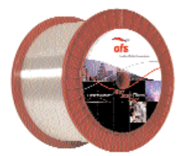
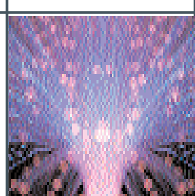
Leading Optical Innovations

50 µm or 62.5 µm?

Choosing the Right Multimode Fiber for Data Communications

John E. George
Fiber Offer Development Manager





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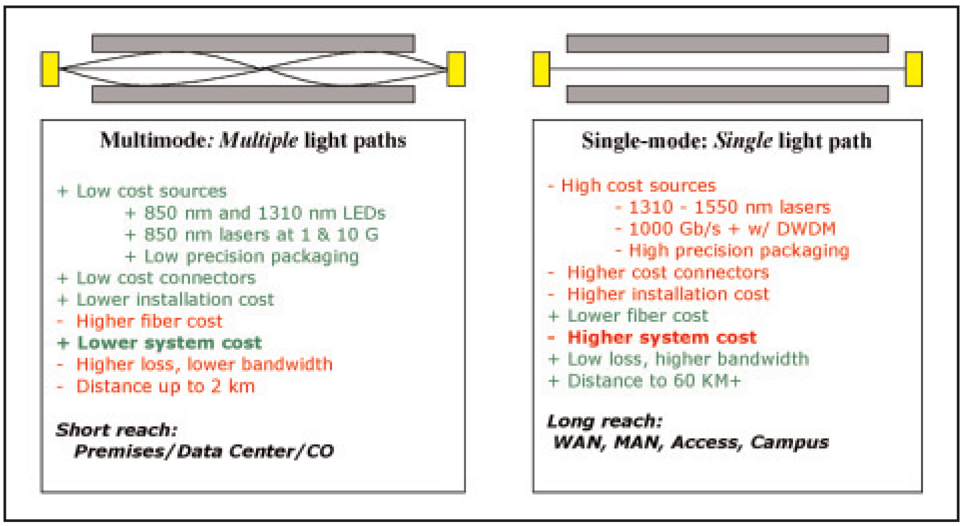
Multimode fiber systems traditionally have provided the most cost-effective solutions for meeting increased bandwidth demands in Local Area Networks (LANs), Storage Area Networks (SANs), central offices, and data centers. These systems enable lower transceiver, connector, and connector installation costs at data rates up to one Gigabit per second (Gb/s), and provide the same cost benefits for today's 10 Gb/s applications. Compared with single-mode fiber (see below), multimode fiber will continue to provide the most practical, economical support for short reach applications.



The network designer or end user who specifies short reach systems still must choose from two types of multimode fiber - 50 µm or 62.5 µm. The question is: Which can best support their applications today and into the future?

The Evolution of 50 µm and 62.5 µm Applications

The first optical fibers, deployed in the 1970s for both short reach and longer reach applications, were 50 µm multimode fiber. (The numbers being cited - 50 µm and 62.5 µm - refer to the diameter of the fiber's core, which is the area through which light signals are transmitted.) In the early 1980s, 50 µm multimode fiber was replaced in longer distance installations by single-mode fiber. After the introduction of single-mode fiber, 50 µm multimode was used only for short-reach interconnects, such as building and campus backbones needing support over distances from 300 meters to 2000 meters.

But as data rates and manufacturing volumes increased, it became apparent that 50 µm fiber had shortcomings even in the short-reach applications of that time. First, 50 µm fiber could not support emerging applications, in which data was transmitted at 10 Megabits per second (Mb/s) rates at 850 nanometers (nm) over the 2 kilometer (km) distances required by some campus installations; the light-emitting diode (LED) sources used for those applications had a very large "spot" that did not fully couple power into the 50 µm core. Instead, 50 µm fiber was limited to distances of about 1.2 km. Second, stresses caused by the cabling process increased the attenuation (loss of signal strength) in the fiber.

62.5 um multimode fiber was introduced in 1985 to solve these two problems. Because more light from LEDs could be coupled into its larger core, 62.5 µm 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. For these reasons, 62.5 µm fiber became the primary installed medium in North America, most of Europe, and much of Asia for short reach applications in LANs, data centers, and campuses designed to operate at 10 Mb/s.

Higher Transmission Rates, Bandwidth Demands Drive Migration to 50 µm

Changing market conditions have driven the re-establishment of 50 µm fiber as a better solution for applications >10 Mb/s. The 100 Mb/s Ethernet standard, published in 1995, called for the use of LEDs that take advantage of lower fiber attenuation at 1300 nm. 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.

As data rates hit 1 Gb/s and 10 Gb/s, it became apparent that 62.5 µm fiber had reached its performance limit, due to its lower bandwidth at 850 nm. By comparison, 50 µm fiber could offer as much as ten times the bandwidth of the 62.5 µm option, enabling robust support of 1 Gb/s and 10 Gb/s applications. And because 1 Gb/s and 10 Gb/s transmission uses small-spot lasers, issues about power coupling in 50 µm fiber disappeared. The IEEE 1 Gigabit Ethernet standard published in 1998 uses low cost 850 nm 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 fiber. And, in the recently published 10 Gb/s Ethernet standard using low cost 850 nm VCSELs, a new, high bandwidth 50 µm fiber supports up to 300 meters, while comparable bandwidth in 62.5 µm fiber is limited to 26 - 33 meters.

