DATA CENTERS

A holistic view of the data center and the opportunities to enhance its infrastructure to meet current and future demands

Chapter 6

Fiber selection

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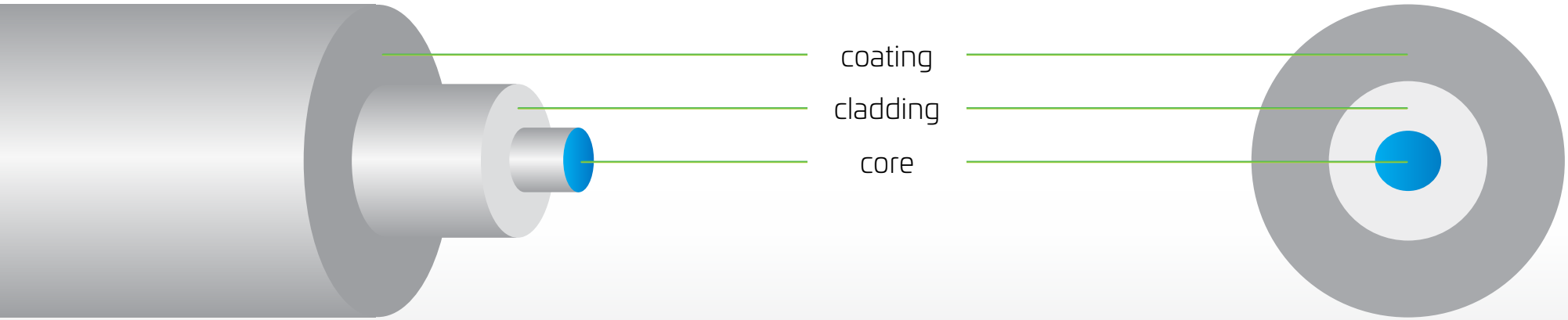
Vital connections for today's data centers

The data center is at the core of today's business—and fiber-optic connectivity is the fabric, carrying vital data to drive critical business processes and providing connectivity to link servers, switches and storage systems.

Data center designers have two high-level choices when it comes to fiber types: multimode fiber and singlemode fiber. In this chapter, we'll discuss the development, deployment and advantages of each fiber type, as well as the connectors that pull it all together.

Multimode fiber: the low-cost platform



6 | Fiber selection

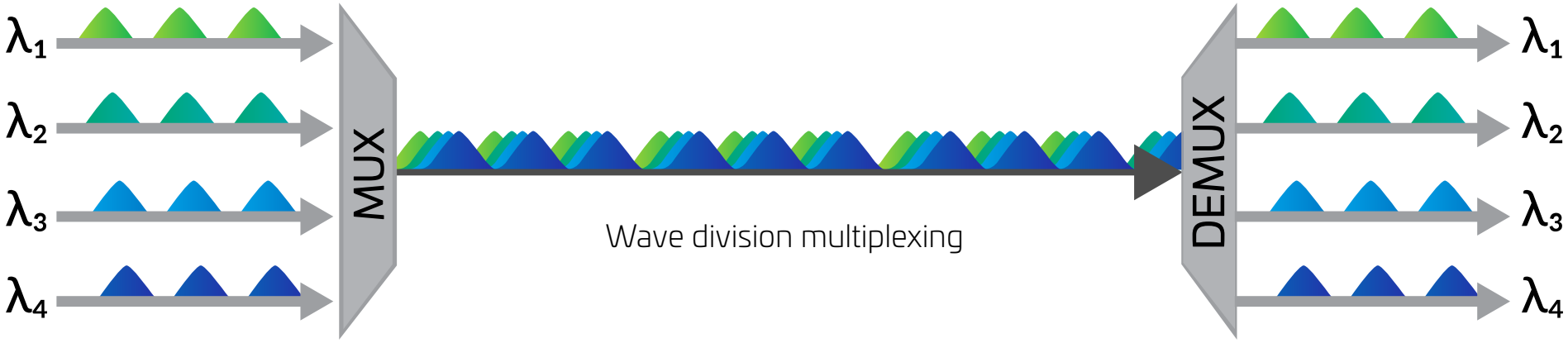
Today, multimode fiber (MMF) is the workhorse medium for data centers because it is the lowest-cost way to transport data at high rates over the relatively short distances in these environments. MMF has evolved from being optimized for multimegabit-per-second transmission using light-emitting diode (LED) light sources to being optimized to support multigigabit transmission using 850 nm vertical cavity surface emitting laser (VCSEL) sources, which tend to be less expensive than their singlemode counterparts.

