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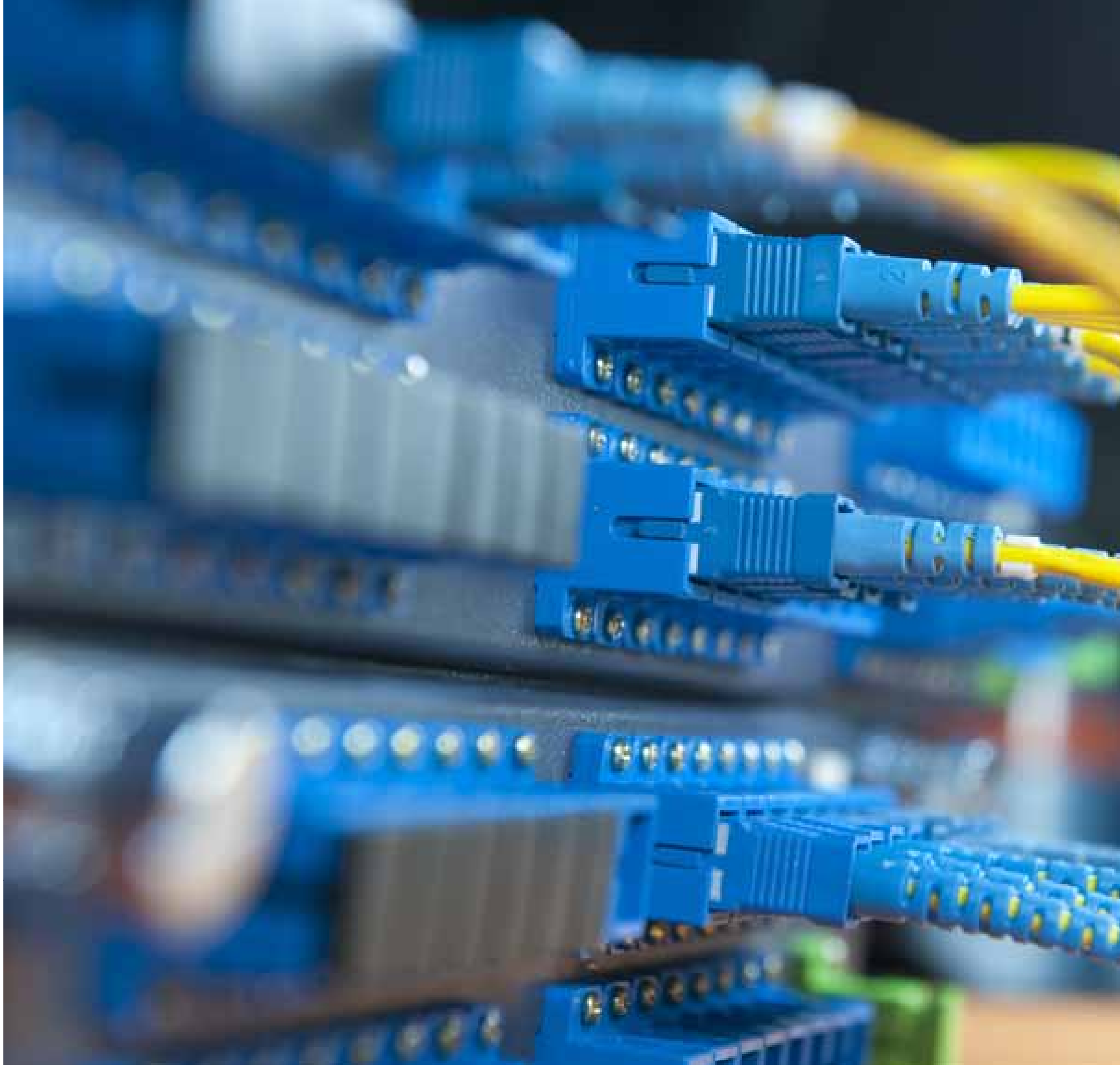

Multimode or Singlemode

Which is Best for the Enterprise?

Applications such as voice over Internet protocol (VoIP), video streaming and teleconferencing are pushing data communication rates to 10 Gigabits per second (Gb/s) and beyond in enterprise networks. Meanwhile, today's data centers are rapidly adopting 10 Gb/s transmission, while state-of-the-art data centers are introducing 40 Gb/s links, with 100 Gb/s just around the corner.

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These higher speeds might lead system designers to believe that singlemode optical fiber has an increasing advantage over multimode optical fiber in premises applications. However, higher speeds do not automatically mean that singlemode optical fiber is the right choice.

Although singlemode optical fiber has advantages in terms of bandwidth and reach for longer distances (> 550 meters [m] at 10 Gb/s), multimode optical fiber easily supports most distances required for premises and enterprise networks. In fact, multimode optical fiber can support

by John Kamino

100 Gb/s transmission to 150 m for high-speed data center links.

Furthermore, the optoelectronics used with multimode optical fiber are generally much less expensive than those required for a singlemode system. Multimode optical fiber also is easier to install and terminate in the field—an important consideration in enterprise environments with frequent moves, adds, and changes (MACs).

