Simplify Fiber Optic Cabling Migrations with a Multi-Path™ System

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Over the past decade, speeds have increased dramatically from megabits per second (Mbit/s) to gigabits per second (Gbit/s) in the data center space. This has created challenges for data center managers designing fiber cabling topologies to handle these higher speeds.

One challenge in particular has been polarity, also known as light path. Polarity is the position of the fiber strands in the channel to ensure transmitted data is properly received.

The Telecommunications Industry Association (TIA) has approved three MPO polarity methods as standards in the document named ANSI/TIA-568.3-D. These three MPO polarity methods are titled Method A, Method B and Method C. The methods show light path (transmit to receive) using two fibers as duplex and twelve fibers as parallel connections.

They show MPO connectors as male (pinned) or female (non-pinned), and with "Key Up" or "Key Down" orientation when mating in an MPO coupler. To better explore the three MPO polarity methods, understanding the components in each link is essential.

Duplex Link

A duplex link has a duplex patch cord (LC to LC) on each end of the link. The duplex patch cord plugs into an MPO/LC cassette module on each end of the link.

Between the cassette modules is the MPO to MPO trunk. The MPO connector has a key to ensure fiber position when mating. The MPO coupler that mates the connectors can be Key Up to Key Down, Key Down to Key Down or Key Up to Key Up. Figure 1 shows an example of a duplex link.

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Figure 1

Parallel Link

A parallel link has a parallel patch cord (12-fiber MPO to MPO) on each end of the link. The parallel patch cord plugs into an MPO coupler panel on each end of the link then into the optic.

Between the MPO coupler panel is the MPO fiber trunk. The MPO coupler that mates the connectors can be Key Up to Key Down or Key Up to Key Up. Figure 2 shows an example of a parallel link.

Figure 2

Mixing and matching these separate components can create confusion and nonfunctioning connections for end users.

In both duplex and parallel links, there are polarity options for the LC to LC patch cords, the MPO to MPO patch cords, and the MPO couplers due to key orientation being up or down in the cassette module and the MPO trunks. Therefore, mixing and matching these separate components can create confusion and nonfunctioning connections for end users. Understanding the basic differences in each of the three MPO polarity methods can help determine which method to deploy.

Method A

Method A was the first to gain acceptance in the data center cabling marketplace. It is easy to install Method A because all the fibers are run as straight polarity. The MPO couplers are Key Up to Key Down for both duplex and parallel connections.

The cross (transmit to receive) for duplex occurs with an A-to-B patch cord on one side of the link. The other side of the link uses an A-to-A patch cord as straight polarity. The same idea occurs with the 12-fiber MPO to MPO patch cord. The flip (fiber 1 to fiber 12) corrects the light path for transmit to receive. One side of the link has a flipped MPO patch cord while the other side has a straight MPO patch cord.

Method A requires the end user to manage two separate duplex jumpers as A-to-B and A-to-A. For parallel links the end user needs to manage 12-fiber MPO patch cords as straight and flipped. Many polarity issues in the data center arise from these patch cord options. Method A requires the need to stock four different polarity patch cords and understand on which side of the link they are used.

Method B

Method B gained popularity when the data center space began supporting optics that use 12- or 24-fiber MPO connectors. These optics run 40GE or 100GE speeds.

The philosophy behind Method B is that the end user can easily transition from duplex connections (ST, SC or LC) to parallel connections (12- or 24-fiber MPO). The data center operator can unplug a cassette module from the backbone or horizontal MPO trunk and insert an MPO coupler panel. This would switch the patch cord from duplex to parallel.

However, the challenge with Method B is that three different MPO couplers can be used in the duplex and parallel link types. These are Key Up to Key Down, Key Down to Key Down and Key Up to Key Up. Another difficulty with this mix of MPO coupler types occurs when the end user wants to install singlemode angled MPOs into the cabling plant. This scenario requires specific, proprietary product.

With Method B, there are two different cassette module types in a link. This creates the need to stock two different cassette module part numbers, which can be another challenge. But the duplex or parallel patch cords are the same for each side of the link – an improvement over Method A.

The ability to connect newer 12- and 24-fiber MPO optics is a benefit as well. As the speeds in the data center move from 40GE to 400GE, these parallel optics will become more common in the data center space.

