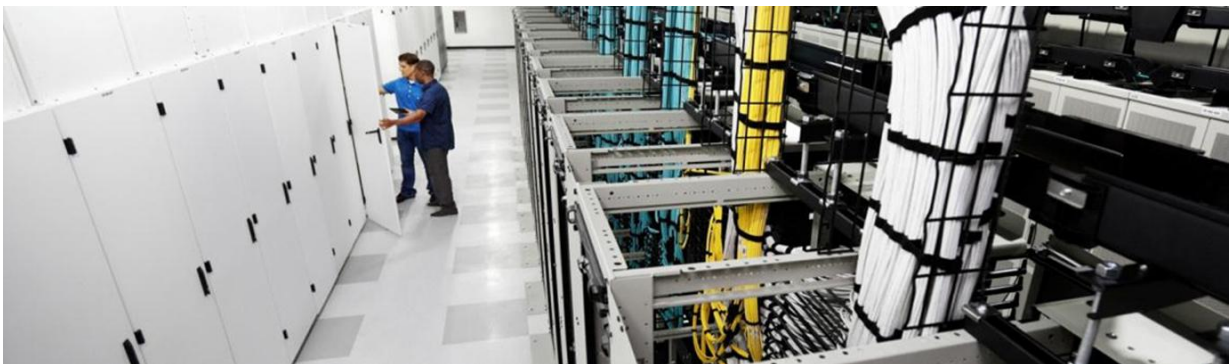


Simplified 40-Gbps Cabling Deployment Solutions with Cisco Nexus 9000 Series Switches

Panduit and Cisco Accelerate Implementation of
Next-Generation Data Center Network Architecture



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What You Will Learn

With the ever expanding bandwidth needs that virtualization and cloud technologies have applied to the data center network, staying ahead of the curve is extremely important to maintain a competitive advantage. This document introduces products from Cisco and Panduit that address the associated needs. This document also maps the logical designs to the physical layout and displays these products deployed within the data center network. The first section of this document introduces the Cisco Nexus® 9000 Series Switches and typical deployment scenarios and use cases. The second section describes the cabling scenarios and the optics needed for the interworking of the products from both companies. The last portion of the document summarizes some Panduit product offerings and next steps.

Introduction

Data centers are undertaking some profound changes due to the ongoing data center consolidation, virtualization and cloud technology, and increasing demand on application workload extensivity and agility. All these driving forces are changing every facet of data center, flattening its topology from the traditional core-aggregation-access 3-tier design to the spine-leaf 2-tier architecture, boosting its bandwidth capacity from 1GE at access and 10GE at aggregation to 10GE at leaf and 40GE at spine, and morphing its operational model from per-box CLI manual approach to system-level automated process through Restful API. While performance, bandwidth and latency are remaining as most important elements in datacenter networks, management and operational agility and simplicity have elevated themselves to the top of mind of datacenter architects and operator.

Cisco Nexus 9500 and 9300 series switches are the next generation products aiming to take datacenter networks through all these transitions and even beyond. With their unprecedented performance and port density, they are well suited in both the traditional 3-tier design and the spine-leaf design providing forwarding capacity for fast increasing server-to-server traffic. They're also equipped with unmatched programmability and automation functionalities to transform datacenter network management model.

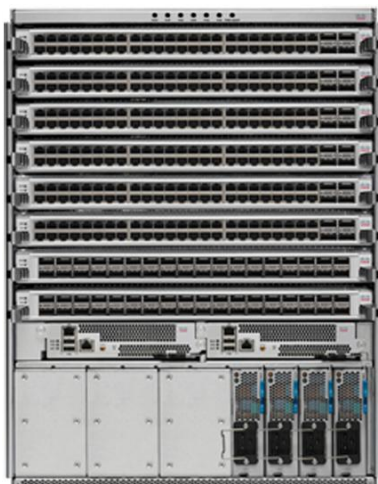
Cisco Nexus 9000 Series Switches

The Cisco Nexus® 9000 Series Switches are the foundation of the Cisco next generation datacenter solution. Designed to meet the requirements of mission-critical data centers, these switches deliver exceptional availability, outstanding scalability, and the enhanced Cisco NX-OS Software data center switching feature set.

The Cisco Nexus 9000 Switches are the latest extension to the Cisco Nexus Family of modular switches. It encompasses the Nexus 9500 Series modular switches and the Nexus 9300 Series fixed-port switches. The Cisco Nexus 9508, 9396 and 93128 Switches are the first members of the Cisco Nexus 9000 Series platform. They are high-density 10, 40, and future100 Gigabit Ethernet switches designed for a broad range of environments including physical and virtual computing, Big Data applications, and high-performance computing (HPC).

The Cisco Nexus 9508 (Figure 1) is a 13RU switch offering 8 line cards slots with a comprehensive selection of modular line cards. Configurable with up to 1152 10 Gigabit Ethernet or 288 40 Gigabit Ethernet ports, the switch provides sufficient capacity for both access and aggregation layer deployments. The Cisco Nexus 9508 has three line card options as an initial offering. The first option is a 36 port QSFP+ 40Gbps line card. This card can handle 36 ports of full line rate 40Gbps or 144 ports of 10Gbps in 4x10 mode. The second option has 48 ports of 10GBase-T and 4 ports of QSFP+ 40Gbps. The third has 48 ports of SFP+ 10Gbps and 4 ports QSFP+ 40Gbps.

Figure 1: Cisco Nexus 9508 Switch: Port View



The Cisco Nexus9300 Series Switches are fixed switches built to provide 1/10Gbps and future FCoE server access connectivity. The Cisco Nexus 9396 (Figure 2) is a 2RU fixed switch offering 48 ports of 10Gbps (SFP+) and 12 ports of 40 Gbps (QSFP+) with a non-blocking switch architecture. The Cisco Nexus 93128 (Figure 3) is a 3RU fixed switch with 96 ports of 10GBase-T and 8 ports of 40Gbps (QSFP+). Both Nexus 9396 and Nexus 93128 are well suited for data center top-of-rack (ToR), end-of-row (EoR), and collapsed aggregation and access while deployed with Nexus 2000 Fabric Extenders.

Figure 2: Cisco Nexus 9396 Switch



Figure 3: Cisco Nexus 93128 Switch

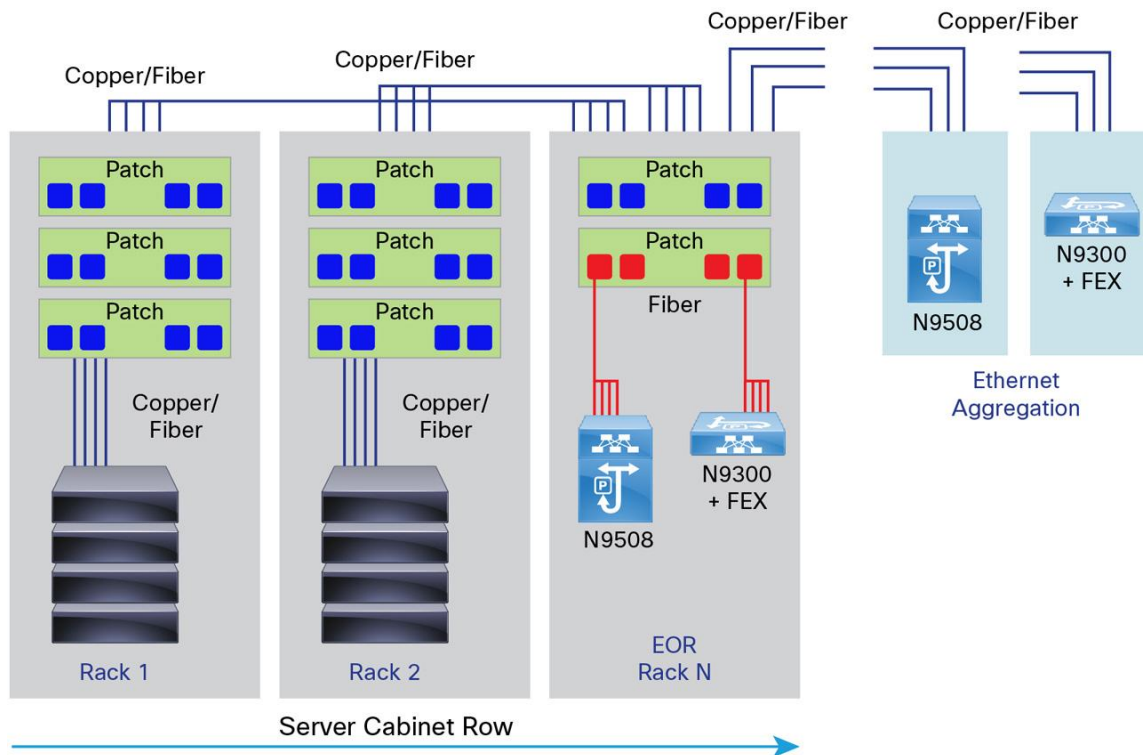


Cisco Nexus 9000 Deployment Scenarios

Integrated line-rate Layer-2 and Layer-3 along with a comprehensive feature set make the Cisco Nexus 9000 Switches excellent for deployments in enterprise, service provider, and commercial environments.

