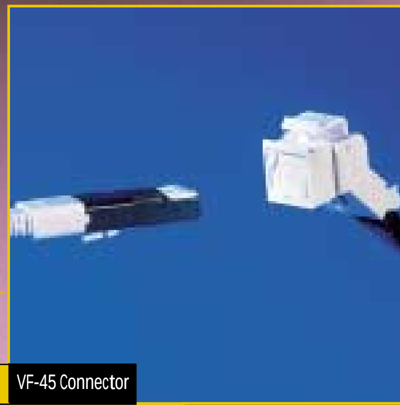

Figure 2: VF-45 Connector

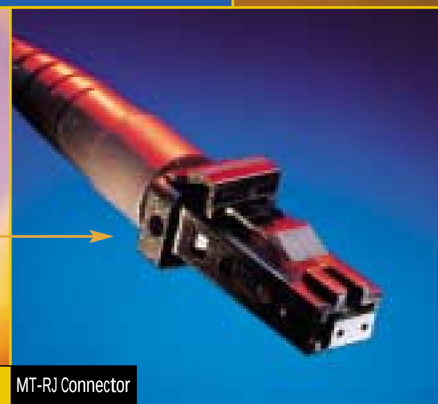

Figure 1: MT-RJ Connector

greater port density on hubs and switches lowers the cost per port, making FTTD solutions more competitive with copper. Moreover, greater port density reduces the space required of telecommunications closets, which could result in more fibers terminated, a smaller telecommunication closet in new builds, or less congestion in existing closets.

Fiber systems with small form factor connectors cost much less than traditional fiber designs and just 20 percent more than CAT5 copper solutions ("Fiber Fights Back"). The bigger the installation, the savings is greater and the gap between copper is narrower. For example, one manufacturer prices a 200-station fiber installation using small form factor connectors at $40,550, compared with $48,200 using standard fiber connectors and $28,350 with CAT5. When the installation increases to 1,000 stations, however, the price tag for a small form factor connector system is $334,500, compared with $410,000 for standard fiber connectors and $332,500 with CAT5 ("Fiber Fights Back"). In the larger installation, the cost difference between copper and FTTD is negligible. The bottom line: Small form factor connectors make the all-fiber network a more attractive option for premises network decision-makers. ■

For more information

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The Evolution of LANs

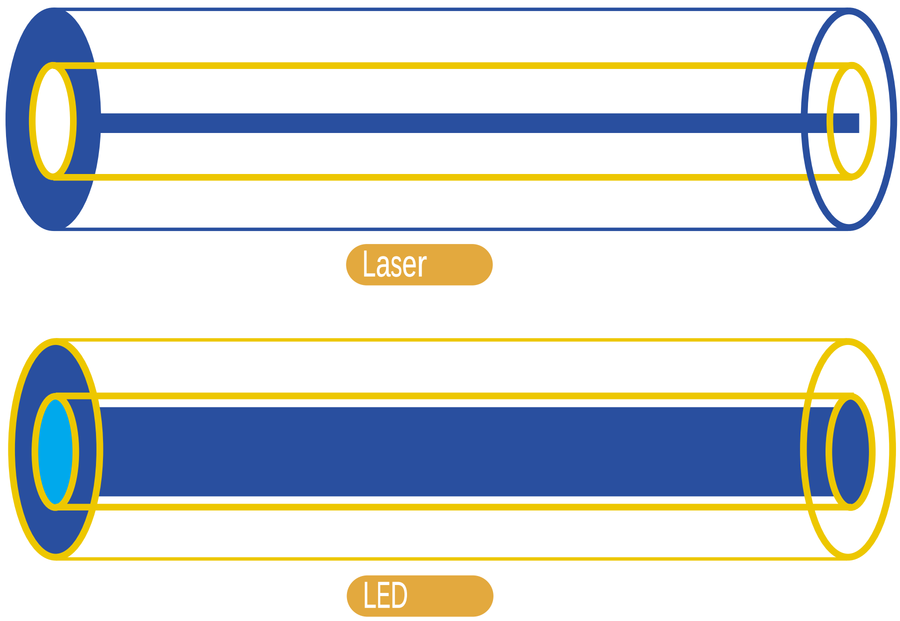

Figure 1: Laser/LED

Lasers focus their power near the center of the core of a multimode fiber, whereas LEDs distribute their power through the entire core. With a laser launch, it is important that the index profile of the fiber is consistent and uniform.