"Each method has its own unique set of advantages and challenges. But one solution for both duplex and parallel transceiver types simply does not exist in the current set of standards."

Method C

Method C is a modification of Method A aimed at duplex connections. This method works well with storage applications running 8GFC, 16GFC, and 32GFC Fibre Channel that utilize duplex SC and LC connectors. It also works well with duplex connectivity for Ethernet that can support speeds up to 40GE for use with bi-directional optics.

A benefit of this method is that it allows the use of standard A-to-B patch cords on both ends of the link. All the MPO couplers are Key Up to Key Down. The cross of transmit to receive takes place in the MPO trunk. Both side cassette modules in the link are the same as straight polarity. The downside of this method is that converting from duplex to parallel links requires costly conversion modules in place of the cassette modules.

Figure 3 summarizes the different components needed for the three different MPO polarity methods.

Figure 3

	A-to-A Duplex Jumper	A-to-B Duplex Jumper	MPO Jumper Straight	MPO Jumper Flipped	MPO Jumper Crossed	Cassette Same on Both Ends	Cassette Two Types	MPO Trunk Straight	MPO Trunk Flipped	MPO Trunk Crossed
Method A	✓	✓	✓	✓		✓		✓		
Method B		✓		✓			✓		✓	
Method C		✓		✓	✓	✓				✓

The goal of a multi-path system is to simplify the cabling migration process and reduce the need for multiple transition components.

Limitations of Methods A, B and C

All three standard methods can support duplex links effectively, however each method has several limitations.

Method A utilizes straight-through modules and trunks, but it requires two different types of patch cords. If two of the same polarity patch cords are used, the link will not work properly.

Method B requires two different MPO coupler combinations which can prove cumbersome in some instances. These two coupler combinations result in two different cassette modules on each end of the link. Also, using angled singlemode MPO connectors can be challenging to ensure proper alignment mating of the angled MPO ferrule.

While Methods A and B can support parallel links, Method C typically uses a conversion module which can add significant cost to the link. Conversion modules are not a standards-based product.

In addition, none of the methods properly address the next generation of optics that will run 200GE and 400GE. Those speeds will be run on parallel optics as 24 fibers on multimode glass at 100 meters, and as 12 fibers on singlemode glass at 500 meters.

Each method has its own unique set of advantages and challenges. But one solution for both duplex and parallel transceiver types simply does not exist in the current set of standards.

Figure 4

	Method A	Method B	Method C
Requires Two Different Jumpers	✓		
Requires Two Different Modules		✓	
Conversion Modules			✓
Requires Proprietary Singlemode Connectors		✓	
Requires male-to-female MPO jumpers	✓	✓	✓

Multi-Path™ Solution

This dilemma has led cabling solution providers like CABLExpress to seek new ways to deliver a simple, effective system that can effectively handle multiple paths with very little disruption or added cost. The goal of a multi-path™ system is to simplify the cabling migration process and reduce the need for multiple transition components.

The first advantage of a multi-path solution is that it uses only standard A-to-B duplex jumpers. Also, the 12-fiber flipped MPO/female to MPO/female parallel jumpers plug into optic connections and work properly, running transmit to receive. The end user only needs to stock one type of jumper for each kind of optic. This simplifies the cabling process and eliminates the confusion that arises from gender and polarity types.

The MPO couplers in a multi-path system are all the same: Key Up to Key Down. The back of the cassette modules feature MPO/female ports. This makes the migration from duplex to parallel links seamless, because of the identical Key Up to Key Down couplers with female gender. Data center managers can simply remove the cassette module and install an MPO coupler panel without requiring a non-standard (male to female) MPO jumper.

The MPO trunk in a multi-path system is built as flipped light path similar to Method B but always as MPO/male to MPO/male. This allows the use of 12-fiber flipped MPO/female to MPO/female parallel jumpers on the ends. Having a flipped light path backbone or horizontal trunk will work for the next generation of optics running 200GE and 400GE. Figure 5 summarizes the different components needed for the three different MPO polarity Methods A, B and C and adds multi-path.

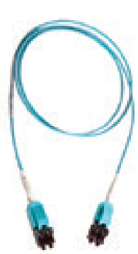
"Having a flipped light path backbone or horizontal trunk will work for the next generation of optics running 200GE and 400GE."