Multimode versus Singlemode—What's the Difference?

The two optical fiber types get their names from the way they transmit light. Generally designed for systems of moderate to long distance (e.g., metropolitan, access and long-haul networks), singlemode optical fibers have a small core size (< 10 microns [µm]) that permit 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 optical 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 singlemode connectors because of the more stringent alignment requirements of singlemode optical fiber. Whether optical fibers are factory or field terminated, singlemode component and labor costs are higher due to the increased level of precision required both in the components and the connector end-face finish.

One of the greater advantages of multimode over singlemode is the cost differential for optoelectronics. The cable contribution to the total cost of a link is approximately five percent, while the switch and transceivers make up almost 95 percent (see Figure 1). A typical 10 Gb/s singlemode transceiver can cost more than twice as much as a comparable multimode transceiver (see Figure 2), and the cost differential at 100 Gb/s is even greater. Preliminary numbers show singlemode 100 Gb/s transceivers costing more than 25 times as much as multimode transceivers.

Network Considerations

Singlemode electronics also requires significantly more power than its multimode counterpart. Transceivers such as 100 Gb/s multimode are expected to draw less than six watts, while a singlemode transceiver draws approximately 20 watts. As data centers grow larger, power consumption becomes a pivotal issue—reducing the energy required to support the network is a critical objective for data center managers.

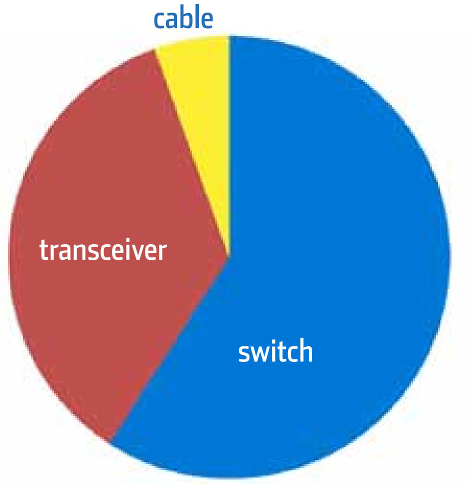
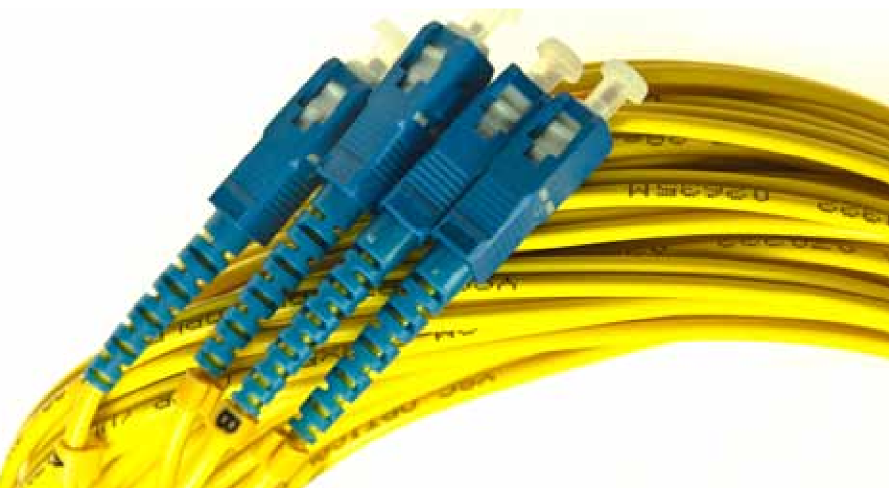


Figure 1: Total link cost of switches, transceiver and cable

This reduced power requirement also means that more multimode transceivers can be mounted in a 1U rack space—16 (or 32) multimode ports can be mounted in a space that can only accommodate four singlemode ports. Rack space real estate is a precious commodity, and improved bandwidth density is another key advantage of a multimode solution.

Enterprise environments present particular network challenges, including large numbers of links, high connection density and components that get handled frequently. Multimode optical fibers are ideally suited for these conditions. Since distances within a