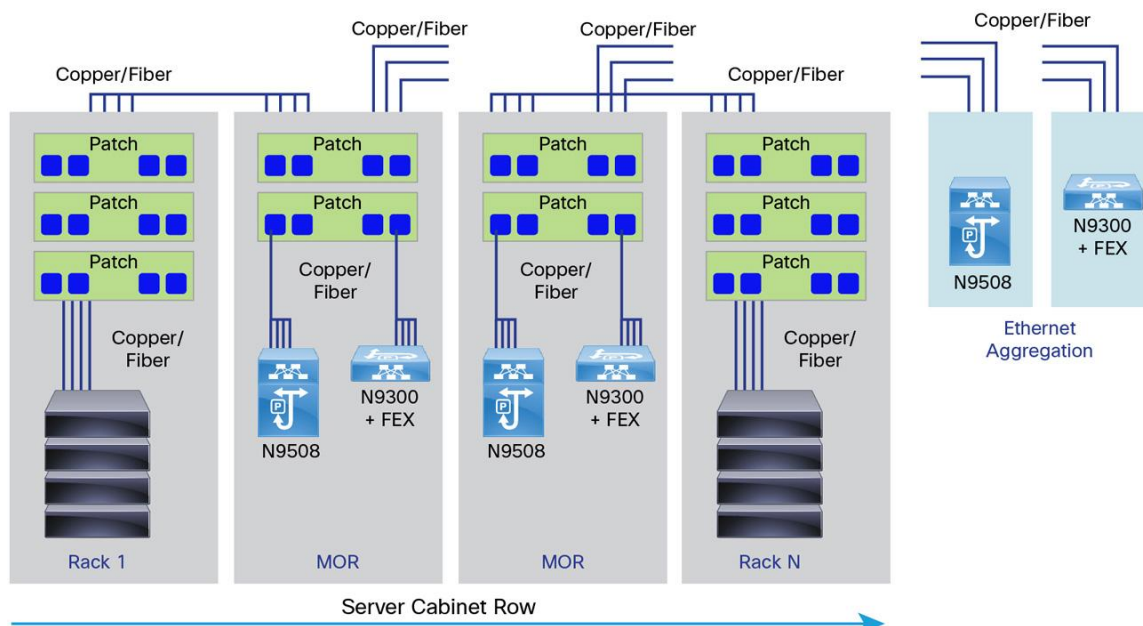
The Cisco Nexus 9500 Series Switches can be deployed with Cisco Nexus fabric extenders in both EoR and MoR designs. For an EoR or MoR design, servers can use standard RJ-45 cables to ToR patch panels in the rack. The bundles of copper cables from each rack are routed to the EoR or MoR network racks and to the appropriate Cisco Nexus Switch or Cisco Nexus Fabric Extender with a Cisco Nexus parent switch as shown in Figure 4. Connectivity from the Cisco Nexus 9000 Series Switches to the aggregation layer Cisco Nexus 9000 Series Switches can be performed by fiber optic cabling (OM3 or OM4) or copper cabling (RJ-45 or Direct-Attached Copper Cabling).

Figure 4: EoR Design Using Cisco Nexus 9000 Series Switches



In MoR deployments, instead of long cable runs, the copper cable is routed from each server rack to a pair of racks positioned next to each other in the middle of the row. This approach reduces the extreme cable lengths from the far-end server cabinets using an EoR design. In both the EoR and MoR designs, if the trunks and ToR panels are fiber based, then it is possible to use fiber-based fabric extenders or connect directly to Cisco Nexus 9000 Series Switches (Figure 5).

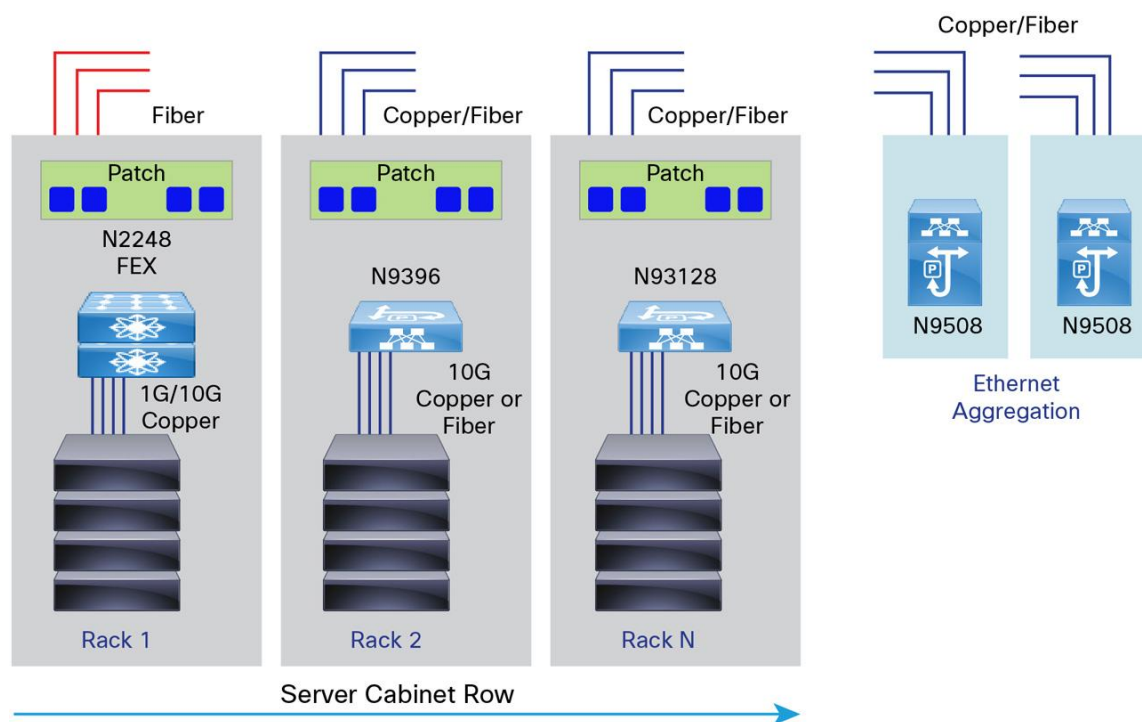
Figure 5: Middle-of-Row (MoR) Design Using Cisco Nexus9000 Series Switches



With an EoR or MoR design using the Cisco Nexus 9000 Series with fabric extenders, there are fewer switches to manage, reducing capital expenditures (CapEx). The Cisco Nexus 2000 Series Fabric Extenders are logically managed as part of the Cisco Nexus 9000 Series switch, so you get the additional benefit of lower operating expenses (OpEx) because there are fewer management points.

In ToR designs, various devices can be used such as the Cisco Nexus 3000 Series Switches, Cisco Nexus 2000 Series Fabric Extenders, and Cisco Nexus 9396 or 93128. In ToR designs, the servers in the computer rack connect directly to either a Cisco Nexus 9396 or 93128 Switch or a Cisco Nexus 2000 Series Fabric Extender in the same rack. All cabling for servers stays within the racks, as short patch cables, Twinax cables, or fiber from the server to the ToR network device. From each rack, a fiber typically would run directly to an aggregation switch. For shorter distances not exceeding 10 meters, passive or active Twinax cabling can also be used between the ToR and aggregation. A ToR design has the benefit of less bulky and less expensive copper cabling between racks and throughout the data center. With less copper cabling, there is less airflow obstruction, with the added benefit of a network with fewer racks and less infrastructure needed for patching and cable management (Figure 6).

