COMMSCOPE®

Design Guide

Fiber Migration

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Upgrading your data center to fiber: critical considerations

Data center bandwidth demands continue to grow, requiring higher capacity and throughput. Addressing those needs **efficiently** and **effectively** requires a strategic approach, one that focuses on existing user expectations as well as evolving technologies and future capacity requirements.

It's a complex balancing act that assesses enterprise-specific resources and productivity goals with marketplace capabilities and opportunities. Making the right decisions—ones that position your facility for both short- and long-term readiness—requires partnering with an expert in data center design and deployment.
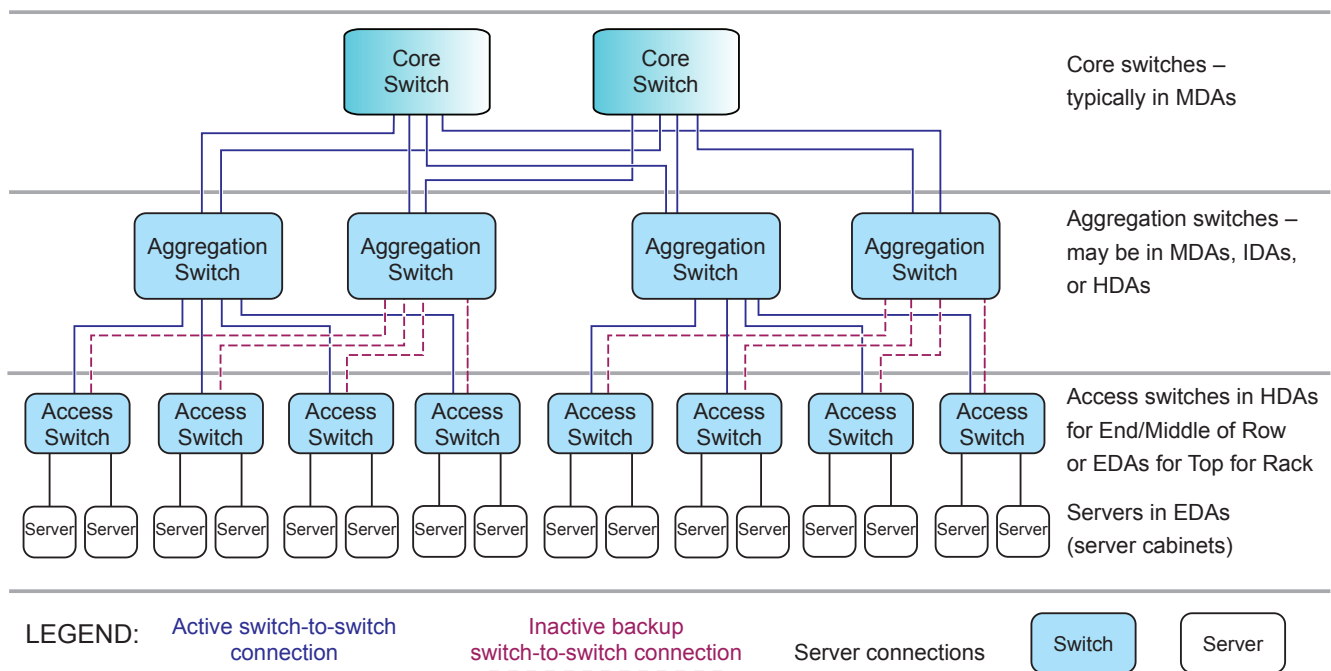
CommScope is a global leader in helping companies upgrade and migrate their data center facilities to fully leverage advanced technologies, including the power of fiber. For more than 30 years, we have been helping companies successfully deploy the most powerful and productive facilities, ones that set industry standards for performance and excellence.

It's a deliberate process—one that considers your existing architecture as well as future needs. And it begins with an assessment of these critical challenges and concerns:

New data center architectures

Data center designs and architectures have evolved to accommodate the growth of cloud-based services, which benefit traditional, private data centers as well as new "mega" facilities.

A traditional data center focuses on north-south traffic (see Figure 1), though such a design fails to adequately address latency, which is critical in many of today's applications.


Figure 1. Traditional three-tier data center architecture.

Core switches – typically in MDAs

Aggregation switches – may be in MDAs, IDAs, or HDAs

Access switches in HDAs for End/Middle of Row or EDAs for Top for Rack

Servers in EDAs (server cabinets)

LEGEND: Active switch-to-switch connection | Inactive backup switch-to-switch connection | Server connections | Switch | Server

MDA – main distribution area
IDA – intermediate distribution area
HDA – horizontal distribution area

