White Paper

Migrate to a 40-Gbps Data Center with Cisco QSFP BiDi Technology

What You Will Learn

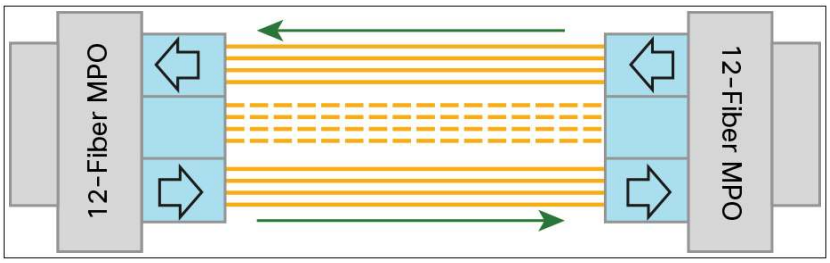
As a result of data center consolidation, server virtualization, and new applications that require higher data transport rates, the data center network is shifting to 10 Gbps at the access layer and 40 Gbps at the aggregation layer. High-performance and high-density 10- and 40-Gbps network devices, such as Cisco Nexus® 9500 and 9300 platform switches, are now available at attractive prices for this transition. However, to support 40-Gbps connectivity, data center architects are challenged by the need for a major upgrade of the cabling infrastructure, which can be too expensive or disruptive to allow data centers to quickly adopt and migrate to the 40-Gbps technology. Cisco solves this problem with innovative 40-Gbps Quad Small Form-Factor Pluggable (QSFP) bidirectional (BiDi) technology that allows zero-cost fiber migration by reusing the current 10-Gbps cabling for 40-Gbps device connectivity.

This document introduces the 40-Gbps Cisco QSFP BiDi transceiver and demonstrates the cost saving it provides customers for migration to 40 Gbps.

Challenges with Existing 40-Gbps Transceivers

Existing short-reach (SR) transceivers for 40-Gbps connectivity in a QSFP form factor, such as QSFP SR4 and QSFP CSR4, use independent transmitter and receiver sections, each with 4 parallel fiber strands. For a duplex 40-Gbps connection, 8 fiber strands are required. Both QSFP SR4 and QSFP CRS4 use MPO 12-fiber (MPO-12F) connectors. As a result, 4 fiber strands in each connection are wasted. Figure 1 shows the existing short-reach 40-Gbps QSFP solutions.

Figure 1. Concept of Existing 40-Gbps Transceivers



With existing QSFP transceivers, each direct connection between two devices requires an MPO-to-MPO 12-fiber cable. In the case of structured cabling with patch panels and fiber trunks, a 40-Gbps connection needs MPO-to-MPO fibers between devices and patch panels and 4 duplex multimode fibers (MMF) in the fiber trunk.

In most of today's data center networks, the aggregation fiber infrastructure is built for 10-Gbps connectivity that either supports direct connections between devices over LC-to-LC MMF or uses LC-to-LC fibers to attach devices to patch panels and provides one duplex MMF fiber in the fiber trunk for each 10-Gbps connection.

40-Gbps connectivity using traditional 40-Gbps transceivers cannot reuse directly connecting LC-to-LC fibers. It also requires four to six times greater fiber density in the fiber trunks to meet the requirements of a 40-Gbps connection. These characteristics make it expensive for customers to migrate from 10-Gbps connectivity to 40-Gbps connectivity in their existing data centers.

Solution with Cisco 40-Gbps QSFP BiDi

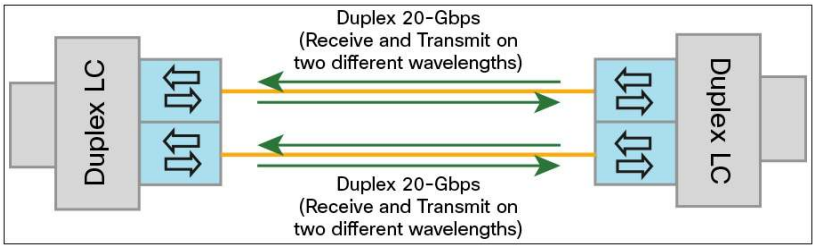
The Cisco QSFP BiDi transceiver addresses the challenges of fiber infrastructure by providing the capability to transmit full-duplex 40-Gbps traffic over one duplex MMF cable with LC connectors. In another words, the Cisco QSFP BiDi transceiver allows 40-connectivity to reuse the existing directly connecting 10-Gbps fibers and the existing fiber trunk without the need to add any fibers.

