Standards Review: OM4 Optical Fiber and the Status of 40G and 100G

White Paper

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There is a lot of activity right now related to standards development in support of multimode fiber. In light of all this activity, there's a natural tendency to want to jump to the end and be the first one to reach the finish line. However, it is critical that we don't get ahead of ourselves in terms of where the standards currently lie and where they are going.

The purpose of this document is to provide an accurate reference for the current state of standards development and also explain Corning's position. The two big efforts that are currently underway are the completion of the 40 Gb/s and 100 Gb/s Ethernet standards and the creation of a new, standardized multimode fiber called OM4.

Part I: 40 Gb/s and 100 Gb/s

As bandwidth demand continues to increase, the need for higher speeds is also growing and the next generation standards are currently being developed. For Ethernet this means 40 Gb/s and 100 Gb/s. These next generation speeds currently include an objective for multimode fiber of "at least 100 m over OM3". OM3 is the only multimode fiber included in the 40/100G objectives. OM1 and OM2 (lower bandwidth 62.5um and 50 um fibers, respectively) are not considered.

The baseline proposal for the multimode fiber objective includes parallel optics. In the case of 40 Gb/s this means 4 fibers x 10 Gb/s for transmit and 4 fibers x 10 Gb/s for receive. This configuration will require the use of one 12F ribbon. For 100 Gb/s it means 10 fibers for transmit and 10 fibers for receive or two 12F ribbons. This may seem like a lot of fiber (and a lot of money), but initial cost analyses show that multimode fiber parallel solutions remain significantly less expensive than single-mode fiber solutions at 40G and 100G for typical LAN and data center distances. Just like at 1G and 10G, this is driven primarily by the high transceiver costs required for use with standard single-mode fibers. 10G single-mode fiber systems require the use of a distributed feedback (DFB) laser, which is significantly more expensive than 850 nm VCSELs used with multimode fiber 10GBASE-SR systems.

Despite the fact that the individual transceivers in the array will still be operating at 10 Gb/s, the distance that the array transceivers can support is significantly less than the distance supported by the current 10GBASE-SR 850nm multimode fiber transceivers. This is because the transceiver specifications that have been accepted as the baseline proposal for the 40 Gb/s and 100 Gb/s multimode fiber objectives are much less stringent than those currently specified for 10GBASE-SR Ethernet.

In order to test the limits of the next generation speeds, Corning purchased commercially available 40 Gb/s 850 nm transceivers (4 x 10 Gb/s VCSEL array) and demonstrated at InterOp NYC in September 2008 that with commercially available Corning® InfiniCor® SX+ fiber, it is possible to extend the OM3 reach to at least 1.5x further than the 40 Gb/s and 100 Gb/s 100 m base line proposals. This was not a

"hero" lab experiment but rather a demonstration of cabled InfiniCor SX+ optical fiber with publicly-available transceivers and optical fiber MTP connectivity solutions.

Although 150 m was the distance shown for the demo, subsequent lab testing showed 250 m was obtainable over InfiniCor SX+ fiber (OM3) with a BER (bit error ratio) better than 10^{-12} (error limit defined by the 40 Gb/s and 100 Gb/s standards).

Although the 40 Gb/s and 100 Gb/s objectives currently call for "at least 100 m over OM3", there is a multimode fiber extended reach adhoc group investigating the need to increase this distance. Corning is actively involved in this effort. We want to ensure that the lowest cost solution is available for premises networks with links longer than 100 m. Corning channel link length analysis indicates 100m only addresses 65% of installed data center lengths. Our demonstration proves that longer distances are technically and commercially achievable. Increasing the link length to somewhere between 150 m and 250 m would ensure that the majority of LAN and data center link lengths are covered.

The 40 Gb/s and 100 Gb/s standards are expected to be complete in mid-2010. Standards tend to lead port sales by several years so we would expect to see port sales for early adopters start around 2013. Given that structured cabling systems are designed to last 10 to 15 years or longer, it makes sense to plan for 40G/100G as you install your networks today. OM3 connectivity solutions and electronics exist today that support duplex fiber transmission and also provide an easy migration to parallel optics, the solution of the future. Corning's minEMBc bandwidth measurement is the best way to ensure that the OM3 fibers you purchase will perform as advertised. Corning measures every reel of 50 µm InfiniCor® fiber and has never had a field return for multimode bandwidth failure, ever.

Part II: OM4

Various standards organizations (TIA TR-42.12 and IEC SC86A) are now discussing higher bandwidth multimode fiber detail fiber standards (i.e. OM4). Current OM4 proposals recommend an effective laser bandwidth equal to that which is currently being sold as Corning® InfiniCor® eSX+ fiber (OM3+). This higher bandwidth fiber (850nm EMB $\geq$ 4700 MHz-km) could be used for higher serial bit rates, longer link lengths or increased margin for more connectivity.

It is important to note that the OM4 standard is still under development and the final fiber specifications are still being debated. OM3 fibers (such as InfiniCor SX+ fiber) are currently the highest standardized multimode bandwidth fibers (850nm EMB $\geq$ 2000 MHz.km). OM4 is likely to be standardized in 2009/2010.

One driver for standardizing a higher bandwidth multimode fiber would be to help support higher speed transmission. However, the fiber itself cannot always ensure better performance. Such is the case right now with the current baseline proposals for 40G and 100G. As mentioned above, the transceiver specifications that are currently proposed in the standards call for a much broader spectral width (as well as increased jitter and a few other changes) as compared to the current 10GBASE-SR transceivers. These 40 and 100 Gb/s transceivers, as currently specified, are becoming chromatic dispersion limited and therefore the link length with an OM3 fiber and an OM4 fiber (as currently proposed with EMB = 4700 MHz.km) are nearly the same. There just isn't much benefit with an OM4 fiber as the transceiver standard is currently defined. The extended reach adhoc is looking for ways to increase the distance on both OM3 and OM4 but a decision has yet to be made.

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