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A more direct path for server-to-server communication is achieved with "fat tree" or "spine-leaf" architecture (see Figure 2). In such a configuration, there is a high density of connection between leaf and spine switches, which enhance "any-to-any" connectivity.
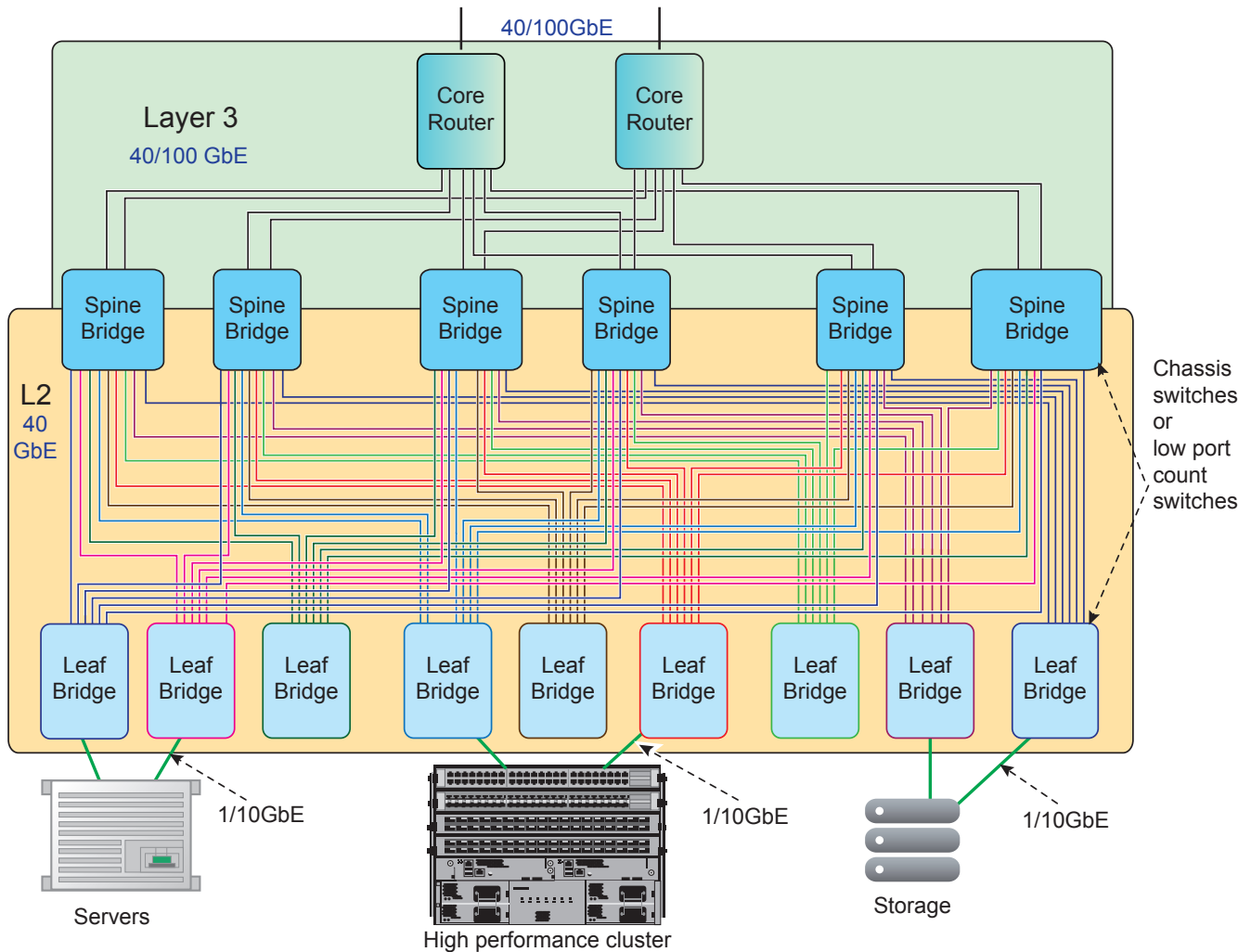

Figure 2. A fat-tree switch architecture has a high density of connection between leaf and spine switches, enhancing any-to-any connectivity.

The spine-leaf architecture offers numerous advantages for applications, including eliminating the need for an aggregation switch, which improves latency. Mega-data centers, and even smaller traditional data centers, can benefit from this architecture.

We offer a myriad of solutions to help customers upgrade their architecture regardless of where their aggregation switches are located.

Upgrading the data center

Figure 3 illustrates a traditional architecture: The core switch is located in the MDA, the aggregation switch is located in the IDA, and the access switch is located in the HDA.

Core Switch/MDA   Aggregation Switch/IDA   Access Switch/HDA
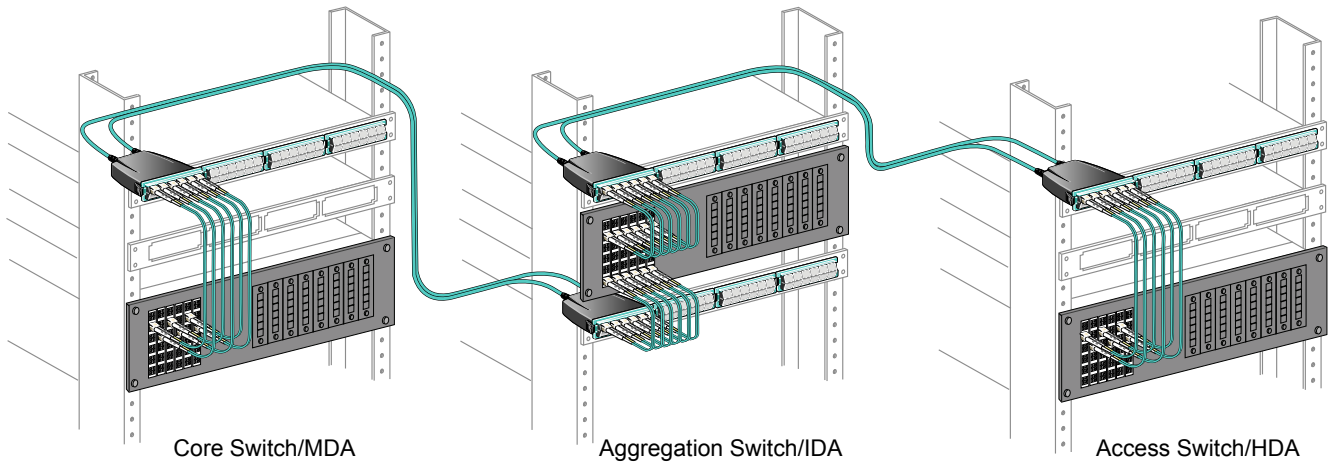
Figure 3. A traditional architecture has the core switch, aggregation switch, and access switch in different locations.

