

CORNING

LANscape®
Pretium® Solutions

Migration to 40/100G in the Data Center with OM3 and OM4 Optical Connectivity

Needs in the Data Center

With the continued requirement for expansion and growth in the data center, cabling infrastructures must provide reliability, manageability and flexibility. Deployment of an optical connectivity solution enables for an infrastructure that meets these requirements for current applications and data rates. An additional key factor when choosing the type of optical connectivity is scalability. Scalability refers to not only the physical expansion of the data center with respect to additional servers, switches or storage devices, but to the scalability of the infrastructure to support a migration path for increasing data rates. As technology evolves and standards are completed to define data rates such as 40/100G, Fibre Channel (32G and beyond) and InfiniBand (40G and beyond), the cabling infrastructures installed today must provide scalability to accommodate the need for more bandwidth in support of future applications.

The Need for Speed

Current data rates are not able to meet the needs of the future with the rising demand to support high-bandwidth applications. With Ethernet applications now operating at 1 and 10G, it is clear that to support future networking requirements, 40/100G technologies and standards are required.

The requirement for higher data rates is being driven by many factors. Switching and routing, virtualization, convergence and high-performance computing environments are examples of where these higher network speeds will be required within the data center environment. Additionally, Internet exchanges and service provider peering points and high-bandwidth applications such as video on demand will drive the need for a migration from 10G to 40/100G interfaces.

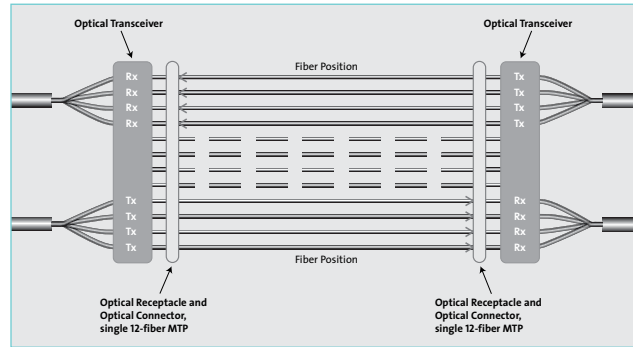
IEEE 802.3ba 40/100 Gigabit Ethernet Standard Ratified

The Institute of Electrical and Electronics Engineers (IEEE) 802.3ba 40/100G Ethernet Standard was ratified in June 2010. The standard provides specific guidance for 40/100G transmission with multimode and single-mode fibers. The standard does not have guidance for CAT UTP/STP copper cable.

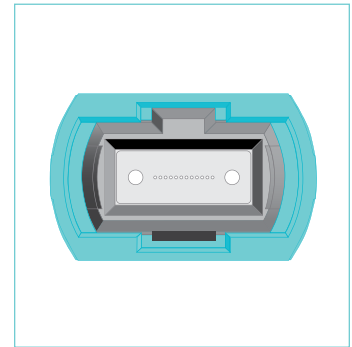
OM3 and OM4 are the only multimode fibers included in the standard. Multimode fibers utilize parallel optics transmission instead of serial transmission due to the 850 nm VCSEL modulation limits. Single-mode fiber guidance utilizes duplex fiber wavelength-division multiplexing (WDM) serial transmission. Multimode fiber continues to offer a significant value proposition compared to single-mode fiber for short length interconnects in the data center.

Parallel optics transmission, compared to traditional serial transmission, uses an optic module interface where data is simultaneously transmitted and received over multiple fibers. The 40GBASE-SR4 and 100GBASE-SR10 variant interfaces are as follows: 4 x 10G on four fibers per direction and 10 x 10G on 10 fibers per direction, respectively.