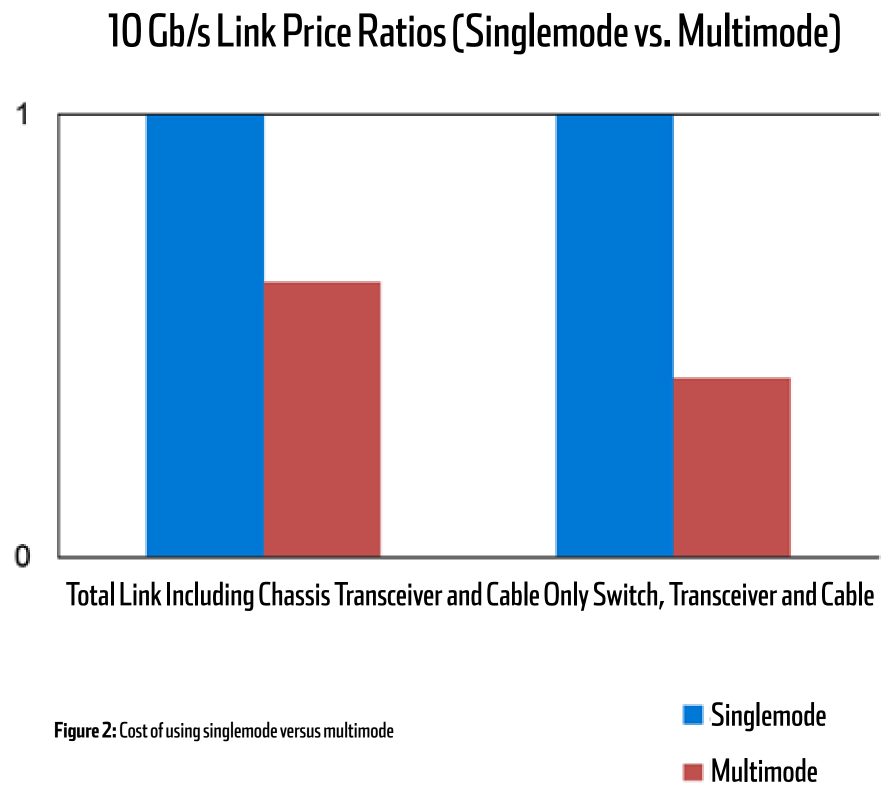


Figure 2: Cost of using singlemode versus multimode

premises system rarely approach 550 m, multimode optical fiber should be the choice for these applications. In data centers, where 100 Gb/s links are expected, multimode optical fiber is the preferred media for links of 150 m and less.

Beyond 550 m at 10 Gb/s (or 150 m at 100 Gb/s), it is necessary to use singlemode optical fiber. There are new choices for singlemode optical fiber today. Consider your options carefully. For example, a bend-insensitive full spectrum singlemode optical fiber provides more transceiver options and more bandwidth, and is less sensitive to handling of the cables and patch cords than conventional singlemode optical fiber.

The network designer or end user who specifies multimode optical fiber for short-reach systems still must choose from two types—50 µm or 62.5 µm. In the 1970s, 50 µm multimode optical fibers were first deployed for short and long reach applications. In 1985, 62.5 µm multimode optical fiber was introduced and supported campus applications up to 2 kilometers (km) at 10 Mb/s. Its larger core was ideally suited for light emitting diode (LED) based transmitters.

The introduction in the mid-1990s of the vertical cavity surface emitting laser (VCSEL) light source, with its smaller diameter laser source, drove a shift to the higher 50 µm optical fiber bandwidth. Today, 50 µm laser-optimized multimode (OM4 and OM3) optical fiber offers significant bandwidth and reach advantages for most building applications, while preserving the low system cost advantages of multimode optical fiber.

Planning for the Future

Since optoelectronics represents a large percentage of total system cost, the most economical solution for 10 Gb/s transmission in the enterprise is 50 µm OM3 or OM4 optical fibers that have been designed and manufactured for use with inexpensive VCSELs. This cost advantage holds true at higher speeds, because 100 Gb/s transceivers are designed to take advantage of 10 Gb/s enterprise technology.

With an eye to the future, a next generation 100 Gb/s Optical Ethernet Study Group has been formed to begin work on a 4x25 Gb/s solution for 100 Gb/s Ethernet. By allowing an easy upgrade path from current 40 Gb/s (4x10 Gb/s) Ethernet to 100 Gb/s, this will provide higher speed 25 Gb/s transmission over each pair of optical fibers, instead of simply adding 10 Gb/s lanes.

For singlemode optical fiber, wavelength division multiplexing (WDM) is used to achieve these higher rates. For 40 Gb/s Ethernet, four lasers transmitting at four different wavelengths are launched onto a single optical fiber, while 100 Gb/s Ethernet uses four lasers operating at 25 Gb/s.

Why not use singlemode optical fiber with a single laser (serial transmission) operating at 100 Gb/s? Such a laser is not commercially available today, and likely will not be in the near future. It will be challenging to develop and produce such a laser cost-effectively. Therefore, achieving higher speeds on singlemode optical fiber requires WDM optics using four lasers to drive four wavelengths. This complexity, combined with the other challenges previously identified, makes singlemode solutions significantly more expensive. In general, multimode optical fiber continues to be the most cost-effective choice for enterprise 10 Gb/s applications up to 550 m, and data center 40/100 Gb/s applications up to 150 m. Singlemode optical fiber is best used for distances beyond these lengths.

If, however, the network's transmission distances indicate the use of singlemode optical fiber, consider specifying the latest optical fibers with features like bend insensitivity and reduced water peak. These optical fibers are designed to provide long-term reliability in applications with tight bends and small enclosures. ■