Trunk cables connect the switches to one another (LazrSPEED® 550 InstaPATCH® 360 trunk cables with 24 fibers) and the modules breakout the trunk (i.e., InstaPATCH 360 LazrSPEED standard modules with 12 LC duplex ports). Patch cords complete the connectivity (i.e., LazrSPEED 550 LC to LC, fiber patch cord, 1.6 mm duplex, plenum).

When making a full architectural change in a spine/leaf architecture, the end-to-end connectivity changes (see Figure 4) as the density of connections increases between the spine (interconnection) switch and leaf (access) switch.

Our high-density shelves offer flexibility in implementing a solution in space-constrained applications, with lower density options available to optimize density vs. usability. These are available in 360G2-UHD shelves in 1U, 2U, and 4U sizes as well as the 360G2-UHD fixed shelf—which comes in 2U and 4U sizes.

Spine Switch   Cross-Connect   Leaf Switch
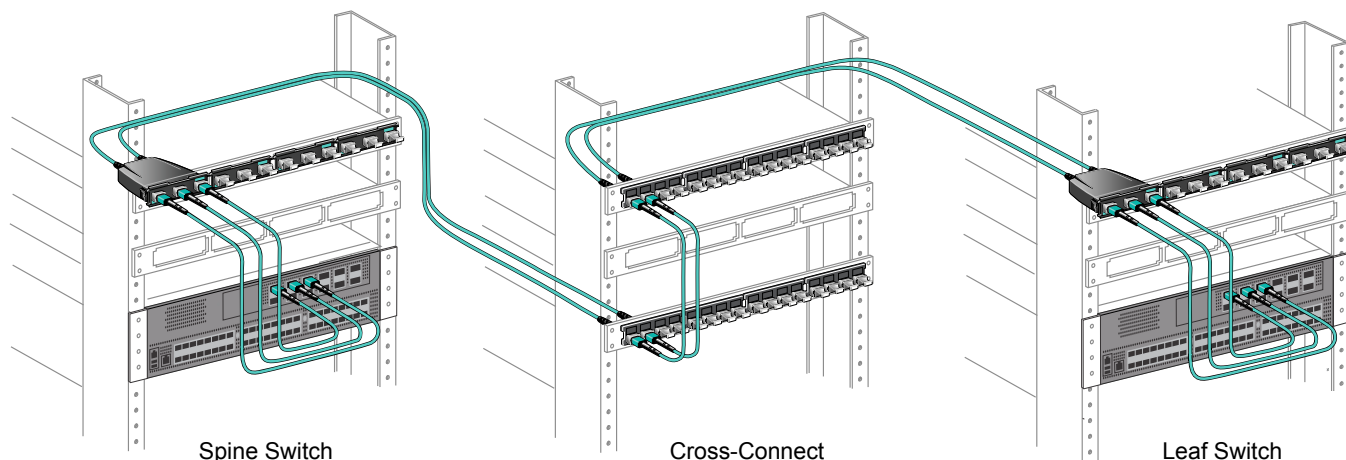
Figure 4. A traditional two-fiber cross-connect application channel with InstaPATCH 360.

Such a scenario applies to changes in architecture and does not impact data rates. However, a more likely scenario is that, when the switches are eliminated, the pipe connecting the remaining switches will need to increase capacity.

Upgrading connection data rates

There are several common scenarios when upgrading connection data rates. Our ANSI/TIA-568-C standard approved Method B solutions ease infrastructure upgrades. To learn more, see the white paper *Optical Fiber Array Connectivity Evolves to Support New Parallel Optic Applications Extending Method B Advantages* at www.commscope.com.

Migration paths

One upgrade possibility beyond 10G incorporates four 10Gb/s SFP+ transceiver connections at the leaf end to a 40Gb/s QSFP+ on the spine end. This requires a QSFP fanout cable MPO (female) to 8LC. Our InstaPATCH 360 fanout cable is one such option.