Figure 6: Top-of-Rack (ToR) Design using Nexus 9000 Series Switches



For the ToR design in Figure 6, the Cisco Nexus 2248 will connect to the parent switch in the aggregation layer (Cisco Nexus 9508).

For all three deployment scenarios, Table 1 lists the Cisco Nexus 2200 platform fabric extenders available and the interface type and speed options.

Table 1. Fabric Extender Connectivity Options

Fabric Extenders	Host Facing					Network Facing	
	100MBAS E-T	1000MBA SE-T	1-Gbps SFP	10-Gbps SFP+	10GBAS E-T	10-Gbps SFP+	4 x 10-Gbps QSFP+
Cisco Nexus 2224TP	✓	✓				✓	
Cisco Nexus 2248TP	✓	✓				✓	
Cisco Nexus 2248TP-E	✓	✓				✓	
Cisco Nexus 2232PP			✓	✓		✓	
Cisco Nexus 2232TM					✓	✓	
Cisco Nexus 2232TM-E					✓	✓	
Cisco Nexus 2248PQ			✓	✓			✓

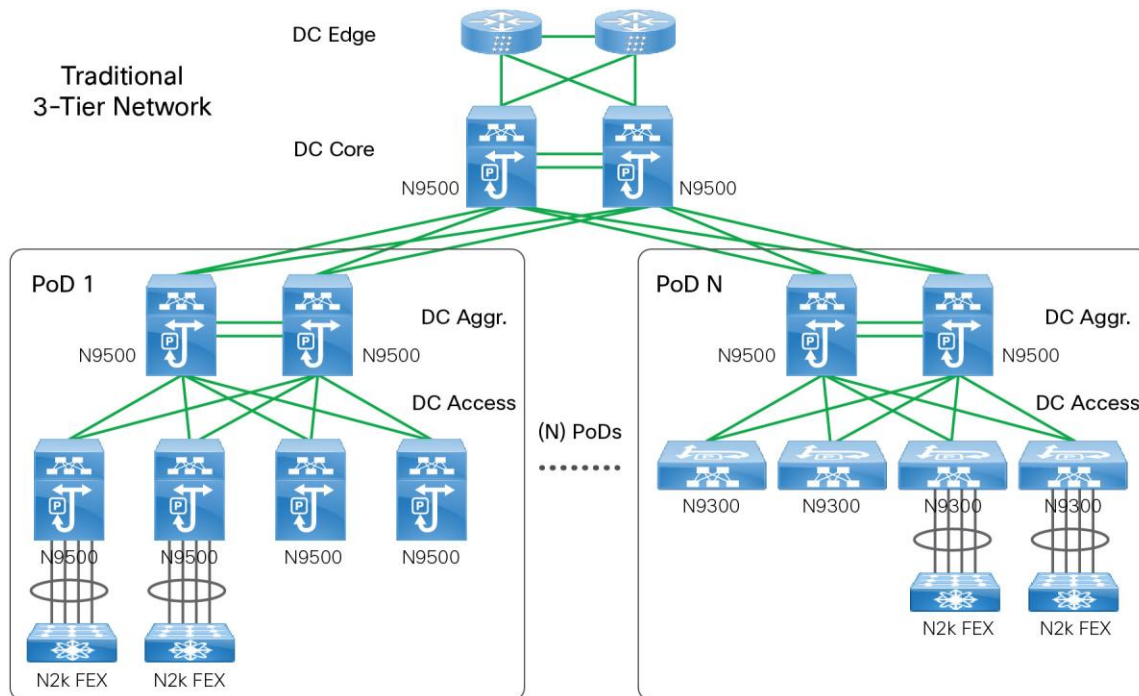
Cisco Nexus 9000 Series Use Case

The Cisco Nexus 9000 Series is a strong fit for the data center use cases described here.

Traditional 3-Tier Architecture

In a traditional data center network, it's common that the network is deployed in the 3-tier architecture, including data center core, data center aggregation and data center access as show in Figure 7. Nexus 9000 switches have a natural fit into this design with Nexus 9500 at the aggregation layer and Nexus 9500 or Nexus 9300 at the access layer.

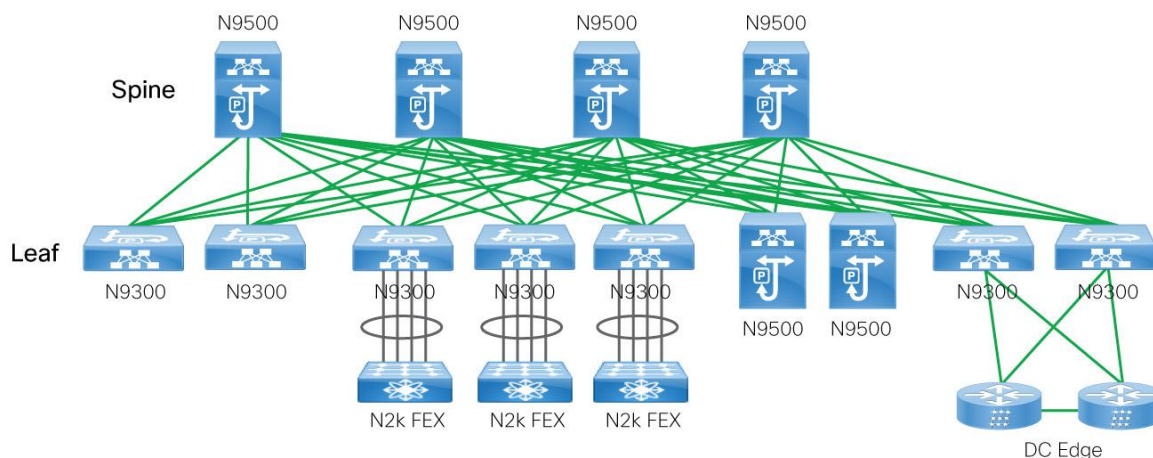
Figure 7: Traditional 3-Tier Network Architecture



Large-Scale Fabric (Layer 2 and 3) with Leaf-and-Spine Architecture

To meet the growing demands for scale, performance and flexibility in today's data centers, the trend in network design is to flatten the architecture using high-density and low-latency switches as leaves and spines in a Layer-2 or Layer-3 network. A network built using a leaf-and-spine architecture allows connections scaling from hundreds to 10,000 or more servers with high east-west traffic flows. The leaf-and-spine architecture helps ensure low latency with cut-through forwarding as packets traverse the network using a low hop count. The spine switch creates a non-blocking, low-latency fabric, forwarding packets between leaves. The leaf switches provide connectivity to servers. Use of a CLOS architecture helps ensure the highest possible network availability with little impact on customer traffic in the event of a failure. In the topology in Figure 8, the Cisco Nexus 9000 Series are deployed in a leaf-and-spine architecture with Nexus 9500 as spines and Nexus 9300 or 9500 as leafs. Nexus 2000 Fabric Extender can be attached to either Nexus 9300 or Nexus 9500 to provide cost effective server connectivity, especially 1Gbps server connectivity.

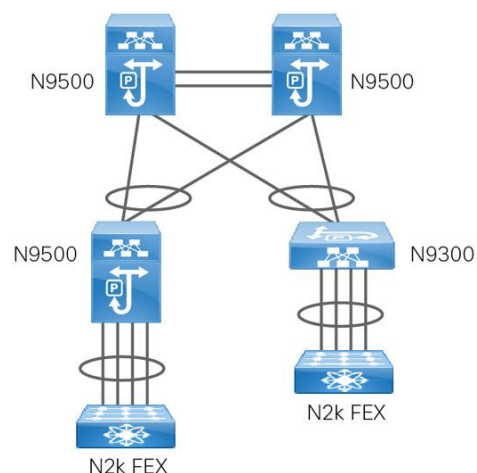
Figure 8: Large-Scale Fabric: Leaf-and-Spine Architecture



Fabric Extender Architecture: High-Density Fabric Extender Aggregator

Cisco FEX Technology is based on the emerging IEEE 802.1br standard. Designing the network using Cisco FEX Technology provides flexibility, reduces cabling infrastructure, and provides a single point of management, helping customers scale their networks. With its high 10- and 40-Gbps port density, the Cisco Nexus 9000 Series Switches can be used as a high-density fabric extender aggregation platform for the Cisco Nexus 2200 platform products (Figure 9).

