Multimode or Single-Mode Fiber?

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Applications such as HDTV, data centers, and high-performance computing are pushing data communication rates to 40 and 100 Gigabit Ethernet and beyond in enterprise networks. With the recent introduction of 10 Gb/s LAN on Motherboard (LOM) technology, industry experts are predicting that 10 Gb/s ports will be coming to end user desktops and laptops in the future. If enterprise LAN networks are to fully utilize 10 Gb/s desktop speeds, even higher backbone speeds will be needed.

What's more, server virtualization, cloud computing, and higher speed ports are driving networks to higher 40/100 Gb/s speeds in data centers. High-performance computing applications are currently implementing 100 Gb/s speeds and beyond. This migration often raises the question, "Should I install single-mode or multimode fiber in my network?"

System designers might conclude that single-mode fiber enjoys an increasing advantage over multimode fiber in premises applications. However, higher speeds do not automatically mean single-mode fiber is the right choice.

Although single-mode fiber has advantages for longer distances (> 550 meters at 10 Gb/s), multimode fiber easily supports most distances required for enterprise networks and data centers. In fact, multimode fiber can support 100 Gb/s transmission to 150 meters, supporting the vast majority of data center links.

Furthermore, the optoelectronics commonly used with multimode fiber are 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?

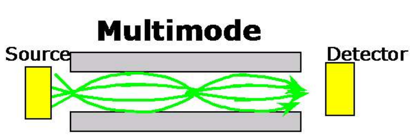
The two fiber types get their names from the way they transmit light. Generally designed for systems of moderate to long distance (e.g., metro, access, and long-haul networks), single-mode fibers have a small core size (< 10 µm) that permits only one "mode" or ray of light to be transmitted. This tiny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

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, decreasing alignment costs. Also, multimode connectors cost less than single-mode connectors due to the more stringent alignment requirements of single-mode fiber.

In the data center, pre-terminated solutions continue the overall cost advantage of multimode over single-mode fiber, enabling the use of low cost 850 nm parallel transmission. Here, even with the cabling cost advantage of single-mode for longer links, the much lower cost electronics make multimode much more cost effective (see table, next page).

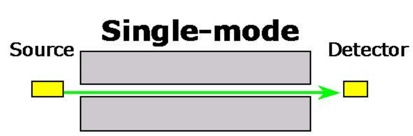
Beyond 150 meters at 100 Gb/s (or 550 meters at 10 Gb/s), it is necessary to utilize single-mode fiber.

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



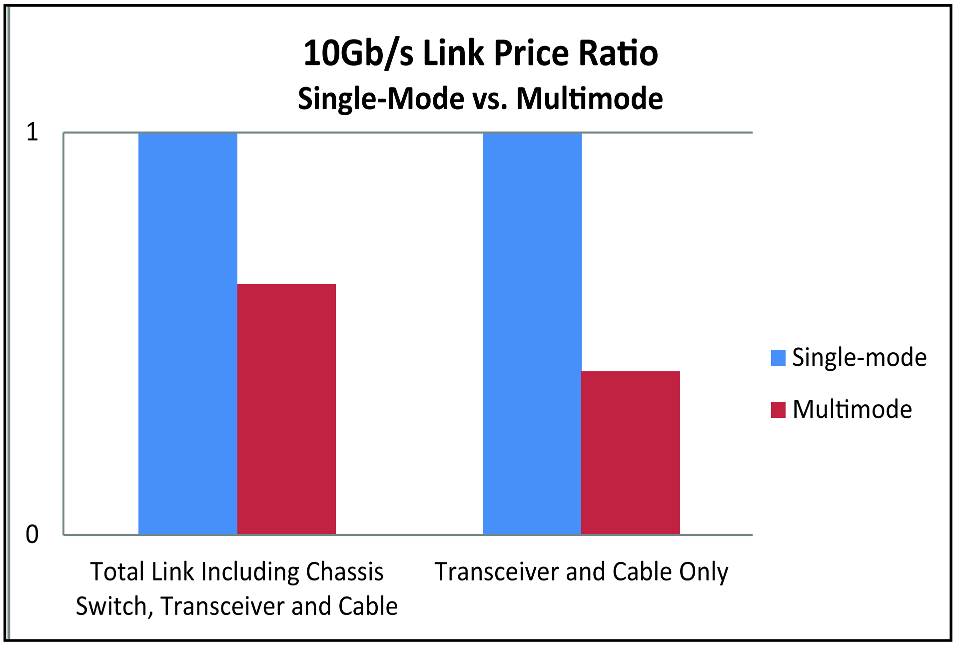
- + Low cost sources
  - + 850 nm and 1310 nm LEDs
  - + 850 nm lasers at 1 & 10 Gb/s
  - + Low precision packaging
- + Low cost connectors
- + Lower installation cost
- - Higher fiber cost
- **+ Lower system cost**
- - Higher loss, lower bandwidth
- - Distance up to 2 km