Figure 5 illustrates one side of the transmission path utilizing this fanout in conjunction with a 40Gb/s QSFP+ to aggregate four 10Gb/s SFP+ transceivers. QSFP+ transceivers on the switches yield higher port densities and throughput for a given RU. This is an increasingly popular option from switch vendors.
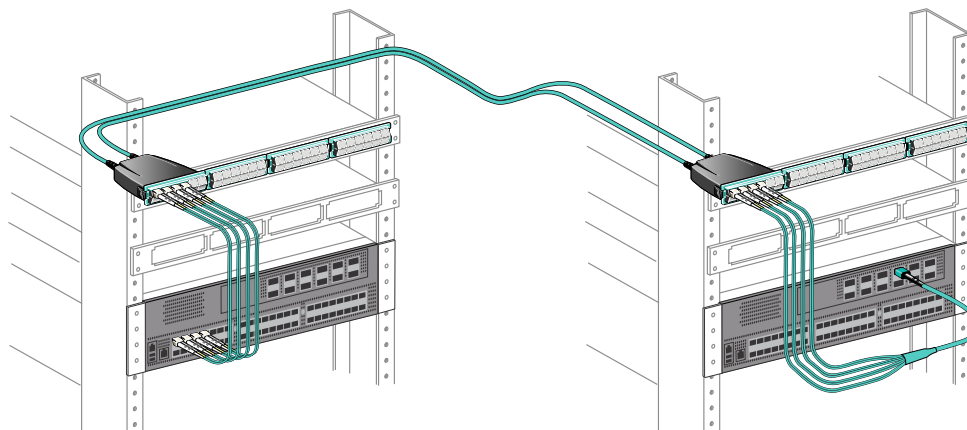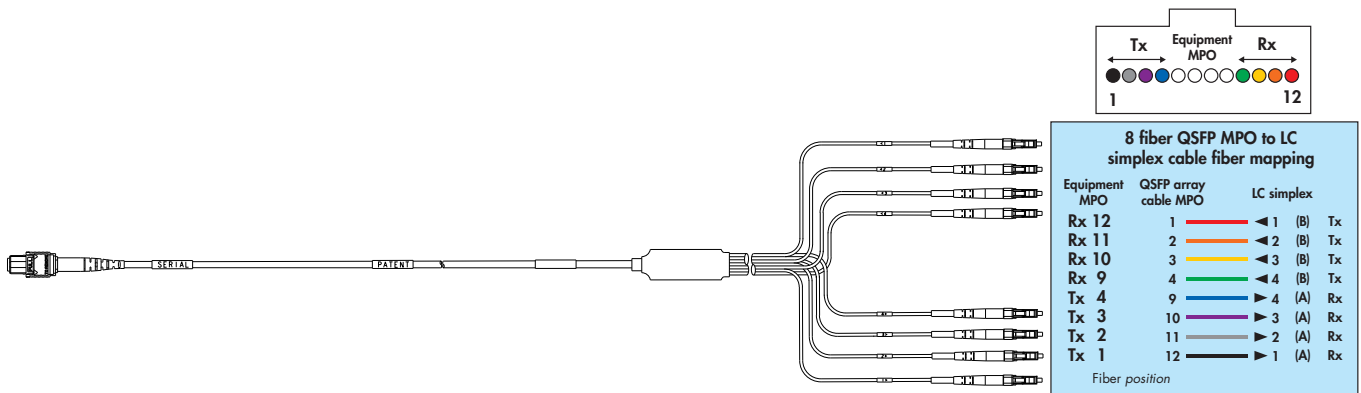

Figure 5. A simple 40Gb/s upgrade on the InstaPATCH 360 line.

Figure 6 shows connectivity of the MPO lanes and the LC breakouts to SFP+ or other duplex transceivers. Connecting an MPO connector to a QSFP+ transceiver fixes transmit and receive directions, per Figure 6.

LC fibers, with the arrow pointing toward the tip of the LC connector, have light transmitted from the MPO end to the LC connector. These should be connected to receivers one through four, as labeled on the connectors.

Position the InstaPATCH 360 modules in the alpha position on one end and the beta position on the other. Connect the remaining LC connectors (arrows pointed away from the LC connectors) to the corresponding number on the TX side of each pair (TX is on the left of a TX/RX pair when viewing the LC connector adapter oriented with the LC tab up).

8 fiber QSFP MPO to LC simplex cable fiber mapping

Equipment MPO	QSFP array cable MPO	LC simplex		
Rx 12	1	◄ 1	(B)	Tx
Rx 11	2	◄ 2	(B)	Tx
Rx 10	3	◄ 3	(B)	Tx
Rx 9	4	◄ 4	(B)	Tx
Tx 4	9	► 4	(A)	Rx
Tx 3	10	► 3	(A)	Rx
Tx 2	11	► 2	(A)	Rx
Tx 1	12	► 1	(A)	Rx

Fiber *position*

Figure 6. Connectivity of the MPO lanes and the LC breakouts to SFP+ or other duplex transceivers.

Another possible configuration incorporates interconnected banks of QSFP+ transceivers (MPO to MPO connectivity; see Figure 7).
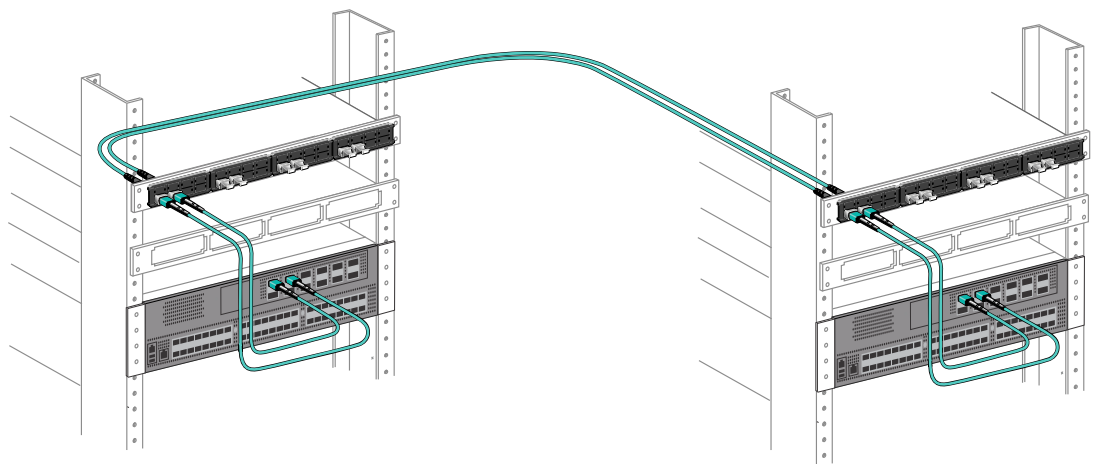

Figure 7. QSFP+ end-to-end connection through dedicated 12-fiber trunks and cords.

