Providing information on the use of fiber in customer-owned networks

Choosing the Right Multimode Fiber for Data Communications

September 2008

Executive Summary

Multimode fiber systems offer flexible, reliable and cost effective cabling solutions for local area networks (LANs), Storage Area Networks (SANs), central offices and data centers. Multimode fibers support data rates from 10 and 100 Megabits per second (Mb/s) up to today's 1 Gigabit per second (Gb/s) and 10 Gb/s applications, with standards in development to support data rates up to 40 Gb/s and 100 Gb/s.

Three types of multimode fiber are currently found in premises networks: 62.5 µm multimode fiber (OM1), 50 µm multimode fiber (OM2), and laser optimized 50 µm multimode fiber (OM3). 50 µm and 62.5 µm refer to the diameter of the fiber core, which is the area that carries light signals. For the most part, OM1 fiber is found in legacy systems. Over the past five years, network designers have migrated to 50 µm fiber, especially laser optimized multimode fibers (OM3), as they can support higher data rates and longer distances. Considering the higher bandwidth advantage, and the applications that most customers will use today or in the future, the Fiber Optics LAN Section recommends that for new installations, customers install OM3 fiber.

The Evolution of Multimode Fiber Designs

While 50 µm multimode fiber might seem new, in the 1970s, when optical fiber was introduced, standard 50 µm fiber (OM2) was the most popular of the early fiber types available, and was used for both long haul and short reach applications.

After the introduction of single-mode fiber in the 1980s for long haul telephony applications, multimode fibers were applied to short-reach interconnects, such as building and campus backbones needing support over distances from 300 meters to 2000 meters. As with many technology choices, there were trade offs between 50 µm multimode and the singlemode fiber systems. The light-emitting diode (LED) sources used for multimode applications had a very large "spot" and the 50 µm fiber did not fully couple the available power into the 50 µm core. Consequently, 50 µm fiber used with 850 nm wavelength LEDs was limited in distance. Receivers were not always able to detect an adequate light power at the distant end of the backbone. Still, network designers were reluctant to install single mode fibers as the power sources remained more expensive and there was no need in most premises applications for the long link lengths the more expensive singlemode facilities would provide.

62.5 µm multimode fiber (OM1) was introduced in 1985 to solve these two problems. Because more light from LEDs could be coupled into its larger core, OM1 fiber could support 2 km campuses at 10 Mb/s. At the same time, its higher numerical aperture, which can be thought of as the fiber's "light gathering" ability, made it easier to cable. Through much of the 1980's and 90's one multimode fiber, 62.5 µm core FDDI fiber became a defacto standard among the vast majority of LAN installations. Despite continual upgrades in LAN bandwidth requirements, FDDI grade fiber remained a workhorse for backbone fiber installations for many years, and is still present in legacy systems.

Faster Transmission Rates, Higher Bandwidth Demands Drive Migration to 50 µm

While 62.5 µm fiber dominated the premises market for more than a decade, changing market conditions have re-established 50 µm fiber as the best solution for applications >10 Mb/s. The 100 Mb/s Fast Ethernet standard, published in 1995, called for the use of LEDs that take advantage of lower fiber attenuation at 1300 nm wavelength. This offset the LED coupling loss into 50 µm fiber caused by its smaller core diameter; therefore, 50 µm fiber was able to support the same 2 km reach at 100 Mb/s as 62.5 µm fiber.

Only 3 years later, the IEEE Gigabit Ethernet standard published in 1998 specified low cost 850 nm wavelength Vertical Cavity Surface Emitting Lasers (VCSELs) that can reach 1000 meters over 50 µm fiber, compared to 220-275 meters on standard 62.5 µm. As data rates rise to multi-Gigabit speeds, it is apparent that 62.5 µm fiber is stretched beyond its performance limit, due to its lower bandwidth at 850 nm. By comparison, 50 µm fiber can provide as much as ten times the bandwidth of the 62.5 µm, enabling more robust support of 1 Gb/s and 10 Gb/s applications. Because 1 Gb/s and 10 Gb/s transmitters use small spot-size lasers, concerns over power coupling efficiencies into 50 µm fiber are no longer an issue.

The 10 Gb/s Ethernet standard, published in 2002, takes advantage of laser optimized 50 µm fiber (OM3) that supports 300 meter reach using 850 nm VCSELs. OM1 multimode fiber, in comparison, would support just 26 - 33 meters.

New Generation 50 µm Fiber Extends Link Lengths, Supports Higher Data Rates

Laser Optimized Multimode Fiber was introduced in 1999. It supports 300-meter link lengths for 10 Gb/s applications and is tested to ensure a 2,000 MHz•km Effective Modal Bandwidth (EMB). Its industry-standard 50 µm core size couples sufficient power from LED sources to support legacy applications like Ethernet, Token Ring, FDDI, and Fast Ethernet for virtually all in-building networks and most campus networks. The 50 µm core size is also directly compatible with laser-based applications like Gigabit Ethernet and Fibre Channel, etc. Furthermore, it is the recommended multimode fiber type in ANSI/EIA/TIA-942, *Telecommunications Infrastructure Standard for Data Centers*.

OM3 fiber is a logical and cost-effective choice for short-range applications that need to support 1Gb/s or multi-gigabit speeds, especially when the cabling component costs account for less than 3% of the total spend. Compared to the total installation cost of networks using lower bandwidth OM1 or OM2 fibers, the premium for OM3 fiber is typically about 1% and yet can offer significant cost savings for the electronics when upgrading to higher speeds, e.g. 10 Gb/s.

Laser Optimized 50 µm Fiber - Today's Preferred Choice

Today 1Gb/s-ready backbone solutions are the norm and offer 10x speed capability at almost cost parity of 100 Mb/s LED-based systems. OM3 fiber has a significantly higher bandwidth advantage for longer reach 1 Gb/s and 10 Gb/s applications that most customers will use today or in the future, while preserving the low system cost advantages of multimode fiber.

In addition, OM3 fiber shares the same connector technologies and installation techniques as 62.5 µm fiber, which means installers can leverage their existing fiber installation experience without additional training. All of this, coupled with the fact that greatly improved cabling materials and processes have made 50 µm fiber cable-friendly, is driving the migration to OM3 as the multimode fiber of choice in LANs, SANs, data center interconnects and, now, Access applications. As a result of these factors, the Fiber Optics LAN Section recommends that for new installations, customers install OM3 fiber.

What's in the future?

Taking a peek "under the tent", fiber manufacturers are developing a 50 µm with extended bandwidth (preliminarily being referred to as "OM4" fiber), that potentially could be used to extend the system cost benefits enabled by 850 nm VCSEL technology to ultra long building backbones and medium length campus backbones. It would support 10 Gb/s Ethernet, Fibre Channel, and OIF applications to distances as much as 550 meters (subject to some conditions) by utilizing an EMB of 4,700 MHz-km, more than double the IEEE requirement for 10 Gb/s 300 meter support.

Check for future updates on fiber and related technologies at www.fols.org.