Figure 9: Fabric Extender Aggregation



The Cisco Nexus 2000 Series Fabric Extenders can be physically located at the top of the rack, and Cisco Nexus 9000 Series Switch can reside in the middle of the row or at the end of the row. This positioning takes advantage of both EoR network consolidation and ToR cabling savings. The Cisco Nexus 9000 Series Switches are compatible with integrated transceivers and Twinax cabling solutions, which deliver cost-effective connectivity for 1 or 10 Gigabit Ethernet to servers at the rack level, eliminating the need for expensive optical transceivers.

Cisco and Panduit Wiring Scenario

Using the three topologies discussed in the previous section, the scenarios in this section presents the high-level cabling and optics requirements for the Cisco Nexus 9000 series. Typical wiring solutions that include products from Cisco and Panduit are described.

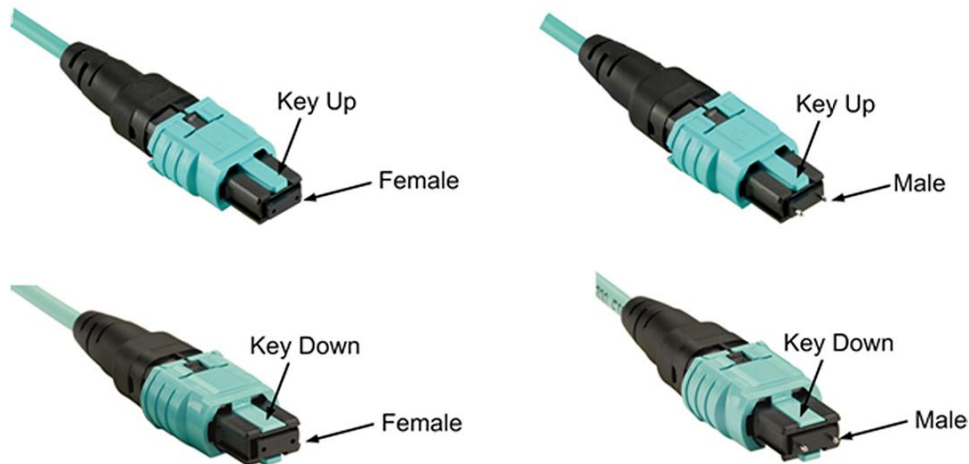
The wiring scenarios described here can be used in a Cisco Nexus 9000 Series deployment.

PanMPO Connector

Introducing the PanMPO Connector, Panduit's revolutionary MPO connector that protects your fiber infrastructure investment and improves operational efficiency to save time and money. Change polarity and gender on your fiber cable assemblies on the fly with the PanMPO Connector. This unique, patented connector helps ease the migration from 10G Ethernet to 40G Ethernet, while keeping the installation in compliance.

- Easily convert between male and female gender, and between key-up and key-down polarity for a standards-compliant 10G or 40G/100G Ethernet installation
- Connector changes are made in the field, as needed
- Always have the right cable assembly on hand
- Available on trunks, harnesses, interconnects and reference cords

Figure 10: PanMPO Connector Options

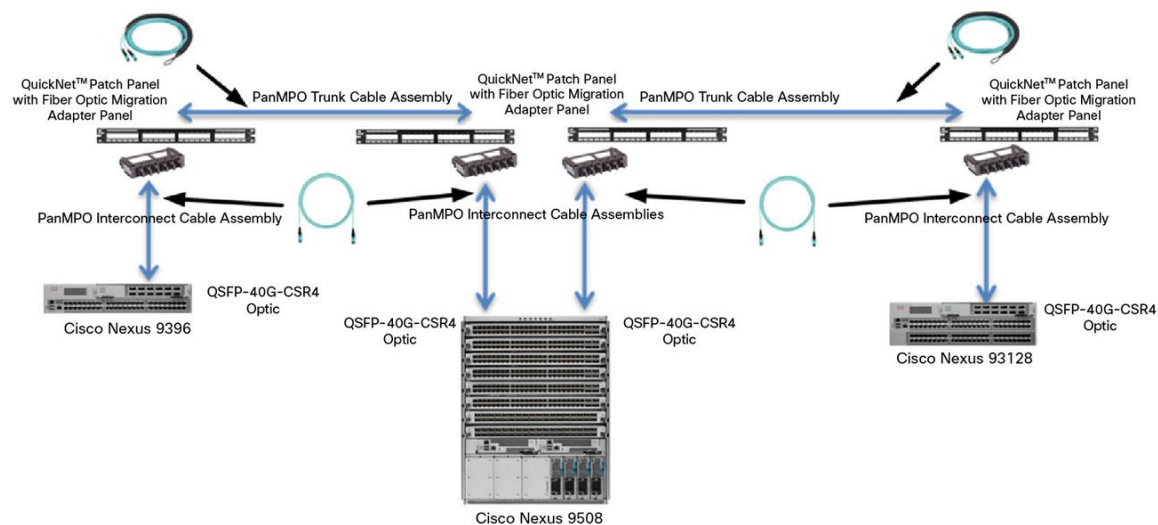


40GE QSFP SR4/CSR4 Optics Cabling Options

Cisco Nexus 9396 and 93128 to Cisco Nexus 9508 Series Using QSFP+-to-QSFP+ PanMPO Connectivity for Multimode Connectivity

Figure 11 shows this scenario.

Figure 11: Cisco Nexus 9396 and 93128 to Cisco Nexus 9508 PanMPO to PanMPO Multimode Cabling Components



For distances less than 400 meters, the use of PanMPO multimode fiber cabling is generally the preferred cabling method. Figure 11 shows a wiring option for connecting a Cisco Nexus 9396 to a Cisco Nexus 9508 and to a Cisco Nexus 93128 Switch using PanMPO interconnect cable assemblies. With Cisco QSFP-40G-SR4 optics, this scenario is capable of distances of up to 100 meters on OM3 fiber or 150 meters with OM4 fiber. The QSFP-40G-CSR4 optics can be used for distances of up to 300 meters with OM3 fiber or 400 meters with OM4 fiber. With Panduit Signature Core fiber cabling, this scenario can be used for distances up to 550 meters. Panduit Signature Core is the next generation in multimode optical fiber and connectivity. This revolutionary advancement in multimode fiber systems delivers the ultimate in design flexibility, verified optical performance, and signal integrity far beyond the requirements, helping ensure consistent performance and reliability of critical systems.

From the Cisco Nexus 9396 port, the QSFP-40G-SR4 or QSFP-40G-CSR4 optics connects to an PanMPO fiber interconnect cable to the front of the fiber optic adapter panel. The fiber optic adapter panel fits into the Quicknet patch panel. The PanMPO fiber trunk cable plugs into the back of the fiber optic adapter panel using the port that corresponds to the port that the interconnect cable used in the front. On the remote end, the PanMPO fiber trunk cable plugs into the back of the fiber optic adapter panel. The PanMPO fiber interconnect cable plugs into the corresponding port on the front of the panel on one side and into the optics with the switch on the other end.

The PanMPO interconnect fiber assembly used in the scenario is a Female PanMPO-to-Female PanMPO cable, and the PanMPO trunk cable assembly is a Male PanMPO-to-Male PanMPO cable. The reasoning behind this cabling methodology is that the interconnect (or intracabinet) cables will always be Female to Female, because MPO optics in a switch or router are always male connectors per the IEEE standards and will always accept FemaleMPO connectors. The trunk cabling will then always be Male PanMPO-to-Male PanMPO trunk cables. The use of this cabling methodology throughout the datacenter allows a simplified cabling scheme and quick identification of interconnect and trunk cabling.

In addition to using the Female PanMPO for interconnect cables and the Male PanMPO for trunk cables, you should use Method B polarity (key upto key up) cabling for both the interconnect and trunk cables. This approach standardizes the type of cable used throughout the datacenter, eliminating the need for several different interconnect cable types, as would be necessary if you used other polarity methods in the infrastructure.

Table 2 shows the Cisco and Panduit optics and cabling options with corresponding part numbers for a QSFP+-to-QSFP+ multimode connection. Figure 12 shows a PanMPO cabling scenario.