If a trunk extender is needed, CommScope's Method B delivers correct polarity independent of the number of connections in a deployment.

The previous example requires 12-fiber MPO cable assemblies to connect the transceivers. Viewing the transceiver with the key up, the four left-most fibers transmit light, the four fibers farthest right carry signals to the transceiver receivers, and the four fibers in the center are left unused. The same is true for transceivers using other form factors (i.e., CFP, CFP2, and CFP4).

Our 2x3 conversion modules (360DM-2x3P-LS InstaPATCH 360 2x3 conversion module) enable 100 percent fiber utilization in the trunk. Figure 8 below shows an example of how this is done in an end-to-end configuration.
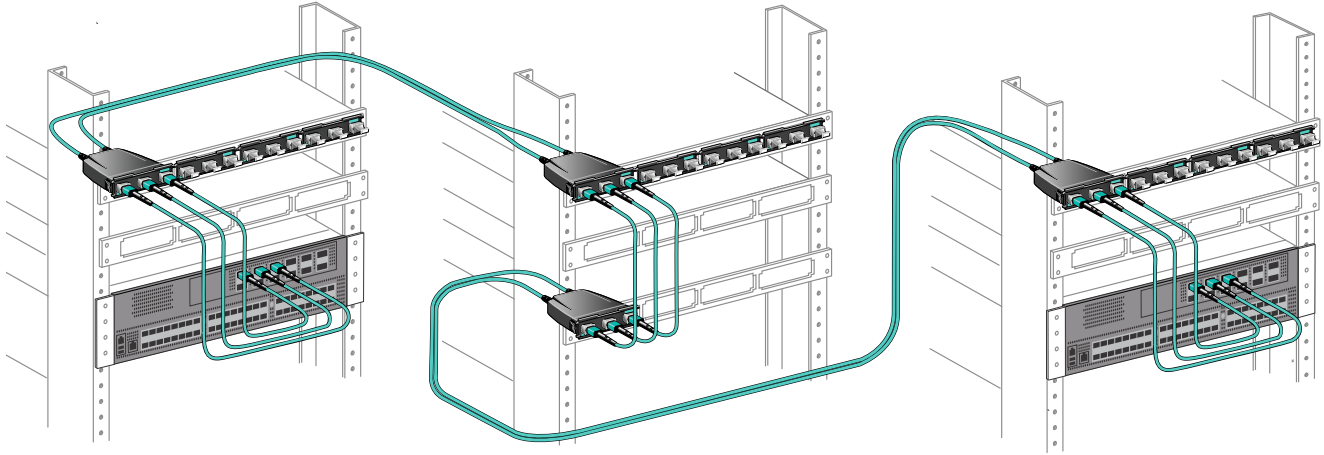
Figure 8. 2x3 conversion module implementation enables 100 percent fiber utilization in the trunk.

The 2x3 conversion modules must be used in pairs—one at each end of the link. The eight live fibers from each of the three QSFP+ transceivers are transmitted through the trunks using the full 24 fibers. The second 2x3 module unpacks these fibers to connect to the 3 QSFP+ transceivers on the other end.

Figure 9 shows the internal wiring of the 2x3 conversion module. Each four-fiber pair is grouped to combine the three active eight-fiber groups into the two 12-fiber connectors in the trunk cable.
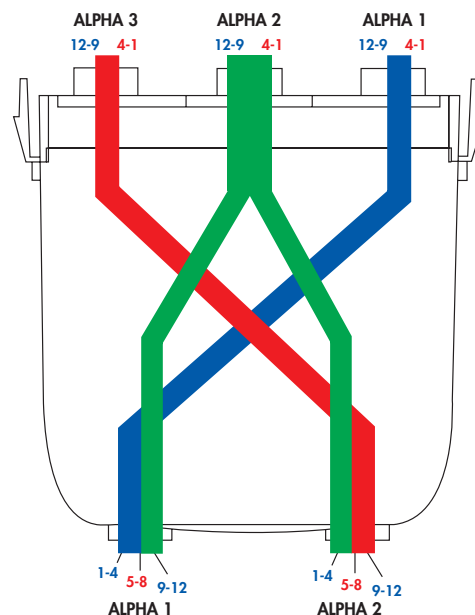

Figure 9. CommScope's 2x3 internal connectivity achieves 100% trunk fiber utilization.

There is an alternative fanout solution available that takes advantage of 100 percent fiber utilization through a fiber trunk run. For those needing a direct connection with 100 percent fiber trunk utilization, our 24-fiber 2x3 array fanout (Figure 10) delivers the same functionality as our module. Connectivity of the fanout is identical to the 2x3 module. They are interchangeable, but must be used in pairs - one (fanout or module) at each end of the link (Alpha configuration on one end and Beta on the other).

Inspect the fanout or module labels to ensure correct connectivity: Transceiver Alpha 1 on one end should be connected to transceiver Beta 1 on the other end. For further details, consult the installation guide.
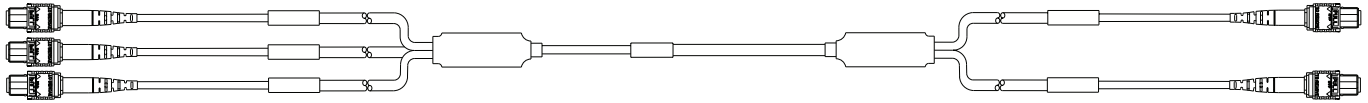
**Figure 10. The 24-fiber 2x3 array fanout delivers the same functionality as the module.**

After upgrading the path from 1G/ 10G up to 40Gb/s, the next steps in data throughput is 100Gb/s (and even 120Gb/s). There will be several options to achieve end-to-end 100G transmission in the future. In the near term, a CXP form factor—which, for Ethernet, has 10 lanes of 10Gb/s—delivers 100Gb/s connectivity.