50 µm - Today's Preferred Choice

The 100 Mb/s minimum in today's backbone applications makes irrelevant the reach advantage of 62.5 µm fiber at 10 Mb/s. And 50 µm fiber has significant bandwidth and reach advantages for the 1 Gb/s and 10 Gb/s applications that most customers will use, while preserving the low system cost advantages of multimode fiber. In addition, 50 µm fiber uses the same connectors and installation techniques as 62.5 µm fiber. 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 50 µm as the multimode fiber of choice in LANs, SANs, data center interconnects and, now, Access applications.

Choosing the Best 50 µm Fiber for Your Application

To enable low cost, short reach applications, OFS recommends the following grades of 50 µm fiber:

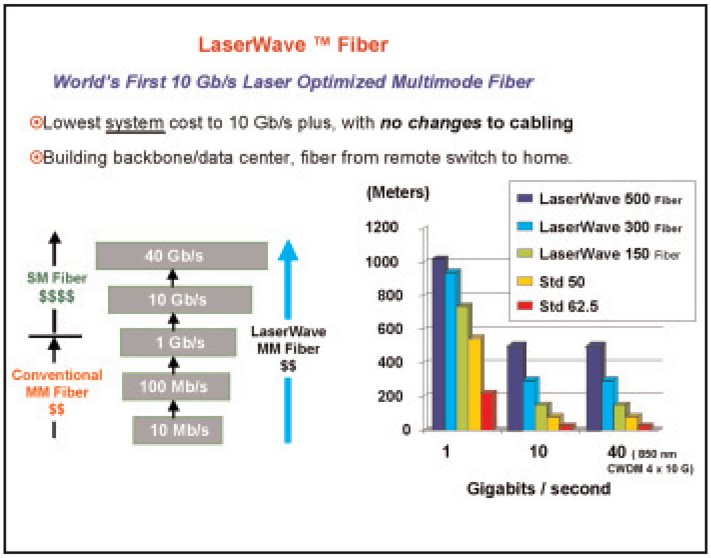
LaserWave™ 500 Fiber was created by OFS to extend the system cost benefits enabled by LaserWave 300 and LaserWave 150 fibers to ultra long building backbones and medium length campus backbones. LaserWave 500 Fiber supports 10 Gb/s Ethernet, Fibre Channel, and OIF standards up to 500 meters with 4 LC connections, and 550 meters for point-to-point links without connections, using low cost 850 nm VCSELs. The OFS manufacturing process provides this extraordinary performance by producing LaserWave 500 Fiber with a Differential Mode Delay (DMD) of almost zero, resulting in an industry leading 4000 MHz-km of effective modal bandwidth at 850 nm.

LaserWave 300 Fiber is designed specifically to support 300 meter link lengths for 10 Gb/s applications. LaserWave 300 Fiber features a DMD controlled core that ensures 10 Gb/s support with 850 nm serial applications for distances up to 300 meters. 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. In fact, LaserWave 300 Fiber is the first optical fiber solution to support up to 1000 meters for low cost 850 nm VCSEL-based Gigabit Ethernet (1000BASE-SX) applications while extending the reach of increasingly popular 2.5 Gb/s parallel applications to 600 meters.

LaserWave 150 Fiber provides legacy support similar to that of LaserWave 300 Fiber, but more cost-effectively extends the distance of 1 Gb/s to 2.5 Gb/s applications at 850 nm. It extends the reach of 1000BASE-SX applications to 750 meters and parallel 850 nm 2.5 Gb/s VCSEL arrays to 430 meters. For 10 Gb/s serial applications, LaserWave 150 Fiber more cost-effectively supports the 40 percent of building backbones that are less than 150 meters in length. Like LaserWave 300 Fiber, LaserWave 150 Fiber is a DMD-controlled fiber that provides optimum performance with laser sources.

GigaGuide® 50 and OFS Standard 50 µm Fibers should be used in lieu of 62.5 µm fiber in cases where LaserWave Fiber is not required. They provide the same sub 1 Gb/s support as the LaserWave fibers, and superior support compared to 62.5 µm fibers for 1 Gb/s and 10 Gb/s applications. And in consideration of future cabling upgrades, standard 50 µm or GigaGuide 50 fibers may be interconnected directly to LaserWave Fiber without concern for high insertion loss that can limit system performance when interconnecting different core sizes.

Of further benefit to the user, LaserWave and GigaGuide fibers do not require expensive mode conditioning patch cords to support 1 Gb/s and 10 Gb/s 1310 nm lasers. These cords are required in the IEEE 802.3 standard for conventional 50 µm and 62.5 µm fibers running 1 Gb/s and 10 Gb/s lasers at 1310 nm, and can cost hundreds of dollars each.



About the Author

John E. George is the fiber offer development manager in the systems engineering organization of OFS Laboratories (Norcross, GA), where he is responsible for coordinating development of optical interconnect solutions for short reach network applications.

The OFS Multimode Optical Fiber Center of Excellence

Dedicated to innovation in the development of multimode fiber, OFS designs and manufactures graded-index multi-mode fiber capable of higher bandwidth performance over increasingly long distances.

Among U.S. manufacturers, OFS offers the widest range of graded-index multimode fibers as standard selections. Products include fibers with core/clad ratios of 50/125 µm and 62.5/125 µm, and laser-certified fiber designed for trans-mission speeds of up to 10 Gb/s.

Founded as SpecTran Communication Fiber Technologies, the OFS Multimode Optical Fiber Center of Excellence operates a state-of-the-art facility that has been supplying leading cable manufacturers with high-performance optical fiber since 1981.

Once a part of Lucent Technologies, the facility benefits from the full technical support of OFS Laboratories, the direct descendant of Bell Labs, with its unmatched reputa-tion for communications technology expertise.

The OFS Multimode Optical Fiber Center of Excellence is located in Sturbridge, Massachusetts.

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