The local area network (LAN) market has undergone significant changes over the last year. The major catalyst of the transformation of the market is the exponential growth of data moving across a network. Recent figures from UUNET, an Internet backbone provider, show that Internet usage is doubling every 3.6 months. With this surging demand for data, LAN managers have been forced to rapidly evaluate and adopt new technologies.

What Every Network Professional Should Know

To help meet this demand for more data, the IEEE Gigabit Ethernet Committee (IEEE 802.3z) completed the Gigabit Ethernet (GbE) standard in June of 1998. The standard enables Gigabit Ethernet LANs to transmit data at 1,000 megabits per second (Mbps), compared to 10 Mbps for Ethernet and 100 Mbps for Fast Ethernet. Additionally, since GbE evolved from the Ethernet and Fast Ethernet standards, which are the most ubiquitous networking protocols, network managers will find the new GbE protocol very familiar. Many of their current Ethernet management tools also will support GbE.

Unlike previous protocols, the GbE protocol utilizes laser light sources at both 850nm and 1300nm. Lasers focus their power near the center of the core of a multimode optical fiber, propagating fewer modes in the fiber compared to an overfilled launch (see Figure 1). Typical laser sources include: 850nm vertical-cavity surface-emitting lasers (VCSELs), 1300nm Fabry-Perot lasers, and 780nm CD lasers. Lasers enable much higher bandwidth capacity and support high-speed protocols, such as Gigabit Ethernet and beyond, to satisfy the requirements of bandwidth-hungry applications.

Previous LAN protocols have relied on light emitting diodes (LEDs) for light sources in the 850nm operating window. The advantage of LEDs is that they are an inexpensive light source compared to most laser sources. By operating at 850nm with LEDs, network managers could have the bandwidth and benefits of fiber at a lower cost. The introduction of VCSELs has reduced this advantage because the manufacturing costs of VCSELs are much lower than other lasers.

The disadvantage LEDs bring is that the maximum data rate achievable with an LED is 622 Mbps. LEDs distribute their power throughout the entire index profile of the fiber, propagating literally hundreds of modes (see Figure 1). As these modes propagate down the fiber, the different path each mode takes results in different arrival times at the receiver. This pulse spreading at the receiver limits the maximum bandwidth that LEDs are able to achieve. LEDs have served the industry well over the past 25 years satisfying users' needs at Ethernet and Fast Ethernet speeds. The future, however, belongs to lasers and high-speed protocols such as Gigabit Ethernet.

Since the LAN market historically has been dominated by LEDs, standardized measures of multimode optical fiber bandwidth are completed using an overfilled launch (OFL) to insert light into the fiber. In this measurement, the fiber core is filled with hundreds of different modes of light that propagate down the entire length of the fiber. When using an LED-based system, this is an accurate measure of the bandwidth performance of the fiber, because in both testing and operation, an overfilled launch will fill the core with light. However, since lasers only propagate a few modes near the center of the core, an OFL bandwidth measurement may not accurately represent the bandwidth performance achieved with a laser-based system.

