Multimode or Single-Mode Fiber?

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Applications such as Voice over IP, video-streaming, and teleconferencing are pushing data communication rates to 10 Gigabit Ethernet and beyond in enterprise networks.

These higher speeds might lead system designers to believe that single-mode fiber enjoys an increasing advantage over multimode fiber in premises applications. However, higher Ethernet speeds do not automatically mean single-mode fiber is the right choice.

Although single-mode fiber has advantages in terms of bandwidth and reach for longer distances (> 1 kilometer at 1 Gb/s), multimode fiber easily supports most distances required for premises and enterprise networks. In fact, multimode fiber can support 10 Gb/s transmission to 550 meters for long backbone and even short campus runs.

Furthermore, the optoelectronics used with multimode fiber are generally less expensive than those required for a single-mode system. And multimode fiber is easier to install and terminate in the field - important considerations in enterprise environments with frequent moves, adds, and changes.

Multimode and Single-Mode: What's the Difference?

The two fiber types get their names from the way they transmit light. Generally designed for systems of moderate to long distance (e.g., metro, access, and long-haul networks), single-mode fibers have a small core size (< 10 µm) that permits only one mode or ray of light to be transmitted. This tiny core requires precision alignment to inject light from the transceiver into the core, significantly driving up transceiver costs.

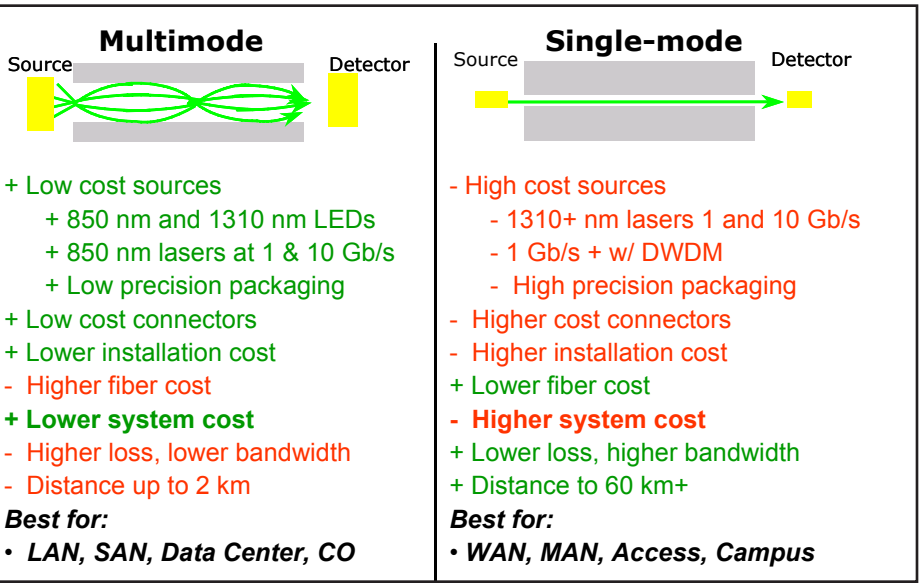
By comparison, multimode fibers have larger cores that guide many modes simultaneously. The larger core makes it much easier to capture light from a transceiver, allowing source costs to be kept down. Similarly, multimode connectors cost less than single-mode connectors due to the more stringent alignment requirements of single-mode fiber. Single-mode connections require more care and skill to terminate, which is why components are often pre-terminated at the factory. Multimode connections, on the other hand, can be easily performed in the field, offering installation flexibility, cost savings, and peace-of-mind.

Multimode fiber continues to be the most cost-effective choice for enterprise applications up to 550 meters.

Enterprise environments present particular network challenges, including limited spaces and tight bends, high connection density, and components that get handled frequently. Multimode fibers are ideally suited for these conditions. And since distances within a premises system rarely approach 550 meters, multimode fiber should be the choice for these applications.

Beyond 550 meters at 10 Gb/s (or 1 km at 1 Gb/s), it is necessary to utilize single-mode fiber. There are new choices for single-mode fiber today, so be sure to consider your options; a bend insensitive full spectrum single-mode fiber provides more transceiver options, more bandwidth, and is less sensitive to handling of the cables and patch cords than conventional single-mode fiber.

The network designer or end user who specifies multimode fiber for short reach systems still must choose from two types - 50 µm or 62.5 µm. 50 µm multimode fibers were first deployed in the 1970s for both short



and long reach applications. 62.5 µm multimode fiber, introduced in 1985, supported campus applications up to 2 kilometers at 10 Mb/s. The mid-1990s, with the introduction of the VCSEL laser light source, saw a shift back to 50 µm fiber. Today, 50 µm laser-optimized multimode (OM3) fiber offers significant bandwidth and reach advantages for most building applications, while preserving the low system cost advantages of 850 nm-based multimode fiber.

Planning for the Future

Since optoelectronics is a large percentage of total system cost, the most economical solution for 10 Gb/s transmission in the enterprise is 50 µm OM3 fibers that have been designed and manufactured for use with inexpensive VCSELs. This cost advantage holds true at higher speeds, because future transceivers are likely to be designed to take advantage of 10 Gb/s enterprise technology.

With an eye to the future, the High Speed Study Group (HSSG) of IEEE voted in November 2006 to support 100 Gb/s as the next Ethernet speed. Additionally, the HSSG is recommending that OM3 fibers support this higher transmission rate using low-cost parallel optics transceiver arrays or a combination of parallel optics and multiple wavelengths (coarse wavelength division multiplexing, or CWDM).

For example, ten OM3 fibers each operating at 10 Gb/s can be aggregated into a 100 Gb/s system (10 x 10 array). Or five OM3 fibers each transmitting two wavelengths can operate at 10 Gb/s (5 x 2 x 10 array).

For single-mode fiber, the HSSG is recommending use of CWDM or DWDM optics. In this case, multiple wavelengths, each operating at 10, 20 or 25 Gb/s, would be transmitted over a single fiber.

Why not use single-mode fiber with a single laser (serial transmission) operating at 100 Gb/s? Such a laser is simply not commercially available today, and probably won't be for a long time. It will be very challenging to develop and produce such a laser cost-effectively. Therefore, achieving higher speeds on single-mode fiber will require CWDM or DWDM optics using multiple lasers to drive multiple wavelengths. But now you are faced with the same transceiver and connector alignment challenges that can drive up the cost of these components when used with single-mode fiber.

In general, then, multimode fiber continues to be the most cost-effective choice for enterprise applications up to 550 meters. Single-mode fiber is best used for distances exceeding 550 meters.

If the network's transmission distances indicate the use of single-mode fiber, consider specifying the recently introduced "bend-insensitive" zero water peak (full spectrum) fibers. These fibers are designed to provide long-term reliability in applications with tight bends and small enclosures.

OFS Optical Fiber Center of Excellence

Dedicated to innovation in the development of multimode fiber, OFS designs and manufactures graded-index multimode fiber capable of high bandwidth performance over 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 transmission speeds of up to 10 Gb/s.

Founded as SpecTran Communication Fiber Technologies, the OFS 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 reputation for communications technology expertise.

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