This leap in performance is reflected in the classifications given by the standards bodies. OM1 and OM2 represented the earlier MMF types with low modal bandwidth and very limited support for higher-speed optics. OM3 and OM4 represent the newer, laser-optimized MMFs typically installed in data centers today. The following table provides examples of some of the current data center applications and the maximum channel lengths over different fiber types.

Application	Standard, MSA or Mfg. Specification	IEEE reference	Media	Speed	Target distance
40 Gigabit Ethernet	40GBASE-SR4	IEEE 802.3ba	4-pair MMF	40 Gb/s	150 m (OM4/OM5)
	40GBASE-eSR4	-	4-pair MMF		400 m (OM4/OM5)
	40G-BiDi	-	1-pair MMF		150 m (OM4) 200 m (OM5)
	40G-SWDM	-	1-pair MMF		350 m (OM4) 440 m (OM5)
	40GBASE-FR	IEEE 802.3bg	1-pair SMF		2 km
	40GBASE-LR4	IEEE 802.3ba	1-pair SMF		10 km
	40GBASE-ER4	IEEE 802.3ba	1-pair SMF		40 km
100 Gigabit Ethernet	100GBASE-SR4	IEEE 802.3bm	4-pair MMF	100 Gb/s	100 m (OM4/OM5)
	100GBASE-eSR4	-	4-pair MMF		300 m (OM4/OM5)
	100GBASE-SR10	IEEE 802.3ba	10-pair MMF		150 m (OM4/OM5)
	100G-SWDM4	-	1-pair MMF		100 m (OM4) 150 m (OM5)
	100G-eSWDM4	-	1-pair MMF		300 m (OM4) 400 m (OM5)
	100G-PSM4	-	4-pair SMF		500 m
	100G-CWDM4 Lite	-	1-pair SMF		500 m
	100G-CWDM4		1-pair SMF		2 Km
	100GBASE-LR4	IEEE 802.3ba	1-pair SMF		10 km
	100GBASE-ER4	IEEE 802.3ba	1-pair SMF		40 km

Introducing wideband multimode fiber (WBMMF)

OM3 and OM4 provide very high modal bandwidth at 850 nm—the predominant wavelength that can be efficiently supported by VCSEL transmitters. To support an increase in performance over a single pair of multimode fibers, additional wavelengths need to be transmitted alongside 850 nm, achieved via a new technology—shortwave wavelength division multiplexing (SWDM). Because the modal bandwidth of OM3 and OM4 fibers was specified for laser operation at 850 nm only, a new specification for optical fiber was required. Many data center managers are now considering wideband multimode fiber (WBMMF), which optimizes the reach of SWDM transmission that delivers four times more information with the same number of fiber strands over practical distances. Being optimized to support the additional wavelengths required for SWDM operation (in the 850 nm to 950 nm range), WBMMF ensures not only more efficient support for future applications across the data center fabric, but also full compatibility with legacy applications because it remains fully compliant with OM4 specifications.



By the middle of 2017, the journey to standardization of WBMMF cabling was complete, having been recognized by ISO/IEC and TIA standard bodies. The OM5 designation was adopted for inclusion of this new cabled optical fiber category in the third edition of the ISO/IEC 11801 standard. Once again, CommScope led the market in next-generation standards development as well as product availability and was one of the first manufacturers to deliver a commercially available OM5 end-to-end solution with the distinctive lime green color that is also being recognized by standards bodies. Well ahead of standards ratification, CommScope introduced the LazrSPEED® OM5 Wideband solution in 2016, knowing that the support of higher data throughput using low-cost optics is exactly what data center managers require to enable next-generation networks today and in the future.