As bandwidth demands continue to escalate, lasers are expected to become the light source of necessity in the future. Consequently, the consistency of the center region of the core of a multimode fiber will become more and more vital to the performance of a high-capacity network. Since all of the laser's power will be concentrated near the center of the core, the concern is that some fiber manufacturing processes — such as inside vapor deposition (IVD) — create profile abnormalities. These profile abnormalities may cause bandwidth collapse and link failure when used in a laser-based system, but would be unnoticed in an LED-based system. One such abnormality is "index depression," which is when the center region of the fiber core exhibits a dip in the index profile — also known as a "centerline dip." Inside vapor deposition manufacturing processes (i.e., MCVD, APVD,

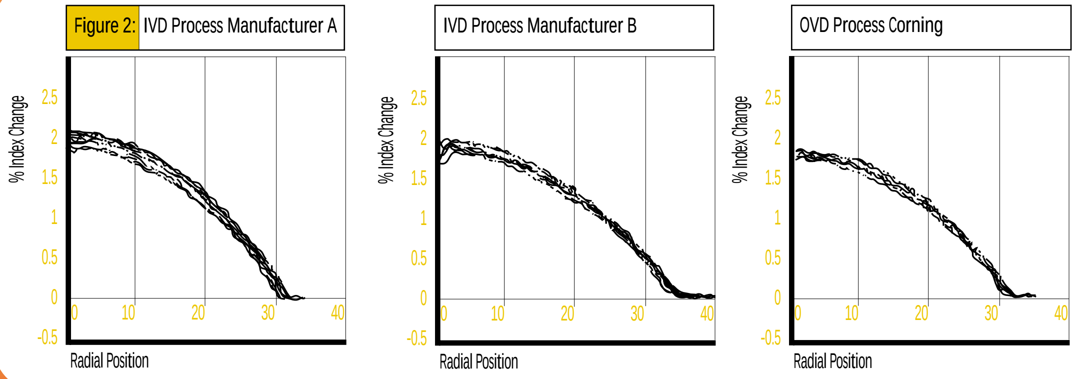

Figure 2: Processes

The IVD manufacturing process can produce less consistent fibers which exhibit "centerline dip." The OVD process produces the most consistent, uniform optical fibers.

and plasma) have an increased probability of producing centerline dips and peaks because of the relatively larger amount of germania diffusion that occurs during tube collapse. Germania is used to modify the index of refraction of the core of an optical fiber. The IVD process generally is a much more complex process with many extra variables to control, making uniform, consistent core profiles difficult to achieve. While these profile abnormalities do not significantly affect LED bandwidth performance, they can devastate laser bandwidth performance.

The outside vapor deposition (OVD) manufacturing process, on the other hand, produces a uniform, consistent profile, and thus a reliable centerline area. The OVD process inherently is better at profile control because there are fewer variables to control. Also since many passes are used during the core deposition process, the transition is smoother in the variation of the index of refraction. In OVD, deposition continues until the correct physical parameters are achieved, producing a tightly controlled index profile at the centerline and at the core-clad interface (see Figure 2). Corning Incorporated invented both the IVD and OVD optical fiber manufacturing processes and ran both processes side by side for several years. After comparing the two, Corning found that OVD produced more consistent, better quality fiber. Consequently, Corning now uses the OVD process exclusively.

To enable the LAN market to satisfy the need for higher bandwidth by migrating to laser sources and the GbE protocol, Corning has introduced a new optical fiber — InfiniCor™ fiber — a fiber designed for operation with lasers and the Gigabit Ethernet protocol. InfiniCor fiber is made with the OVD manufacturing process to ensure a consistent, uniform index profile, with a centerline that is optimized for laser sources. InfiniCor fiber is tested using more than a dozen separate measurement tools to verify performance parameters and compliance with fiber standards. These measurements, in conjunction with Corning's superior manufacturing process, enable Corning to offer InfiniCor — a fiber designed specifically for lasers and high-speed protocols that can satisfy the bandwidth-hungry applications of today and tomorrow.