Polarity issues are eliminated with our Method B system—up to 100 Gb/s (see Figure 11). Such a configuration uses the same trunk cable and trunk extender cables as for the lower speed applications. A 24-fiber MPO connected to two 12-fiber MPO fanouts is the necessary configuration to enable this 100GBASE-SR10 connectivity.
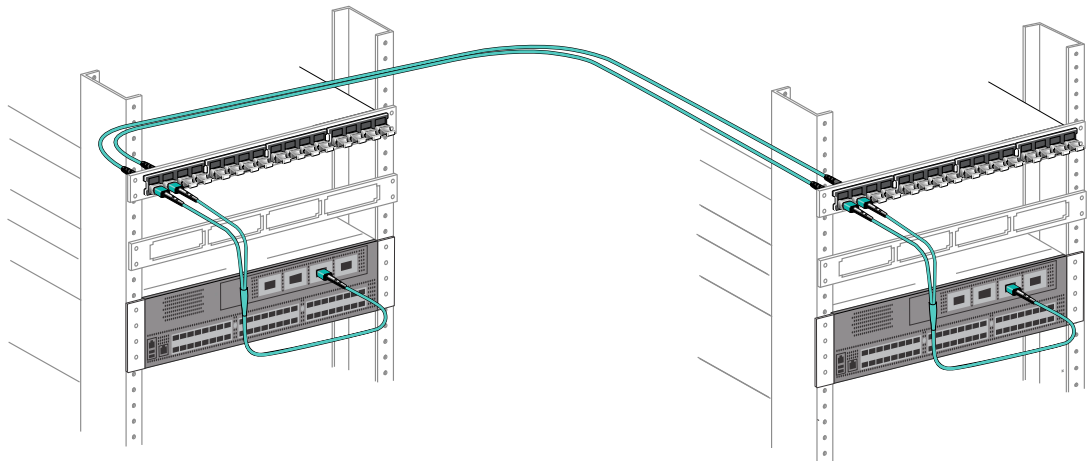
Figure 11. CommScope Method B eliminates polarity issues for implementations up to 100Gb/s.

CommScope's 24-fiber array cord, shown below in Figure 12, allows direct attach capability of CXP-equipped devices.
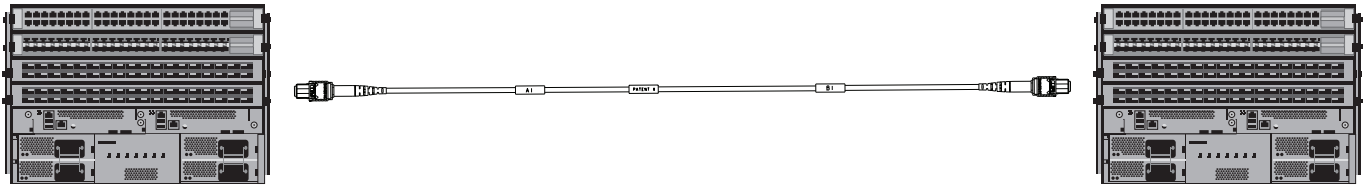
Figure 12. 24-fiber array cords allow for direct attachment of CXP-equipped devices.

A very popular implementation is to use the high density 100G/120G CXP for space-saving. This deployment can then leverage the 10G-per-lane channels to distribute the 10G data anywhere in the data center. CommScope offers several solutions that deliver this breakout functionality.

Figure 13 depicts a fanout cable that separates each TX and RX pair, allowing connectivity to any duplex path reachable by a patch panel. Simply connect this cable to a CXP transceiver and the customer can access the 12 individual transceiver pairs. This method, when used with a patch panel, offers the ultimate in flexibility—allowing connectivity to any row, rack, or shelf.
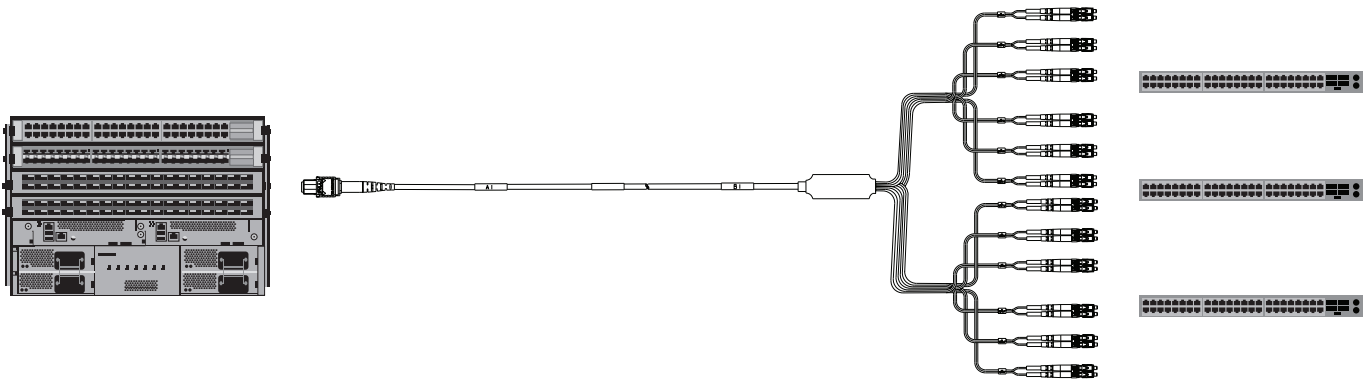
Figure 13. 24-fiber MPO to LC fanout cable allows connections to any duplex path reachable by a patch panel.