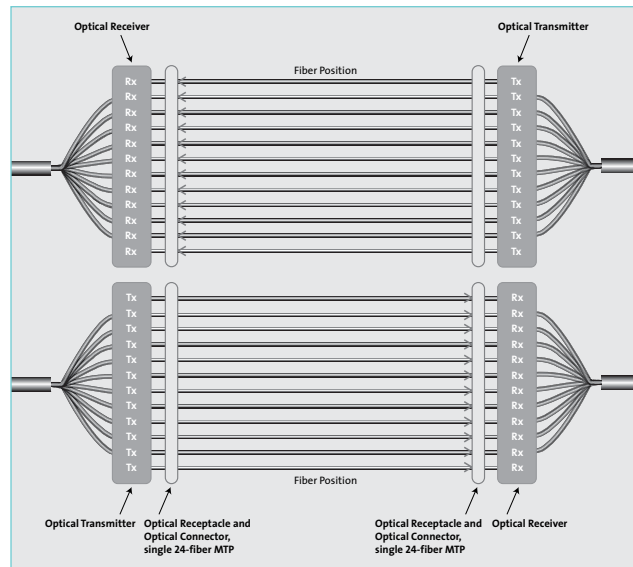
40G



12-fiber MTP® Connector



100G



24-fiber MTP Connector

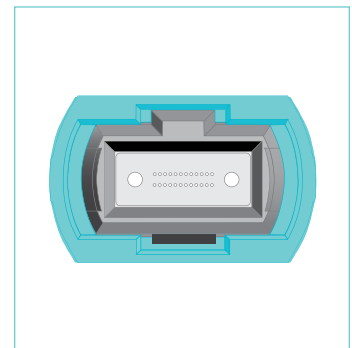


Table 1 below provides the OM3 and OM4 specified distances for Ethernet and Fibre Channel. Each distance assumes 1.5 dB total connector loss with the exception of OM4 40/100G, which assumes 1.0 dB total connector loss. OM3 and OM4 are fully capable to support legacy and emerging data rates such that an expected 15-20 year service life is expected for the physical layer.

Table 1

850 nm Ethernet Distance (m)				
	1G	10G	40G	100G
OM3	1000	300	100	100
OM4	1000	550	150	150

850 nm Fibre Channel Distance (m)			
	4G	8G	16G
OM3	380	150	100
OM4	480	190	125

Cabling Performance Requirements

When evaluating the performance needed for the OM3 and OM4 cabling infrastructure to meet the requirements for 40/100G channel insertion loss transmissions, three criteria should be considered: bandwidth, total connector insertion loss and skew. Each of these factors can impact the cabling infrastructure's ability to meet the standard's transmission distance of at least 100 meters over OM3 fiber and 150 meters over OM4 fiber.

■ Bandwidth

OM3 and OM4 fibers are the only multimode fibers included in the 40/100G standard. The fibers are optimized for 850 nm transmission and have a minimum 2000 MHz·km and 4700 MHz·km effective modal bandwidth (EMB). Fiber EMB measurement techniques are utilized today. The minimum Effective Modal Bandwidth calculate (EMBc) method combines the properties of both the source and fiber and has many advantages compared to the differential modal delay mask method for guaranteeing a system's performance. The EMBc process predicts source-fiber performance by integrating the fundamental properties of light sources with the multimode fiber's modal structure which has been measured using a standardized DMD measurement. The minimum EMBc ensures that the multimode fiber will work for all types of standard compliant sources, including, for example, the extreme hot centered and hot outside lasers. It is therefore a conservative and robust system performance metric. Since the EMBc method predicts fiber performance in scalable units (MHz·km), it can therefore be scaled to predict other bit rates and/or link lengths. Conversely, the DMD mask approach provides a pass-or-fail estimation. With a connectivity solution using OM3 and OM4 fibers that have been measured using the minEMBc technique, the optical infrastructure deployed in the data center will meet the performance criteria set forth by IEEE for bandwidth.

■ Insertion Loss

Insertion loss is a critical performance parameter in current data center cabling deployments. Total connector loss within a system channel impacts the ability to operate over the maximum supportable distance for a given data rate. As total connector loss increases, the supportable distance at that data rate decreases. The 40/100G standard specifies the OM3 fiber to a 100 m distance with a maximum channel loss of 1.9 dB, which includes a 1.5 dB total connector loss budget. OM4 fiber is specified to a 150 m distance with a maximum channel loss of 1.5 dB, which includes a 1.0 dB total connector loss budget. The maximum cabled fiber attenuation is 3.5 dB/km at 850 nm. Thus, the insertion loss specifications of connectivity components should be evaluated when designing data center cabling infrastructures. With low-loss connectivity components, maximum flexibility can be achieved with the ability to introduce multiple connector matings into the connectivity link.