The LAN market is evolving rapidly to keep up with the explosive demand for data. The market is adopting gigabit protocols and laser sources to meet this demand while keeping costs in line. Corning once again is leading the industry by developing a fiber that meets your needs today and well into the future — InfiniCor fiber. ■

For more information

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CENTRAL INTELLIGENCE

Centralized optical fiber networks revolutionize local area network cabling design

The all-optical fiber centralized local area network — a novelty not so long ago — is here to stay. In increasing numbers, network planners are taking advantage of optical fiber's virtually unlimited bandwidth and low signal loss over distance to implement the centralized design. With all data electronics housed in a single location, optical fiber cables provide direct connections to every workstation outlet in the network.

The centralized optical fiber design offers many benefits, including improved security, fewer points of failure and reduced telecommunications closet build-out costs. Consolidating network electronics, analyzers, uninterruptable power sources (UPSs), cross-connects and servers in a single communications closet greatly simplifies LAN management, provides more efficient use of hub ports, and allows for simple implementation of various network applications. Perhaps most significantly, the centralized optical fiber cabling design provides a cost-effective alternative to the traditional design because using fewer active components streamlines installation, simplifies maintenance and lowers overall costs.

Conventional vs. Centralized Networks

In the conventional, decentralized premises data network, backbone cables travel from a main cross-connect (or, in an inter-building network, an intermediate cross-connect) to one or more horizontal cross-connects (HC) within telecommunications closets on each floor of a building. The HC typically includes active electronics equipment: hub, concentrator or switch. Individual outlets for each user are located within 100 meters of the telecommunications closet, and are connected to the HC using a single cable per user in a physical star configuration (see Figure 1).

In the conventional design, most inter- and intra-building backbone cable is optical fiber; the horizontal segment of the network typically is comprised of unshielded twisted-pair (UTP) copper cable. The transmission distance limitations inherent in copper cabling make the distributed design a necessity, in that using copper in the horizontal requires that data electronics be located no more than 100 meters from workstations.

The traditional cabling infrastructure was designed to provide maximum flexibility in the deployment of distributed electronics. However, telecommunications closets take up valuable real estate, and, because of the active electronics, they require power, air conditioning and grounding. Decentralization increases complexity and presents multiple potential points of failure.

Moreover, the use of UTP copper cable in the conventional design places bandwidth limitations on the network. And because of its inherent electrical properties, UTP is vulnerable to electromagnetic interference (EMI), radio frequency interference (RFI), crosstalk and breaches in data security. That is, copper is fairly easy to tap.

Today, after years of the decentralized networks popularity, managers are turnng to a more elegant, efficient and cost-effective design: the optical fiber centralized network. The centralized design provides direct connections between hundreds, even thousands of workstations and a single main cross-connect by using pull-through cables, or a splice or interconnect in the telecommunications closet (see Figure 2).

With network electronics, analyzers, uninterruptable power sources (UPSs), cross-connects and servers consolidated in the main cross-connect, the centralized design is a vehicle for reducing the number of telecommunications closets. The long cabling runs typical of these centralized designs, often exceeding 100 meters, are perfect for fiber, but impractical for copper.

Benefits of the Optical Fiber Centralized Network

Any fiber-to-the-desktop design offers significant networking advantages. Most important, an all-fiber cabling infrastructure provides very high bandwidth, which has become critical for organizations that require ”bandwidth-hungry” applications such as those for graphics, multimedia and real-time video. An optical fiber centralized network is “future-proofed” against growing bandwidth demands from users. Also, the fiber infrastructure is protocol independent, able to accommodate all current and future transmission protocols: FDDI, Asynchronous Transfer Mode (ATM), Gigabit Ethernet, 100Base-FX, 100VG-AnyLAN, Fibre Channel — with no disruptive and expensive recabling. Finally, optical fiber’s immunity to EMI/RFI, impedance mismatches and ground loops improves link performance and virtually eliminates maintenance.

In addition to these performance advantages, the optical fiber centralized design offers numerous cost-saving benefits. With direct connections between network hardware and desktops, maintenance and network management are simplified. There are fewer electronics to maintain in fewer locations, thus reducing downtime and maintenance costs. Also, network reconfiguration is simplified. A network manager can establish workgroup networks very quickly because all cables terminate in a single location.