The Cisco QSFP BiDi transceiver (QSFP-40G-SR-BD) is a short-reach optical transceiver that delivers 40 Gbps over a duplex OM3 or OM4 MMF. It is MSA compliant. Figure 2 shows a Cisco QSFP BiDi transceiver.

Figure 2. Cisco QSFP BiDi Transceiver (QSFP-40G-SR-BD)

The Cisco QSFP BiDi transceiver has two 20-Gbps channels, each transmitted and received simultaneously on two wavelengths over a single MMF strand. The result is an aggregated duplex 40-Gbps link over a duplex fiber of two MMF strands. Cisco QSFP BiDi uses duplex LC connectors. The connection can reach 100 meters on OM3 MMF or 125 meters on OM4 MMF. The Cisco part number for the Cisco QSFP BiDi transceiver is QSFP-40G-SR-BD. Figure 3 shows the technology concept of the Cisco QSFP BiDi transceiver. Cisco products that support 40 Gigabit Ethernet interfaces such as Cisco Nexus® 9000 Series Switches support the QSFP BiDi transceiver. For a complete list of supporting products, refer to the Cisco 40 Gigabit Optical Transceiver product page at http://www.cisco.com/en/US/products/ps11708/index.html.

Figure 3. Concept of QSFP BiDi Transceiver



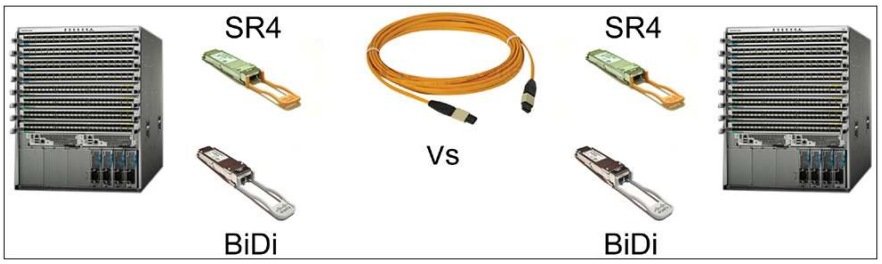
Savings with Cisco QSFP BiDi When Migrating from 10 Gbps to 40 Gbps

This section presents several case studies to demonstrate the savings achieved by using Cisco QSFP BiDi for 40-Gbps connectivity in data center networks. The case studies show how Cisco QSFP BiDi technology can remove the cost barriers for migrating and expanding the existing 10-Gbps cabling footprint to 40-Gbps infrastructure to provide the higher data rate in the data center network.

Case Study 1: 288 x 40-Gbps Connections with Unstructured Cabling

In an unstructured cabling system, devices are connected directly with fiber cables. This direct-attachment design can be used to connect devices within short distances in a data center network. As shown in Figure 4, direct connection between two 40-Gbps devices can be provided by MMF cables with either QSFP SR4 or QSFP BiDi transceivers at two ends.

Figure 4. Direct 40-Gbps Connections



The QSFP SR4 transceiver uses MPO-12F connectors, whereas Cisco QSFP BiDi uses LC connectors. Existing 10-Gbps connections commonly are MMF cables with LC connectors. Therefore, with QSFP SR4 transceivers, none of the existing 10-Gbps MMF cables can be reused because the connector types are different. Cisco QSFP BiDi allows cable reuse, resulting in zero-cost cabling migration from direct 10-Gbps connections to direct 40-Gbps connections.

Table 1 summarizes the costs and savings of migration for 288 existing direct connections. To migrate the existing 288 10-Gbps connections to 40-Gbps connections, Cisco QSFP BiDi does not require any new spending on cables. In comparison to QSFP SR4 transceivers, Cisco QSFP BiDi reduces costs by 100 percent and provides savings of up to US$290 per 40-Gbps port.

Table 1. 10-Gbps to 40-Gbps Direct-Cabling Migration of Existing Connections

Fiber Cable Cost*	30m	60m	100m
QSFP SR4 (288 x 12-fiber connectors) (US$)	$32,058	$53,562	$83,412
Cisco QSFP BiDi (288 x 2-fiber connectors) (US$)	$0	$0	$0
Savings (US$)	$32,058	$53,562	$83,412
Savings per 40-Gbps port (US$)	$111	$186	$290
Percentage cost reduction (US$)	100%	100%	100%

* This example is based on real-world cable cost estimates. The transceiver cost is not included.

For the case in which 288 new direct 40-Gbps connections are needed in addition to the existing cabling infrastructure for a data center migration or expansion, Table 2 summarizes the costs and savings of 288 new connections using Cisco QSFP BiDi instead of QSFP SR4 transceivers. Cisco QSFP BiDi reduces costs by up to 77 percent and provides savings of up to US$221 per 40-Gbps port.