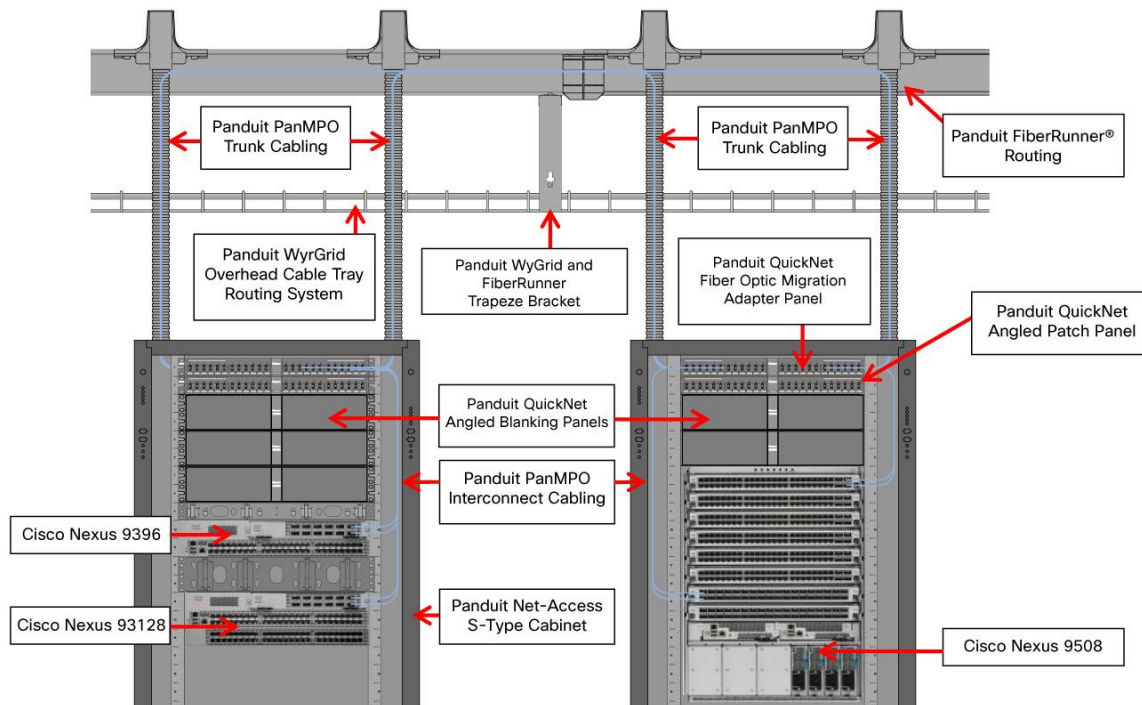
Table 2. Cisco Nexus 9000 Series Switches PanMPO to PanMPO Multimode QSFP+ Optics and Cabling Products

Cisco Product Description	Cisco Part Number
40GBASE SR4 QSFP, 100m with OM3 or 150m with OM4	QSFP-40G-SR4
40GBASE Extended SR4 QSFP, 300m MMF with OM3 or 400m with OM4	QSFP-40G-CSR4
Panduit Product Description	Panduit Part Number
QuickNet 24-Port Patch Panel	QPP24BL
QuickNet Fiber Optic Migration Adapter Panel	FQMAP65CG
QuickNet PanMPO Interconnect Cable Assembly (OM4) (Configured with Female to Female, Method B*)	FZTRP7N7NBNM**
QuickNet PanMPO Interconnect Cable Assembly (OM3) (Configured with Female to Female, Method B*)	FXTRP7N7NBNM**
QuickNet PanMPO Trunk Cable Assembly (OM4) (Configured with Male to Male, Method B*)	FZTYP8E8EBAM**
QuickNet PanMPO Trunk Cable Assembly (OM3) (Configured with Male to Male, Method B*)	FXTYP8E8EBAM**

* PanMPO cable assemblies can change polarity and gender as needed, but should be ordered with the polarity and gender configuration required to accelerate installation.

** Insert distance for correct Panduit product number (for example, 1 meter cable is 001 or FXTYP8E8EBAM001).

Figure 12: Cisco Nexus 9000 PANMPO to PANMPO Cabling Diagram



QSFP+-to-SFP+ Configuration with 4 x 10 Gigabit Ethernet

The Cisco Nexus 9500 series switch interfaces can operate in 40-Gbps or 4 x 10 Gigabit Ethernet mode. In 40-Gbps mode, each physical port is a single 40-Gbps port with the capabilities to support a 40-Gbps flow. If the interface is logically configured as a 4 x 10 Gigabit Ethernet interface, each port becomes four 10-Gbps ports. The use of copper Twinax or fiber hydras or breakout cables allows the ports to connect directly to SFP+ ports. When the ports are in 4 x 10 Gigabit Ethernet mode, the Cisco Nexus 9508 has a total capacity of 1,152 10-Gbps interfaces per switch.

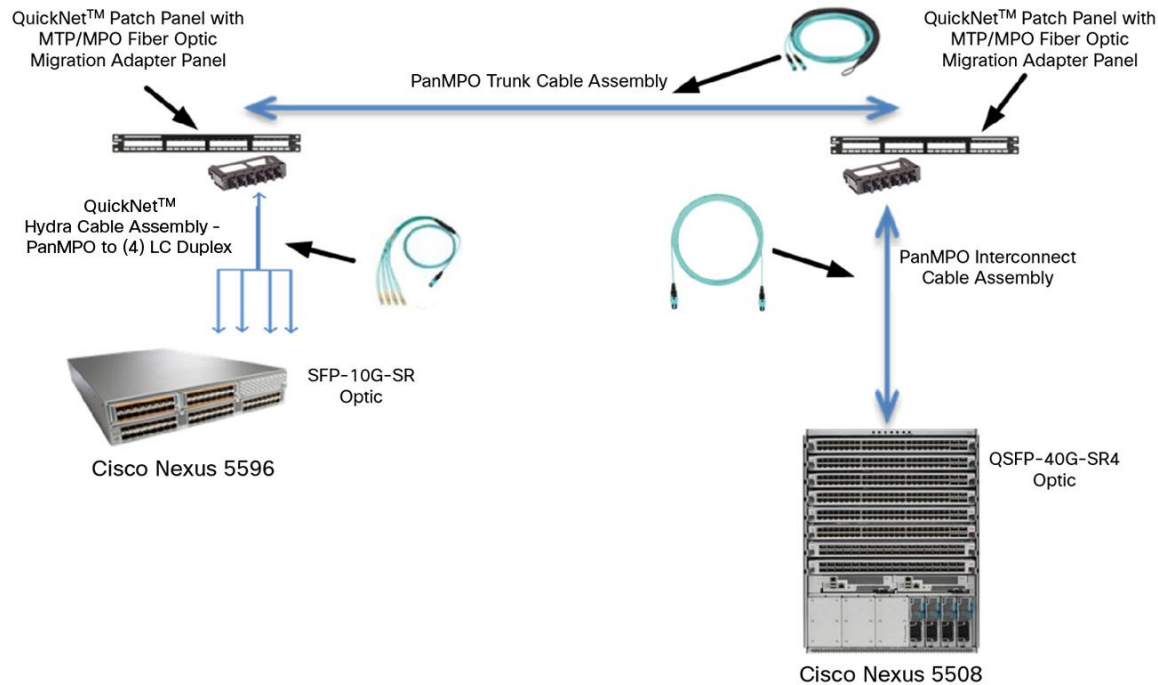
Through the use of a PanMPO to LC breakout cable, the Cisco Nexus 9500 series switches can connect to 10Gbps switch platforms, such as Nexus 5500 switches, or directly to the Cisco Nexus 2000 Series Fabric Extenders. The cable required here would be PanMPO on one end, connecting to the QSFP+ optics in a Cisco Nexus 9500 series switch, and it then would break out into four individual fiber pairs links on the other end. These breakout cables terminate with LC duplex connectors.

Cisco Nexus 9508 to Cisco Nexus 5500 Series or Cisco Nexus 2200 using QSFP-to-SFP+ connectivity with breakout cables has the optics options shown here.

PANMPO to (4) LC Hydra

Figure 13 shows this scenario.