An alternative to breaking out a 120Gb/s CXP is to connect these to three separate 40Gb/s QSFP+s. Figure 14 shows a 24-fiber fanout that utilizes 24 fibers to split the 12 transceivers into three groups of eight. These eight-fiber groups match the TX/RX fibers used on a QSFP transceiver for direct connection to three separate QSFP+ transceivers. Like the 12x10G segregation mentioned above, once split, the 3x8-fiber QSFP+ channels can be distributed through patch panels and 12-fiber based trunking to any area of the data center.
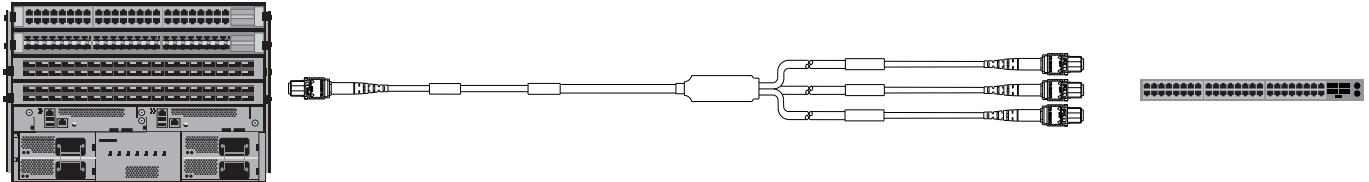
Figure 14. A 24-fiber MPO to 3 MPO QSFP fanout cable splits the 12 transceivers into three groups of eight.

This platform allows for multiple permutations. Our 2x3 conversion module could be inserted here to send traffic across the data center on a trunk that utilizes 100 percent of the fiber. The far end connection would have a 2x3 conversion module to make the connection from the trunk back to three QSFP transceivers. A single eight-fiber MPO end could be broken into individual LCs with a module or an array cable, offering a hybrid of 40G and 10G breakouts. CommScope's modular solution delivers the ultimate in network design flexibility.

Next-generation transceivers

The configuration above works for 10x10G 100GBASE-SR10 enabled by CXP transceivers on multimode fiber. IEEE will be introducing a new standard, IEEE P802.3bm™/D3.0, which defines a new 100GBASE-SR4 parallel transceiver based on 4x25Gb/s transmission, similar to 40G QSFP+. Migration to these requires connectivity identical to those for 40Gb/s using the eight-fiber MPO solutions outlined above.

Care should be taken when upgrading transceivers from 40Gb/s eSR4 to 100GBASE-SR4, as the latter are limited to 100 meters.

Not all migration paths are standards-based. Cisco offers a 40G optical transceiver that requires duplex multimode fibers. Theoretically, one could replace an SFP+ port with a QSFP+ (if available on the hardware device; this requires an identical QSFP+ port on the far end device for connectivity), which accommodates 40Gb/s data.

The Cisco transceiver has an electrical MUX that combines two channels and transmits optically on each fiber in the pair at 20Gb/s. The other 20Gb/s is realized by adding an additional wavelength. Two wavelengths at 20Gb/s = 40Gb/s. CommScope's Method B compliant solution delivers Cisco's 40G BiDi with the same guaranteed polarity, as with any other duplex fiber system.

CommScope Method B for singlemode fiber

The MPO connectors used in our Method B array polarity system are compliant to IEC 61754-7-1 for both the flat end-face variety used for multimode solutions and angled end-face variety used for singlemode solutions (see Figure 15).

Our Method B approach maintains polarity in both singlemode and multimode implementations.
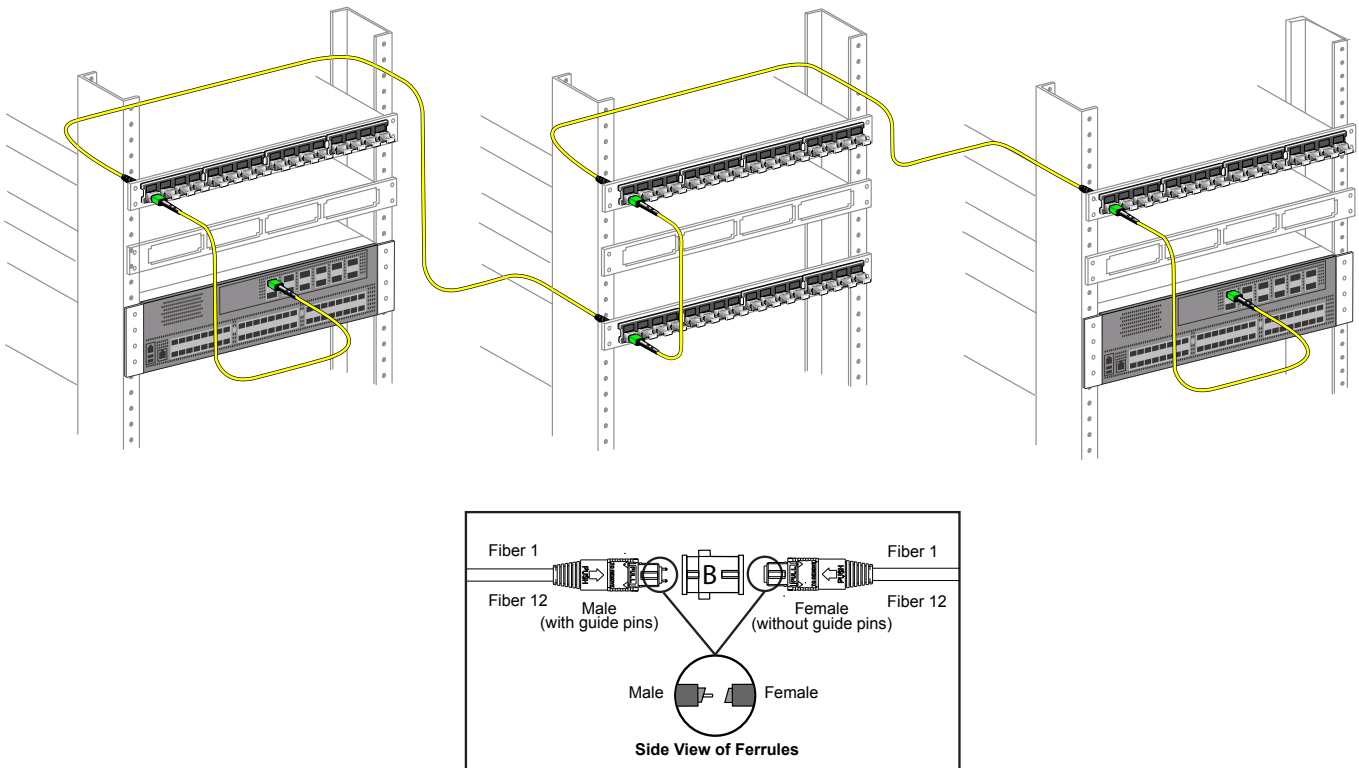
Figure 15. CommScope's IEC 61754-7-1 fully standard-compliant singlemode MPO implementation.