Figure 5

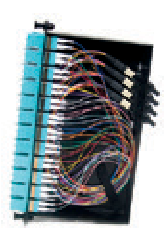
	A-to-A Duplex Jumper	A-to-B Duplex Jumper	MPO Jumper Straight	MPO Jumper Flipped	MPO Jumper Crossed	Cassette Same on Both Ends	Cassette Two Types	MPO Trunk Straight	MPO Trunk Flipped	MPO Trunk Crossed
Method A	✓	✓	✓	✓		✓		✓		
Method B		✓		✓			✓		✓	
Method C		✓		✓	✓	✓				✓
Multi-path		✓		✓		✓			✓	

Figure 6 shows how a multi-path solution uses the same A-to-B duplex jumper on each end. It also uses the same MPO/female cassette module at each end. The MPO trunk in this instance will be MPO/male to MPO/male.

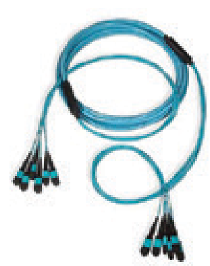
Figure 6



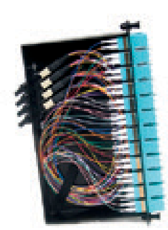
Core/Spine Switch A to B LC Jumper



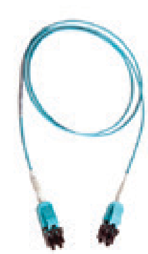
MPO/Female to LC Cassette



MPO/Male to MPO Male Trunk Type: Flipped



MPO/Female to LC Cassette



Core/Spine Switch A to B LC Jumper

Figure 7 shows how a multi-path system uses the same 12-fiber flipped MPO/female to MPO/female jumpers on each end. It uses the same industry-standard Key Up to Key Down MPO couplers on each end. The MPO trunk in this instance will also be MPO/male to MPO/male.

Figure 7

Core/Spine Switch MPO/Female to MPO/Female Jumper Type: Flipped

MPO Coupler Panel

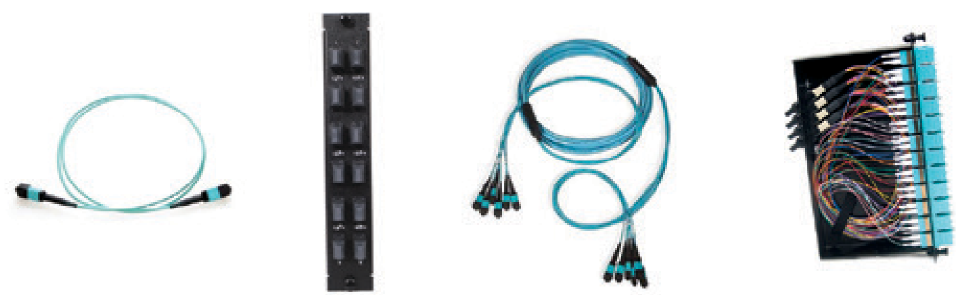
MPO/Male to MPO Male Trunk Type: Flipped

MPO Coupler Panel

Server/Leaf Switch MPO/Female to MPO/Female Jumper Type: Flipped

To have links capable of breaking out optical signals such as 40GE to (4x) 10GE, 100GE to (4x) 25GE , and 128GFCp to (4x) 32GFC, one end of the link would use a cassette module or MPO/female to LC harness. Figure 8 shows a breakout with a cassette module.

Figure 8



Core/Spine Switch MPO/Female to MPO/Female Jumper Type: Flipped

MPO Coupler Panel

MPO/Male to MPO Male Trunk Type: Flipped

Server/Leaf Switch MPO/Female to LC Cassette

Figure 9 shows a breakout with an MPO/female to LC harness. This is an additional option for migration between parallel and duplex connections.

Figure 9

Core/Spine Switch MPO/Female to MPO/Female Jumper Type: Flipped | MPO Coupler Panel | MPO/Male to MPO Male Trunk Type: Flipped | MPO Coupler Panel | Server/Leaf Switch MPO/Female to LC Harness

"Multi-path features several of the advantages of Methods A, B and C."

The Advantages of Multi-Path

Multi-path features several of the advantages of Methods A, B and C. It uses flipped trunks to best serve parallel optic connections. Most large cabling vendors in the data center market recommend flipped polarity backbone or horizontal trunking. It uses the same duplex and parallel jumpers on both ends of the link, and the cassette modules are also the same on both ends of the link.