Figure 13: Cisco Nexus 9508 PanMPO to LC Duplex Hydra Cabling Components



This scenario shows a wiring option connecting a Cisco Nexus 9508 to a Cisco Nexus 5596 using a PanMPO to (4) LC duplex hydra cable assembly. With the QSFP-40G-SR4 optics, this scenario is capable of distances of up to 100 meters with OM3 fiber. With the QSFP-40G-CSR4 optics, this scenario is capable of distances of up to 300 meters with OM3 fiber. In this scenario, the Cisco Nexus 9508 has the QSFP-40G-SR4 optics connector, which is connected to a Female-to-Female PanMPO interconnect cable assembly. The Female-to-Female PanMPO interconnect cable assembly connects to the front of the QuickNet patch panel with the PanMPO fiber optic migration adapter panel. On the back side of the PanMPO fiber optic migration adapter panel, the Male-to-Male PanMPO trunk cable assembly connects to the panel in the corresponding port. On the remote side, the Male-to-Male PanMPO trunk cable assembly connects to the back of the panel, and the Female PanMPO to (4) LC duplex hydra cable assembly connects to the front of the panel. The Female PanMPO to (4) LC duplex hydra cable assembly connects from the front of the panel to four corresponding SFP+ ports with SFP-10G-SR optics in the Cisco Nexus 5596 using LC duplex plugs.

Table 3. Cisco Nexus 9000 PANMPO to LC Hydra Optics and Cabling Products

Cisco Product Description	Cisco Part Number
10GBASE-SR SFP+ transceiver module for MMF, 850-nm wavelength, LC duplex connector	SFP-10G-SR
40GBASE SR4 QSFP, 100m with OM3 or 150m with OM4	QSFP-40G-SR4
40GBASE Extended SR4 QSFP, 300m MMF with OM3 or 400m with OM4	QSFP-40G-CSR4
Panduit Product Description	Panduit Part Number
QuickNet 24-Port Patch Panel	QPP24BL
QuickNet Fiber Optic Migration Adapter Panel	FQMAP65CG

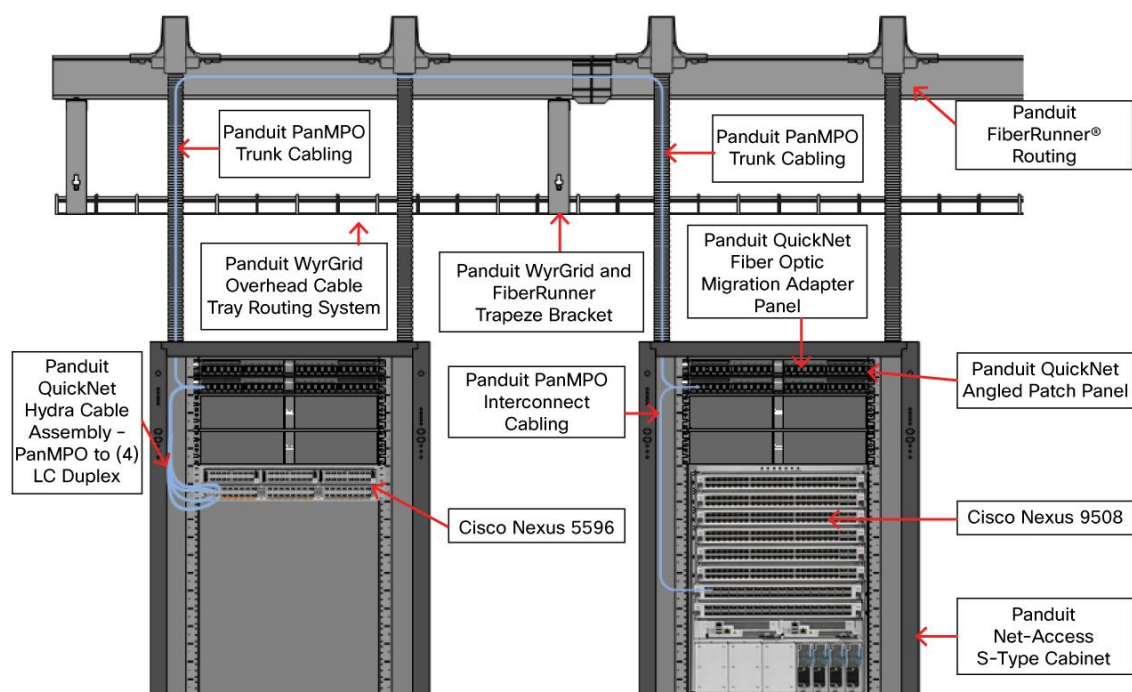
Cisco Product Description	Cisco Part Number
QuickNet PanMPO Interconnect Cable Assembly (OM3) (Configured with Female to Female, Method B[*])	FXTRP7N7NBNM ^{**}
QuickNet PanMPO Trunk Cable Assembly (OM3) (Configured with Male to Male, Method B[*])	FXTYP8E8EBAM ^{**}
QuickNet MPO 8-Fiber Hydra Cable Assembly (OM3) (Female MPO to 4 Duplex LC)	FX8HP5NLSQNM ^{**}

^{*} PanMPO cable assemblies can change polarity and gender as needed, but should be ordered with the polarity and gender configuration required to accelerate installation.

^{**} Insert distance for correct Panduit product number (for example, 1 meter cable is 001 or FX8HP5NLSQNM001).

Figure 14 shows a Cisco Nexus 9508 to Cisco Nexus 5596 using PANMPO to LC Hydra cabling.

Figure 14: Cisco Nexus 9508 PANMPO to LC Hydra Cabling Diagram



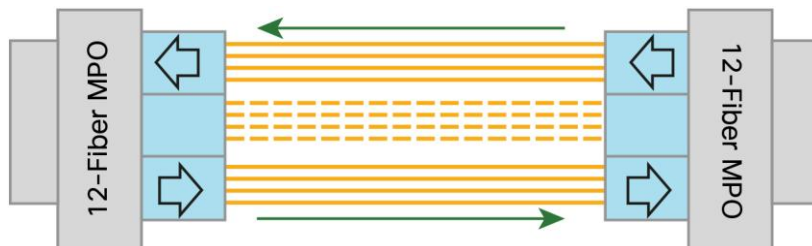
Cisco 40GE QSFP BiDi Optics Cabling Options

Challenges with Existing 40GE Transceivers

Existing short reach transceivers for 40GE in QSFP form factor, such as QSFP SR4 and QSFP CSR4, feature independent transmitter and receiver sections, each with 4 fiber strands in parallel. For a duplex 40G connection, 8 fiber strands are required. Both QSFP SR4 and QSFP CRS4 use MPO 12-fiber connector. As a result, 4 fiber strands in each connection gets wasted.

Figure 15 depicts the concept of existing short reach 40GE QSFP solution.

Figure 15: Concept of Existing 40GE Transceivers



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

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

40GE connectivity won't be able to re-use the direct connecting LC-to-LC fibers. It also requires immense expansion to the fiber trunks to fulfill the 4 fibers/40GE-connection requirement. These differences make it expensive for customers to migrate from 10GE to 40GE.

Cisco 40GE QSFP BiDi Transceiver

QSFP BiDi transceiver addresses the former mentioned fiber infrastructure challenges by providing the capability of transmitting full duplex 40GE over one duplex MMF fiber with LC connectors. In another word, QSFP BiDi transceiver allows for 40GE connectivity to re-use the existing direct connecting 10GE fibers and the exiting fiber trunk without the need to add any additional fibers.

QSFP BiDi (Bi-Directional) is short reach optical transceiver that delivers 40GE over an OM3 or OM4 multi-mode fiber. It's MSA compliant. Figure 16 shows a picture of a QSFP BiDi transceiver.

Figure 16: QSFP BiDi Transceiver (QSFP-40G-SR-BD)



A QSFP BiDi transceiver has 2 channels of 20G, each transmitted and received simultaneously on 2 wavelengths over a single multi-mode fiber strand. The result is an aggregated duplex 40GE link over a duplex multi-mode fiber. QSFP BiDi uses duplex LC connectors. The connection can reach 100 meters on a OM3 multi-mode fiber or 125 meters on a OM4 multi-mode fiber. The Cisco PID for QSFP BiDi transceiver is QSFP-40G-SR-BD. Figure 17 depict the concept of QSFP BiDi transceiver.