Table 2. New 40-Gbps Direct-Cabling Deployment

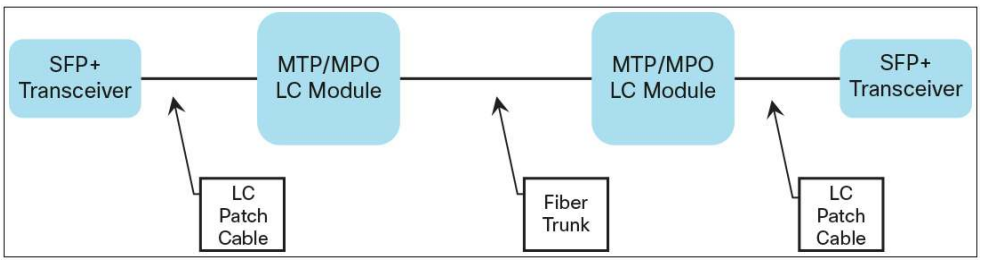
Fiber Cable Cost*	30m	60m	100m
QSFP SR4 (288 x 12-fiber connectors) (US$)	$32,058	$53,562	$83,412
Cisco QSFP BiDi (288 x 2-fiber connectors) (US$)	$7,884	$12,966	$19,647
Savings (US$)	$24,174	$40,599	$63,765
Savings per 40-Gbps port (US$)	$84	$141	$221
Percentage cost reduction	75%	76%	77%

* This example is based on real-world cost estimates.

Case Study 2: 384 x 40-Gbps Connections with Structured Cabling

A structured cabling system is commonly deployed in data center networks to provide flexible and scalable cabling infrastructure. Structured cabling uses short patch cords to attach devices to a patch panel and then runs fiber trunks either to consolidate the cables in a central location for additional connectivity or to direct them to another patch panel to which the remote devices are attached. Figure 5 shows a simple example of a 10-Gbps structured cabling design.

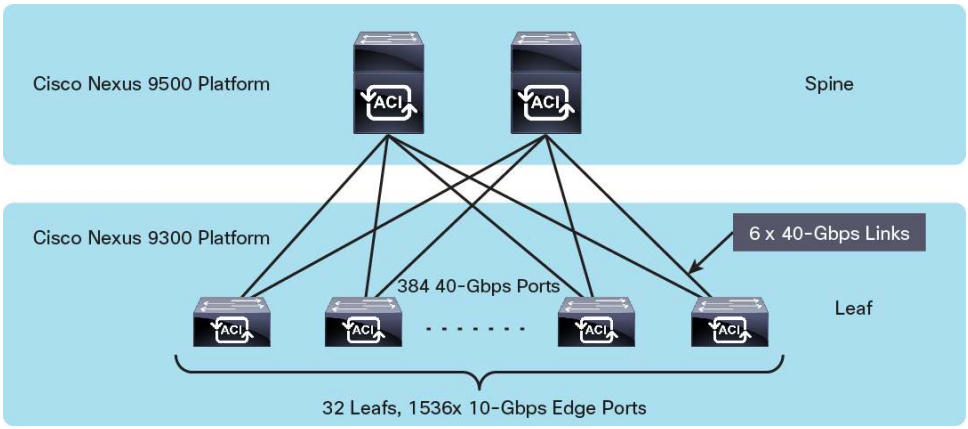
Figure 5. Simple Example of 10-Gbps Structured Cabling



For migration of a data center with a structured 10-Gbps cabling system, Cisco QSFP BiDi technology allows the existing cabling system - including the patch cables, patch panels with MTP/MPO LC modules, and fiber trunks - to be repurposed for 40-Gbps connectivity. In contrast, QSFP SR4 transceivers require new patch cables and patch panels because the connector types differ and the size of the fiber trunk needs to be quadrupled.

This case study examines a simple non-blocking two-tier fabric design (Figure 6) that provides 1536 10-Gbps edge ports on its leaf layer. Its spine layer is composed of two Cisco Nexus 9508 Switches, and its leaf layer consists of 32 Cisco Nexus 9396PX Switches, each with six 40-Gbps links to every spine Cisco Nexus 9508. There are 384 40-Gbps links total between the leaf and spine layers.

Figure 6. Two-Tier Network Example



If 384 x 10-Gbps connections are to be reused to construct this network, no additional spending on cabling will be needed if Cisco QSFP BiDi transceivers are used for all the 40-Gbps links. This scenario thus offers a 100 percent cost savings compared to the cost of reconstructing the cabling system using QSFP SR4 transceivers, including the cost of new patch cables, new patch panels, and expansion of the current fiber trunk.