Indeed, the future of OM5 is very bright. At the end of 2017, the IEEE agreed to initiate a project to define next-generation multimode transmission using shortwave division multiplexing—the transmission technology OM5 was designed to support.

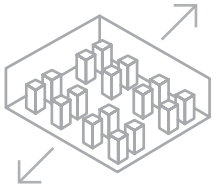
GOALS AND BENEFITS

- Retain legacy application support of OM4
- Increase capacity to > 100 Gbps per fiber
- Reduce fiber count by four
- Boost array cabling capacity for parallel applications
- Enable Ethernet
  40G-SR, 100G-SR, 200G-SR, 400G-SR4
- Enable Fiber Channel:
  128G-SWDM, 256GFC-SWDM
- Extend MMF utility
  as universal data communication medium

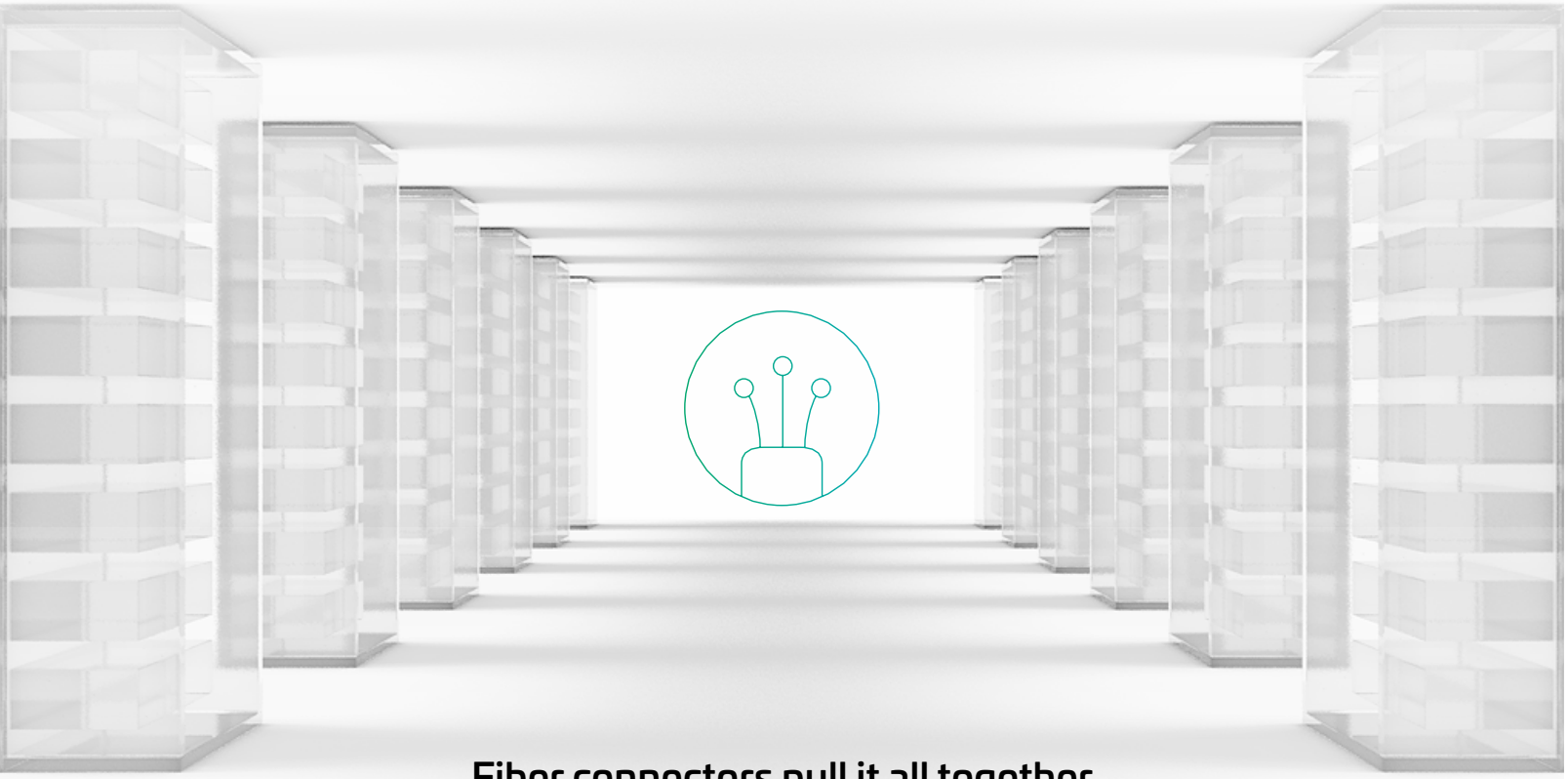
Singlemode fiber: supporting longer distances