Figure 17: Concept of QSFP BiDi Transceiver

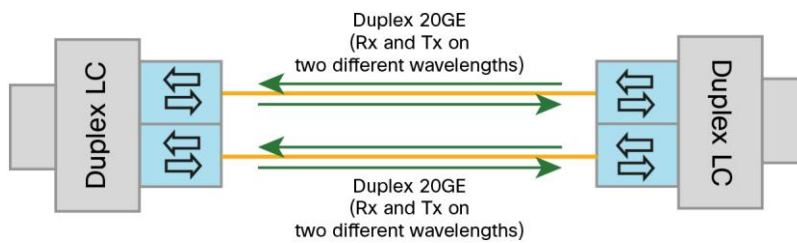


Figure 18: Cisco Nexus 9508 BiDi Optics Cabling Components

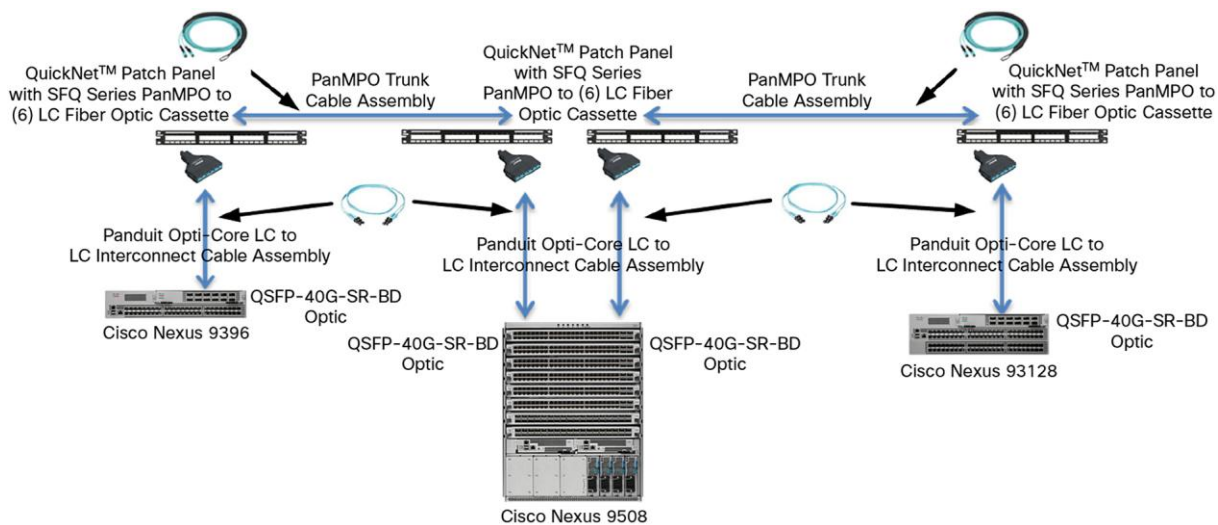


Figure 18 shows a wiring option for connecting a Cisco Nexus 9396 to a Cisco Nexus 9508 and to a Cisco Nexus 93128 Switch using PanMPO interconnect cable assemblies. With Cisco QSFP-40G-SR-BD optics, this scenario is capable of distances of up to 100 meters on OM3 fiber or 125 meters with OM4 fiber.

From the Cisco Nexus 9396 port, the QSFP-40G-SR-BD optic connects to a LC Duplex fiber interconnect cable to the front of the LC fiber optic cassette. The LC fiber optic cassette fits into the Quicknet patch panel. The PanMPO fiber trunk cable plugs into the back of the LC fiber optic cassette. On the remote end, the PanMPO fiber trunk cable plugs into the back of the LC fiber optic cassette. The LC Duplex fiber interconnect cable plugs into the front of the LC fiber optic cassette and into the optics with the switch on the other end.

For a Greenfield Cisco BiDi deployment, Panduit suggests using Method B polarity, which allows for simplified installation. It requires two different types of cassette to be ordered and installed (B1 & B2), but does not require the LC pairs on one side of the connection to be flipped as would be required in Method A polarity. For ease of installation, it is recommended that you standardize the placement of B1 & B2 cassettes - for example, B1 cassettes are installed in spine or network switch cabinets and B2 cassettes are installed in leaf or server side switch cabinets. Like the other scenarios, the PanMPO trunk should be ordered as a Method B Male PanMPO to Male PanMPO.

For a Brownfield 10G network upgrading to a 40G Cisco BiDi deployment, customers will only need to insure that each existing 10G link falls within the reach of the 40G Cisco BiDi optic for the installed fiber type(OM3 or OM4). Otherwise no other cabling changes would be required. If your connection was operational at 10G, it will operate at 40G.

Table 4 shows the Cisco and Panduit optics and cabling options with corresponding part numbers for a BiDi multimode connection. Figure 19 shows a BiDi cabling scenario.

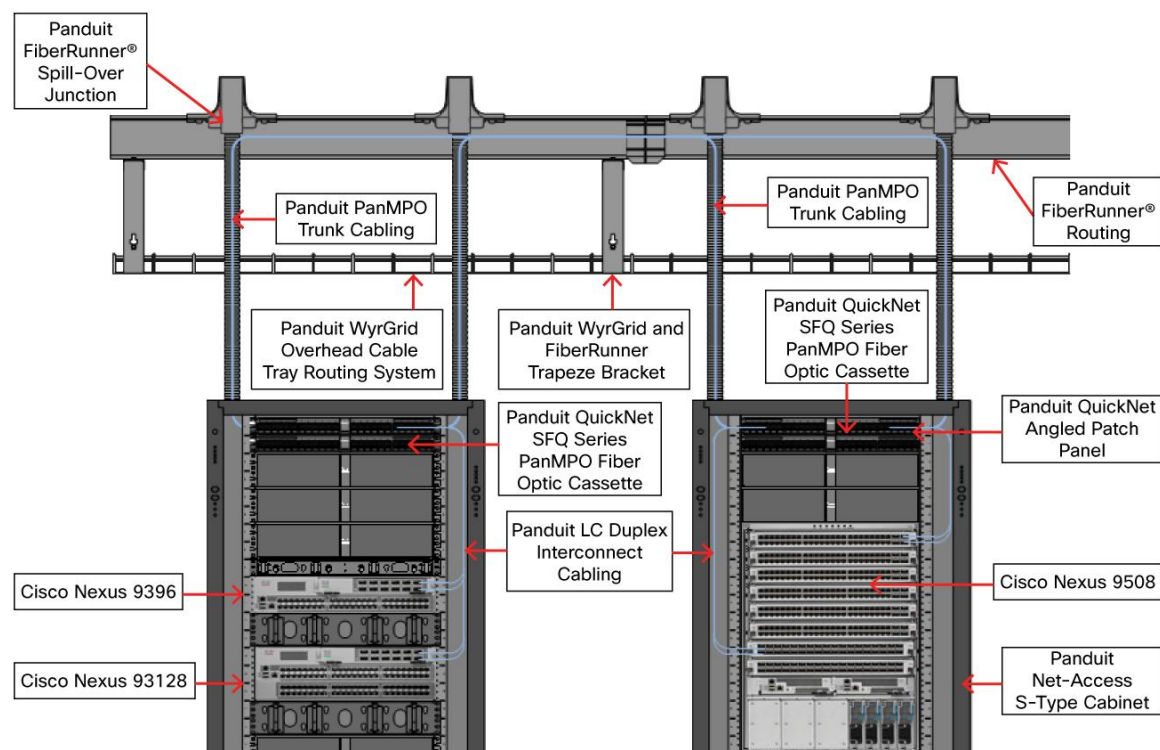
Table 4. Cisco Nexus 9000 Series Switches BiDi Optics and Cabling Products

Cisco Product Description	Cisco Part Number
40GBASE SR-BD QSFP, 100m with OM3 or 125m with OM4	QSFP-40G-SR-BD
Panduit Product Description	Panduit Part Number
QuickNet 24-Port Patch Panel	QPP24BL
QuickNet SFQ Series PanMPO to (6) LC Fiber Optic Cassette (OM4)	FQZO-12-10B1 & FQZO-12-10B2
QuickNet SFQ Series PanMPO to (6) LC Fiber Optic Cassette (OM3)	FQXO-12-10B1 & FQXO-12-10B2
Opti-Core LC Interconnect Cable Assembly (OM4)	FZ2ERLNLNSN**
Opti-Core LC Interconnect Cable Assembly (OM3)	FX2ERLNLNSN**
QuickNet PanMPO Trunk Cable Assembly (OM4) (Configured with Male to Male, Method B*)	FZTYP8E8EBAM**
QuickNet PanMPO Trunk Cable Assembly (OM3) (Configured with Male to Male, Method B*)	FXTYP8E8EBAM**

* PanMPO cable assemblies can change polarity and gender as needed, but should be ordered with the polarity and gender configuration required to accelerate installation.