In addition, it removes several of the disadvantages of the other three methods. It eliminates the need for two different jumper types for duplex and parallel connections. It also eliminates the MPO coupler positions of Key Down to Key Down and Key Up to Key Up, and it eliminates the need for expensive conversion modules.

Next-generation optics will run 200GE and 400GE on 24-fiber MPOs on multimode glass. A multi-path system can easily support these connections (as shown in Figure 7). It simply uses a 24-fiber MPO/female into the optic and breaks out into two 12-fiber MPO/female harnesses into the MPO trunk.

Recently there has been more movement to singlemode structured cabling designs. Most large equipment vendors now offer a 100GE 12-fiber singlemode optic that will go up to 500 meters. This optic would work exactly as shown in Figure 7.

The price of singlemode optics has dropped considerably in the past few years which has resulted in more widespread usage. These efficiencies of higher transport speeds and lower optic costs have been driven in part by large cloud computing companies and their usage of these products.

CABLExpress believes that as data centers move toward 400GE and beyond they will deploy more singlemode fiber structured cabling systems. This makes simplicity in your migration between parallel and duplex connections that much more important. A multi-path system greatly contributes to this simplicity.

Port Replication™

Port replication™ is a great way to increase efficiency and reduce errors in your data center cabling infrastructure. In short, port replication is the act of mirroring the ports of active fiber optic hardware in a passive component (fiber patch panel). This creates a direct, one-to-one relationship between the active hardware ports and the passive structured cabling environment.

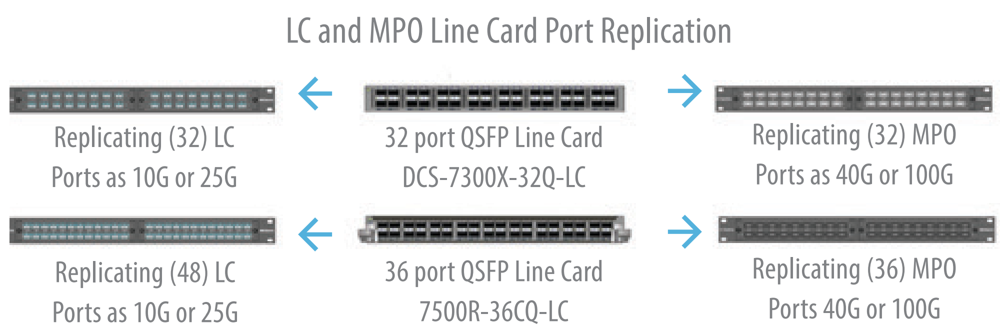
Using port replication in a multi-path system allows for easy user interface as well as simpler migration. Port replication allows switches to be cabled once and then replicated in a Main Distribution Area (MDA), Zone Distribution Area (ZDA), Middle of Row (MoR) cabinet, End of Row (EoR) cabinet or an individual cabinet. This simplifies the cabling process because all of the port numbers on the switches directly correspond to the port numbers on the patch panel.

When replicating LC ports with MPO to LC cassette modules, options come in increments of 8 and 12. This means we have cassettes that have 6, 8, 12, 16, 18, 24, 32, 48 and 64 ports. These nine different options help to replicate all types of vendor switch line cards and blades. This can be accomplished in large, complete switch replication enclosures or smaller 1U solutions.

When replicating MPO ports with MPO coupler panels, options come in 6-, 8-, 12-, 16- and 18-port panels. As an example, a 32-port QSFP line card is replicated in a 1U enclosure with two 16-port MPO coupler panels. One panel is numbered from #1 to #16 and the second panel #17 to #32. The MPO ports on the coupler panel directly mirror the 32-port QSFP line card. See two Arista line cards replicated in Figure 10.

"Using port replication in a multi-path system allows for easy user interface as well as simpler migration"

Figure 10



Conclusion

As the optics in the data center market increase in speed and diversity, the multi-path solution will provide logical components to connect the links. The need to migrate between duplex and parallel transmission while maintaining a well-managed structured cabling infrastructure is critical.

Combining a multi-path structured cabling system with port replication hardware provides a simple migration path from 10Mb to 400GE and beyond. It supports both current and next-generation optics.

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