Best for:
- ***LAN, SAN, Data Center, CO***



- - High cost sources
  - - 1310+ nm lasers 1 and 10 Gb/s
  - - 1 Gb/s + w/ DWDM
  - - High precision packaging
- - Higher cost connectors
- - Higher installation cost
- + Lower fiber cost
- **- Higher system cost**
- + Lower loss, higher bandwidth
- + Distance to 60 km+

Best for:
- ***WAN, MAN, Access, Campus***



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/OM4) fiber offers significant bandwidth and reach advantages for building applications, while preserving the low system cost advantages of 850 nm-based multimode fiber.

In new installations, only 50 µm OM3/OM4 laser-optimized fiber is recommended for today's high-speed enterprise networks and data centers. 62.5 µm (OM1) fiber, or older 50 µm (OM2) fiber, is not recommended.

For existing installations with OM1 fiber or OM2 fiber, users should carefully weigh the costs of re-cabling their network against the limited benefits of extending the current infrastructure. The ability to support high speed 10 Gb/s applications that are becoming common in enterprise networks is a key advantage of OM3/OM4 fiber.

Planning for the Future

Since optoelectronics make up a large percentage of total system cost, the most economical solution for multi-gigabit transmission in the enterprise is 50 µm OM3 or OM4 fibers designed and manufactured for use with inexpensive VCSELs.

Infrastructure managers need to plan ahead for these higher speeds, even if they are not immediately deployed. If new cabling is being installed, higher fiber count cables should be considered. Parallel transmission technology means that 12-fiber cables need to be installed for 40 Gb/s links, and 24-fiber cables are currently needed for 100 Gb/s links. In the enterprise LAN, where installation costs are a significant part of the total structured cabling bill, putting in more fiber now can save future installation costs.

A common question is, "If 40G technology only uses eight fibers (four fibers transmitting and four fibers receiving, each at 10 Gb/s), why do I need to install twelve fiber cables?" The answer lies in the industry-defined interface for the transceiver for these links. The MPO connector is defined as the interface, with a 12-fiber MPO connector used for 40 Gb/s links and a 24-fiber MPO used as the preferred 100 Gb/s interface.

The use of 12-fiber multiples allows users the maximum flexibility in upgrading to the next generation of networking speeds.

Work is beginning on next-generation 100 Gb/s technology. IEEE 802.3bm has been created with the goal of developing lower cost 4x25 Gb/s solutions for 100 Gb/s networks. Both multimode and single-mode solutions are under consideration.

Single-mode solutions include parallel transmission, similar to that used in multimode solutions but with four fibers at 25 Gb/s; and multi-level signaling, similar to that currently used in today's high-speed copper links. Multimode solutions are centered around higher speed VCSELs operating at 25 Gb/s, but other technologies are also being considered.

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 requires WDM optics using multiple lasers driving multiple wavelengths.

In general, then, multimode fiber continues to be the most cost-effective choice for data centers and most enterprise applications. Single-mode fiber is best used for longer distance links, typically found in larger multi-building campuses or ultra-large data centers.

For additional information contact your sales representative. You can also visit our website at www.ofsoptics.com or call 1-88-fiberhelp.

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