■ Skew

The IEEE 802.3ba Standard includes an optical media skew of 79 ns. Optical skew, the difference in time of flight between light signals traveling on different fibers, is an essential consideration for parallel optics transmission. With excessive skew, or delay, across the various channels, transmission errors can occur. Skew testing on Corning Cable Systems MTP® connectivity solutions has demonstrated compliance to a strict 0.75 ns skew requirement as defined in the InfiniBand standard. Deployment of a connectivity solution with strict skew performance ensures compatibility of the cabling

(continued)

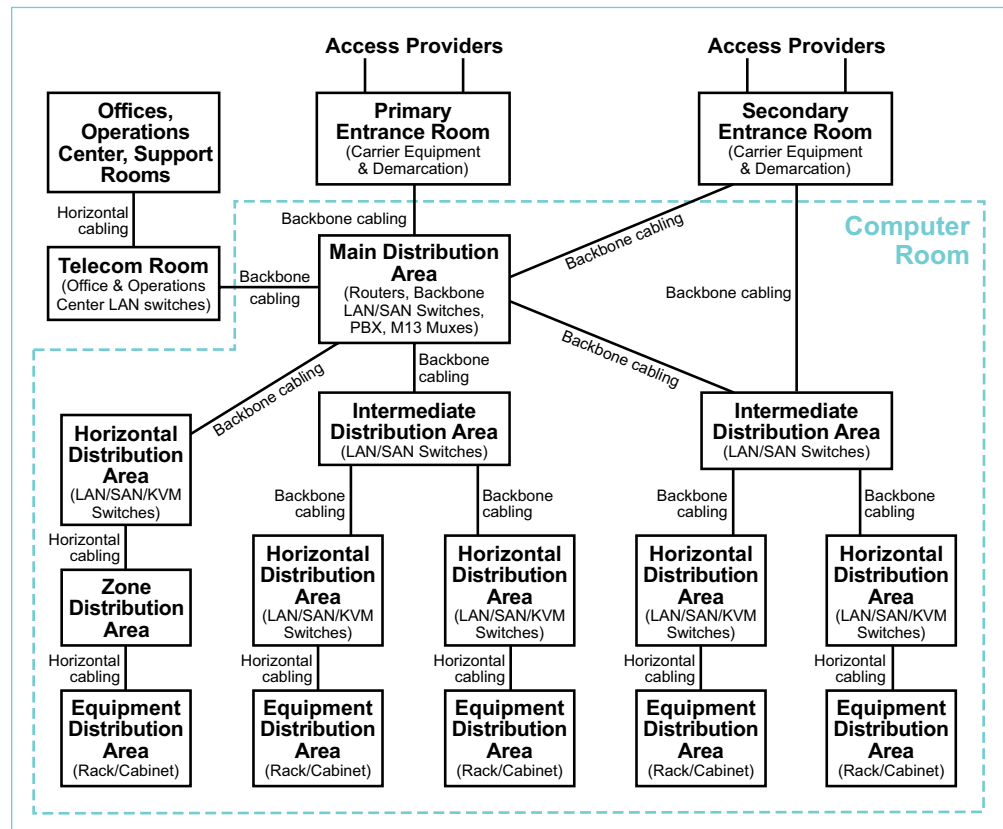
infrastructure across a variety of transmission protocols. When evaluating optical cabling infrastructure solutions for 40/100G applications, selecting one that meets the 0.75 ns skew requirement ensures performance not only for 40/100G, but also for InfiniBand and future Fibre Channel data rates. Additionally, low-skew connectivity solutions validate the quality and consistency of cable designs and terminations to provide long-term reliable operation.

Deploying an optical cabling infrastructure in the data center

Recommended cabling infrastructure deployments in the data center are based upon guidance found in ANSI/TIA-942, “Telecommunications Infrastructure Standard for Data Centers.” Utilizing a distributed star topology in a structured cabling implementation provides the most flexible and manageable infrastructure. Many data center deployments today utilize the reduced topology described in ANSI/TIA-942, where the Horizontal Distribution Areas (HDAs) shown are collapsed to the Main Distribution Area (MDA). In this collapsed architecture, the cabling is installed between the Main Distribution Area and the Zone Distribution Area (ZDA) or Equipment Distribution Areas (EDAs).