If the cabling for this network is an expansion to the existing cabling system, the 384 40-Gbps connections can be built by using MMF cables and QSFP SR4 transceivers or QSFP BiDi transceivers. Figures 7 and 8 respectively show a design example for each option. Tables 3 and 4 provide real-world cost estimates for these two designs. The cost per 40-Gbps connection is calculated first, and then the cost of 384 x 40-Gbps connections is extrapolated. As the tables show, the design with Cisco QSFP BiDi offers approximately 76 percent savings over that with QSFP SR4 transceivers, which is equivalent to a savings of US$1717 per 40-Gbps connection.

Figure 7. Structured 40-Gbps Cabling with QSFP SR4 Transceivers

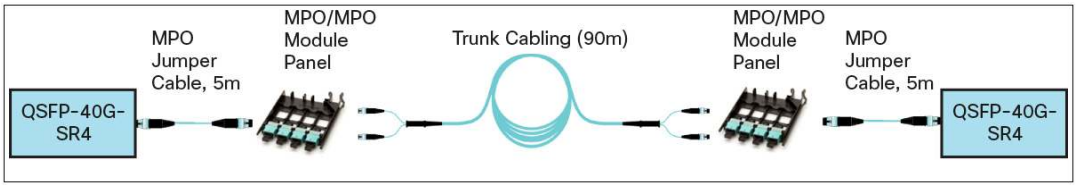


Table 3. Structured 40-Gbps Cable Infrastructure Cost With QSFP SR4 Transceivers

Structured 40-Gbps Cable Infrastructure Using QSFP SR4 Transceivers			
	Unit Price (Manufacturer's List Price US$)	**Quantity**	**Extended Price (Manufacturer's List Price (US$)**
12-fiber MPO-MPO trunk cabling (90m) (only 8 fibers needed for QSFP SR4)	$1844	0.67	$1229
12-fiber MPO-MPO trunk module	$525	0.67	$350
12-fiber MPO jumper	$340	2.00	$680
Prorated fiber pricing per 40-Gbps 100m link			$2259
Extrapolated fiber pricing for 384 x 40-Gbps 100m links			$867,500

Figure 8. Structured 40-Gbps Cabling with QSFP BiDi Transceivers

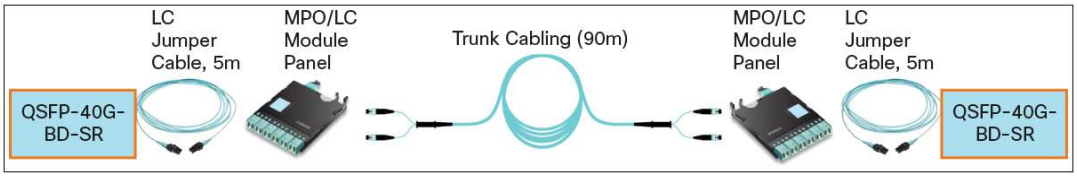


Table 4. Structured 40-Gbps Cable Infrastructure Cost with QSFP BiDi Transceivers

Structured 40-Gbps Cable Infrastructure Using QSFP BiDi Transceivers			
	Unit Price (Manufacturer's List Price US$)	**Quantity**	**Extended Price (Manufacturer's List Price US$)**
12-fiber MPO-MPO trunk cabling (90m) (only 2 fibers needed for QSFP BiDi)	$1844	0.17	$307
12-fiber MPO-LC trunk module	$525	0.17	$88
12-fiber LC jumper	$75	2.00	$150
Prorated fiber pricing per 40 Gigabit Ethernet 100m link			$545
Extrapolated fiber pricing per 40 Gigabit Ethernet 100m link			$209,300

Conclusion

Cisco QSFP BiDi technology removes 40-Gbps cabling cost barriers for migration from 10-Gbps to 40-Gbps connectivity in data center networks. Cisco QSFP BiDi transceivers provide 40-Gbps connectivity with immense saving and simplicity compared to other 40-Gbps QSFP transceivers. The Cisco QSFP BiDi transceiver allows organizations to migrate the existing 10-Gbps cabling infrastructure to 40 Gbps at zero cost and to expand the infrastructure with low capital investment. Together with Cisco Nexus 9000 Series Switches, which introduce attractive pricing for networking devices, Cisco QSFP BiDi technology provides a cost-effective solution for migration from 10-Gbps to 40-Gbps infrastructure.

For More Information

For more information on Cisco 40-Gbps BiDi Transceiver, visit http://www.cisco.com/en/US/products/ps11708/index.html.

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