Fibre Channel

The Fibre Channel application is becoming an increasingly popular choice, due to its backward compatibility, low-cost approach, and ease of upgradability. The T11 standard body will be releasing the 32G Fibre Channel standard in FC-PI-6. This new variant for OM4 at 32G will be 3200-M5F-SN-I and have a reach from 0.5 m-100 m over duplex fibres. This 32GFC variant will be compatible with two generations of Fibre Channel — 16GFC and 8GFC.

Traditionally, the form factor for Fibre Channel transceivers has been duplex-LC SFPs. The next higher offering from Fibre Channel (128G) will deviate from this: FC-PI-6P, 128GFC will be realized through a parallel implementation similar to 100GBASE-SR4 and offer a reach of 100 meters on OM4. QSFP28 will be the leading candidate for the form factor of this transceiver. This 128GFC transceiver will be a natural fit in a breakout capacity, with the 128G transceiver capable of breaking out to four 32GFC transceivers.

Whatever your application, reach and reconfigurability requirements, our Method B solution offers support for your implementation.

Summary of migration solutions

APPLICATIONS	COMMSCOPE SOLUTIONS	PRODUCT NUMBER
100G MPO link via direct	24f MPO jumper	FQX2P2PHF-MAFXXX
100G MPO link via structured cabling	24f MPO to (2) 12f MPO arrays	FQX2PCXHF-MAFXXX
	12f MPO adapter panel	360DP-8MPO
	Trunks with 12f MPO	FGXMPMPAF-MBFXXX
40G MPO link via direct	12f MPO jumper	FQXMPMPGD-MAFXXX
40G MPO link via structured cabling	12f MPO array cord	FQXMPMXGD-MAFXXX
	12f MPO adapter panel	360DP-8MPO
	Trunks with 12f MPO	FGXMPMPAF-MBFXXX
40G MPO link via structured cabling with 100% trunk utilization	12f MPO array cord	FQXMPMXGD-MAFXXX
	2x3 conversion module	360DM-2x3P-LS
	Trunks with 12f MPO	FGXMPMPAF-MBFXXX
120G-40G MPO via direct	24f MPO to (3) QSFP MPO arrays	FQX2PQPHF-MAFXXX
120G-40G MPO via structured cabling	24f MPO to (3) QSFP MPO arrays	FQX2PQPHF-MAFXXX
	Trunks with 12f MPOs	FGXMPMPAF-MBFXXX
	2x3 conversion module	360DM-2x3P-LS
	12f MPO-MPO array cord	FQXMPMPGD-MAFXXX
100G-10G LC via direct	24f MPO to 24f LC arrays	FQX2PLCHF-MAFXXX
100G-10G LC via structured cabling	24f MPO to 24f LC array	FQX2PLCHF-MAFXXX
	12f MPO to LC module	360DM-24LC-LS
	Trunks with 12f MPOs	FGXMPMPAF-MBFXXX
	Duplex LC jumpers	FEXLCLC42-MXFXXX
40G-10G LC via direct	12f MPO to 8f LC array	FQXQPLCG8-MAFXXX
40G-10G LC via structured cabling	12f MPO to 8f LC array	FQXQPLCG8-MAFXXX
	12f MPO to LC module	360DM-24LC-LS
	Trunks with 12f MPOs	FGXMPMPAF-MBFXXX
	Duplex LC jumpers	FEXLCLC42-MXFXXX

We're proud to be a part of your network's story.

Here at CommScope, we embrace our role as a trusted resource, partner, and facilitator. We create the infrastructure that connects the world and evolves with every advance in technology. By investing all of our capabilities, resources, relationships, and products into your toughest challenges, we continue our long history of solving problems together—paving the way for new ideas and fresh ways of thinking.

We're a trusted resource and partner around the world because we're invested in you: your people, your networks, your success. It inspires us to build relationships and infrastructure…connect people and technologies across protocols, oceans, and time zones…and share what we learn along the way.

This is our promise to you.
This is CommScope.

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