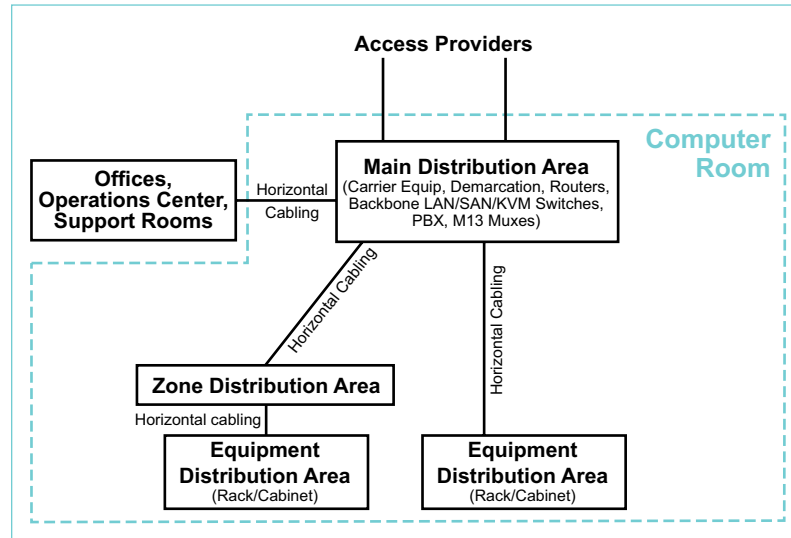


Distributed Star Topology



Source: Draft ANSI/TIA-942, Rev. A

Collapsed/Reduced Star Topology



Source: ANSI/TIA-942



For optimized performance in meeting data center requirements, the topology of the cabling infrastructure should not be selected alone; infrastructure topology and product solutions must be considered in unison.

Cabling deployed in the data center today must be selected to provide support of data rate applications of the future, such as 100G, Fibre Channel > 16G and InfiniBand > 40G. To do this, OM3 or OM4 fiber is a must. In addition to being the OM4 multimode fiber included in the 40/100G standard, OM3 and OM4 fibers provide the highest performance for today's needs. With an 850 nm EMB of 2000 MHz·km and 4700 MHz·km, the fibers provide the extended reach often required for structured cabling installations in the data center. OM3 and OM4 fiber connectivity continues to provide a significant value proposition when compared to single-mode fiber, as multimode fiber utilizes low cost 850 nm transceivers for serial and parallel transmissions.

In addition to the performance requirements discussed, the choice in physical connectivity is also important. Because parallel optics technology requires data transmission across multiple fibers simultaneously, a multifiber, or array, connector is required. Utilizing MTP®-based connectivity in today's installations provides a means to migrate to this multifiber parallel optic interface when needed.

Factory-terminated MTP solutions allow connectivity to be achieved through a simple plug-and-play system. To meet the needs of today's serial Ethernet and Fibre Channel applications, MTP-terminated backbone/horizontal cabling is simply installed into preterminated modules or cassettes.

These modules provide a means for transitioning the MTP connector on the backbone cable to single-fiber connectors such as the LC duplex. Connectivity into the electronics is completed through a standard LC duplex patch cord from the module. When the time comes to migrate to 40/100G, the module and LC duplex patch cords are removed and replaced with MTP adapter panels and MTP patch cords for the parallel optic interfaces.



Multiple loss performance tiers are available for MTP® connectivity solutions. Just as connector loss must be considered with current applications such as 8/16G Fibre Channel and 10G, insertion loss is also a critical factor for 40/100G applications. For example, IEEE 802.3 defines a maximum distance of 300 meters on OM3 multimode fiber for 10G (10GBASE-SR). To achieve this distance, a total connector loss of 1.5 dB is required. As the total connector loss in the channel increases above 1.5 dB, the supportable distance decreases. When extended distances or multiple connector matings are required, low-loss performance modules and connectivity may be necessary.

Additionally, to eliminate concerns of modal noise effects as total connector loss increases, solutions should be selected that have undergone system modal noise testing by the connectivity manufacturer. Selecting a high-quality connectivity solution that provides low insertion loss and eliminates modal noise concerns ensures reliability and performance in the data center cabling infrastructure.

Likewise, with the total connector loss for 40/100G, similar considerations must be evaluated. MTP Connector matings with maximum connector loss specifications of 0.5 dB and 0.35 dB provide alternatives for variations in the infrastructure design as the physical connectivity and channel distance are taken into account to make a final selection in product performance.

Preparing for the Future

To best meet the needs of the future, MTP-based connectivity utilizing OM3 or OM4 fiber is the ideal solution in the data center. With inherent modularity and optimization for a flexible ANSI/TIA-942-compliant structured cabling installation, MTP-based optical fiber systems can be installed for use in today's applications, while providing an easy migration path to future higher speed technologies such as 40/100G.

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