Designed with a much narrower core, singlemode fiber (SMF) is the technology of choice for longer-reach applications in the data center, such as extended runs in the fabric between leaf-and-spine switches, spine and routers, and into the transport network to connect data centers in different locations. SMF provides higher bandwidth and does not have the modal dispersion limitations inherent in MMF. For this reason, SMF is used in applications where support for higher and next-generation bandwidths can be absolutely guaranteed to be supported. This makes it a perfect medium of choice for hyperscale and service provider data center owners to deploy.

Very large data centers as well as hyperscale data centers typically deploy SMF to connect multiple halls and extended equipment zones using a centralized cross-connects architecture at the MDA. They typically use a dedicated optical distribution frame (ODF). Deploying an ODF can help ensure that cables are kept to an optimum length for transmission, while equipment zones and other data halls can be quickly and efficiently patched to one another with minimal disruption to service and networking equipment.



Singlemode fiber also enables duplex transmission at higher speeds because it is able to transport multiple wavelengths, thus reducing fiber counts. It is anticipated that one of the 200GE and 400 GbE applications will utilize four-pair parallel optics over SMF—taking advantage of the lower overall system cost parallel optics can offer. The PSM4 multisource agreement (MSA) also defines a four-pair transceiver for 100G applications.



Fiber connectors pull it all together

Fiber connectors have evolved along with fiber-optic cabling, driven by increasing fiber density. The duplex LC connector emerged during the early 2000s as the predominant two-fiber type—and remains so today.

While the evolution of the duplex connector was underway, array connectors (parallel optics) were also emerging. First deployed in public networks, the multifiber push-on (MPO) connector has become a preferred choice for rapidly deploying cabling into data centers. The compact form of the MPO allows 12 or more fibers to be terminated in a compact plug, occupying the same space as a duplex LC. The MPO's high density enables installation of preterminated, high-strand-count cables, while eliminating the time-consuming process of field installing connectors on site.

White paper:

Wideband multimode fiber—
What is it and why does it make sense?

Design guide:

Fabric networks:
Designing your network for the future—
from 10G through 400G and beyond

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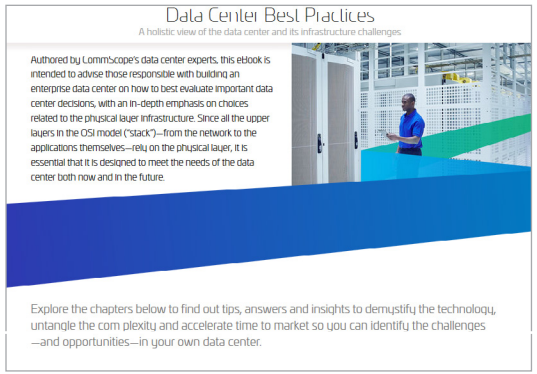

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