The centralized design also is cost-effective because it eliminates the need for multiple telecommunications closets with active electronics, which require power and air-conditioning, as well as devices for fire detection and security. Keep in mind that the average cost of ”owning” a single telecommunications closet — excluding the costs of labor, power and cooling — is approximately $355 per square foot (Source: Gartner Group).

Eliminating the costs associated with housing multiple telecommunications closets in a network translates to considerable first-installed savings. For example, Sellard Communications in Horseheads, NY, designed an optical fiber centralized network for the Erwin, NY, Manufacturing Facility, a part of Corning Incorporated. At the Erwin plant, four telecommunications closets, which were required for the previous network, were replaced with one closet using the centralized design. The resulting savings in first-installed costs amounted to approximately $24,000 per closet. In another centralized design at the Getty Museum, in Los Angeles, 55 closets were replaced with one, at a saving of $73,000 per closet. These numbers are significant, especially when you consider that approximately 45 percent of corporations have three or more telecommunications closets per floor (Source: Digital Equipment Corporation).

The centralized design also is an attractive option when cabling or recabling existing buildings in which closets either do not exist or are not suitable to house active network hardware. In these situations, running optical fiber from the main cross-connect directly to workstations often is the most cost-effective installation method.

Another benefit of the optical fiber centralized design is improved port and chassis utilization. Centralizing all electronics in the main cross-connect reduces the number of ports and chassis required by a network, resulting in cost savings. On average, only 70 percent of hub ports are used in the conventional decentralized design, due to the varying number of users per telecommunications closet. The centralized design is much more efficient — typically hub port usage is 90 percent.

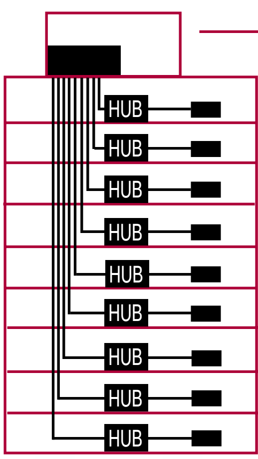


Figure 1: Traditional Design

In the traditional cabling design, cables run to active telecommunications closets located within 300 feet of users. Each closet contains active network electronics; therefore, the space requires power, air conditioning and grounding. Category 5 copper cables connect closets to users.

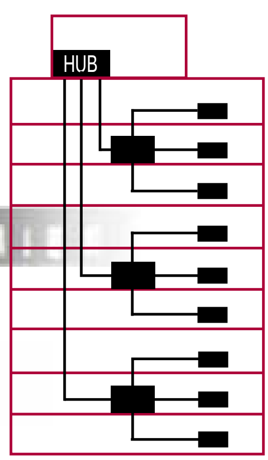
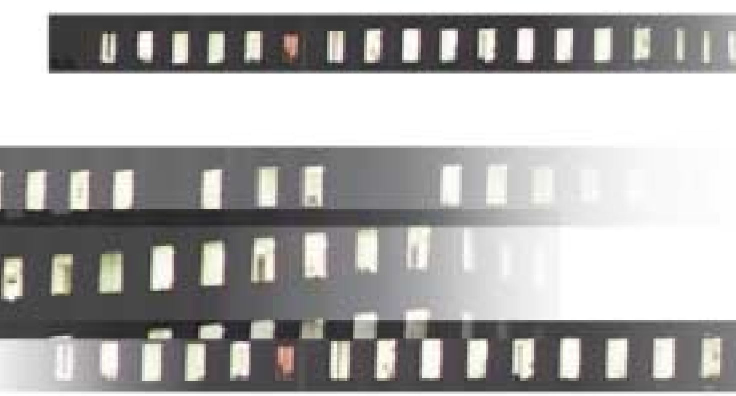


Figure 2: FTTD (fiber to the desk) with Centralized Cabling

In the centralized optical fiber cabling design, fiber to the desktop is achieved with direct connections between a single hub and each user. All data electronics are housed in one location.



That 20 percent differential equals real and immediate savings.

A Centralized Network Success Story: American Video Glass

An optical fiber centralized network recently was completed at the new home of American Video Glass Company (AV), which manufactures glass panels and funnels for television picture tubes. Their newly completed 500,000-square-foot factory, in Mount Pleasant, PA, is equipped with a state-of-the-art information technology and controls infrastructure, the foundation for which is a centralized cabling, fiber-to-the-desktop network designed by Sellard Communications.

Two issues drove the decision to install an all-fiber network at American Video Glass. Most critically, planners wanted to be assured of sufficient information-carrying capacity to run whatever applications they might require in the not-so-distant future. Fiber's virtually unlimited bandwidth provides that assurance. Also, with plant expansion and cabling moves on the horizon, the robust and flexible fiber-optic centralized cabling plant will allow for quick and easy moves and changes.

Without optical fiber none of this would be possible. Other media, particularly copper, cannot meet the bandwidth and attenuation requirements at the distances used in a centralized cabling design such as the one at American Video Glass.

Says Ralph DiNinno, IT & controls manager, "It's more cost feasible to use the fiber-optic centralized cabling design, because there are no closet build-outs and minimal maintenance." With no active electronics distributed throughout the network, there are no large closets to build and maintain — just small cabinets containing wall-mounted splice centers. This reduction in multiple closets played a major part in reducing the cost premium traditionally associated with fiber.

Upfront savings were important to AV network designers. But even more crucial was the opportunity to "future-proof" their cabling infrastructure against soaring bandwidth demands by installing optical fiber throughout their facility. The huge bandwidth offered by optical fiber has already paid off at AV, according to DiNinno. Yet he has gained even greater peace of mind from knowing that his network will not suffer bandwidth bottlenecks any time soon.

"Fact is, we're a brand-new company," says DiNinno. "We have limited history and information about our network and capacity requirements. So, when we designed the network, we installed Ethernet knowing that the bandwidth available on optical fiber could support a change to new electronics, such as for ATM, as our needs grow."

Expanding the network or adding applications will not present problems either. "If we decide to deploy additional workstations," DiNinno says, "the fiber is there to do it."

"Also, long term maintenance is an issue," says DiNinno. "But with the centralized cabling and fiber, maintenance and trouble-shooting do not require going out to hubs. We have home runs, so trouble-shooting is easy. We just test through the hubs in the central computer room."

DiNinno is confident that installing an all-fiber network at American Video Glass has been a smart move — strategically, commercially, financially.

"The fiber allowed us to go with a very simple cable design," DiNinno says. "That eliminated a lot of trouble. The centralized design is excellent."

In addition to performance advantages, the optical fiber centralized design offers numerous cost-saving benefits.

The Future: Centralized Campus Networks

Today the centralized design is being taken to the next level, linking multiple buildings with optical fiber while still housing all data electronics at a single location. This centralized campus design takes advantage of fiber's long transmission distance capabilities to eliminate the need for computing centers in every building.

In one of the first applications of this design, Steuben-Allegany, (NY), BOCES is linking all buildings on its two campuses, in Coopers Plains and Wildwood, NY, with an all-optical fiber centralized network. At each site, all data electronics for numerous buildings reside at a single location. This centralized cross-connect is linked directly to desktops in all buildings — 14 at Coopers Plains and 10 at Wildwood — over optical fiber cables.

The new network, designed by Sellard Communications and currently under construction, will provide Internet access in all buildings, simultaneous instruction at several locations, and instant access to video-based applications. Moreover, the revolutionary centralized campus cabling design will substantially reduce installation and upgrade costs, especially when compared with more conventional systems.

Conclusion

Extending optical fiber all the way to the desktop over centralized networks will simplify maintenance and help avoid bandwidth bottlenecks. By taking advantage of fiber's superior distance performance, network designers can reduce the number of electronic components, increase ease of network administration and most important of all save money. ▪

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