** Insert distance for correct Panduit product number (for example, 1 meter cable is 001 or FZTYP8E8EBAM001).

Figure 19: Cisco Nexus 9000 Series BiDi Cabling Diagram



Copper Cabling Options

QSFP+ Direct-Attach Copper Cabling

Figure 20 shows a wiring option for a Cisco Nexus 9396 to a Cisco Nexus 93128 and a Cisco Nexus 9508 using a QSFP+ direct-attach copper cable assembly. With a Panduit QSFP+ direct-attach copper cable assembly, this scenario is capable of distances of up to 7 meters.

Figure 20: Cisco Nexus 9000 Series Switches QSFP+ 40Gbps Direct-Attach Copper Cabling Diagram

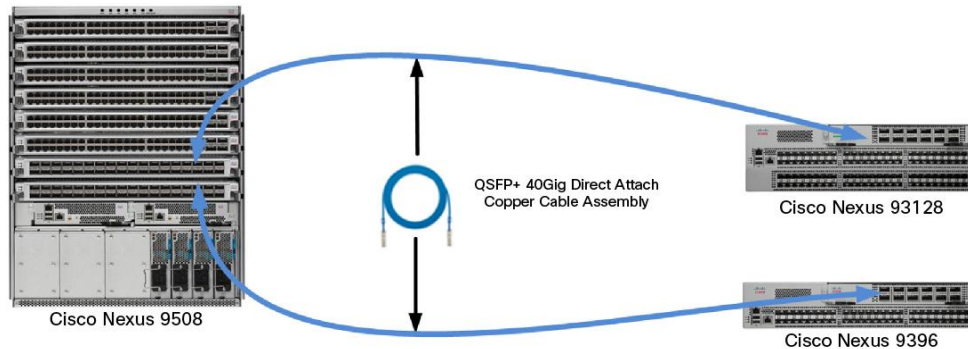


Table 5. Cisco Nexus 9000 Series Switches QSFP+ and SFP+ Direct-attach Copper Cabling Products

Cisco Product Description	Cisco Part Number
Twinax Passive SFP+, 1.5m	SFP-H10GB-CU1-5M ¹
Twinax Passive SFP+, 2m	SFP-H10GB-CU2M ¹
Twinax Passive SFP+, 2.5m	SFP-H10GB-CU2-5M ¹
40GBASE-CR4 direct-attach QSFP copper cable, 1 meter	QSFP-H40G-CU1M
40GBASE-CR4 direct-attach QSFP copper cable, 3 meter	QSFP-H40G-CU3M
40GBASE-CR4 direct-attach QSFP copper cable, 5 meter	QSFP-H40G-CU5M
40GBASE-CR4 direct-attach QSFP active copper cable, 7 meters	QSFP-H40G-ACU7M
40GBASE-CR4 direct-attach QSFP active copper cable, 10 meters	QSFP-H40G-ACU10M
Panduit Product Description	Panduit Part Number
SFP+ 10Gig Direct Attach Passive Cable Assembly, 1 to 7 Meters	PSF1PXA [*] MBU ¹
SFP+ 10Gig Direct Attach Active Cable Assembly, 7 to 15 Meters	PSF1AXD [*] MBU ¹
QSFP+ 40Gig Direct Attach Copper Cable Assembly, 1 Meter	PQSFPXA1MBU
QSFP+ 40Gig Direct Attach Copper Cable Assembly, 2 Meter	PQSFPXA2MBU
QSFP+ 40Gig Direct Attach Copper Cable Assembly, 3 Meter	PQSFPXA3MBU
QSFP+ 40Gig Direct Attach Copper Cable Assembly, 4 Meter	PQSFPXB4MBU
QSFP+ 40Gig Direct Attach Copper Cable Assembly, 5 Meter	PQSFPXC5MBU
QSFP+ 40Gig Direct Attach Copper Cable Assembly, 6 Meter	PQSFPXD6MBU
QSFP+ 40Gig Direct Attach Copper Cable Assembly, 7 Meter	PQSFPXD7MBU

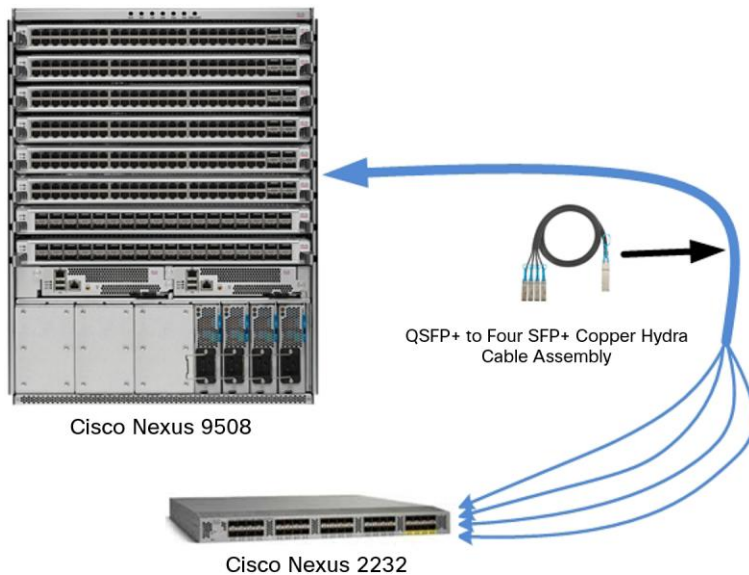
¹ Will be supported in a future release

^{*} Insert distance for correct Panduit product number (for example, 1 meter cable is PSF1PXA1MBU).

QSFP+ to (4) SFP+ Hydra Cable Assembly

Figure 21 shows this scenario.

Figure 21: Cisco Nexus 9508 QSFP+ to SFP+ Hydra Cabling Diagram



This scenario shows a wiring option for connecting a Cisco Nexus 9000 Series Switch to a Cisco Nexus 2232 using a QSFP+ to four SFP+ copper hydra cable assembly. By using passive copper cables cable, lengths upto 5 meters are possible. Active copper cables allow connectivity upto 10 meters. This connection option is typical in ToR, MoR, and EoR deployments, where the distance between switches is within 10meters.

Table 6 lists the Cisco and Panduit cabling options with corresponding part numbers for QSFP+ to (4) SFP+ hydra cable assemblies.

Table 6. Cisco Nexus 9000 Series Switches QSFP+ to SFP+ Hydra Cabling Products

Cisco Product Description	Cisco Part Number
QSFP to 4x SFP+ direct-attach copper cable, 1 meter	QSFP-4SFP10G-CU1M
QSFP to 4x SFP+ direct-attach copper cable, 3 meter	QSFP-4SFP10G-CU3M
QSFP to 4x SFP+ direct-attach copper cable, 5 meter	QSFP-4SFP10G-CU5M
QSFP to 4 x SFP+ direct-attached Active Copper cable, 7 meters	QSFP-4x10G-AC7M
QSFP to 4 x SFP+ direct-attached Active Copper cable, 10 meters	QSFP-4x10G-AC10M
Panduit Product Description	Panduit Part Number
QSFP+ to Four SFP+ Copper Hydra Cable Assembly, 1 Meter	PHQ4SFPXA1MBL
QSFP+ to Four SFP+ Copper Hydra Cable Assembly, 1.5 Meter	PHQ4SFPXA1.5MBL
QSFP+ to Four SFP+ Copper Hydra Cable Assembly, 2 Meter	PHQ4SFPXA2MBL
QSFP+ to Four SFP+ Copper Hydra Cable Assembly, 2.5 Meter	PHQ4SFPXA2.5MBL
QSFP+ to Four SFP+ Copper Hydra Cable Assembly, 3 Meter	PHQ4SFPXA3MBL
QSFP+ to Four SFP+ Copper Hydra Cable Assembly, 3.5 Meter	PHQ4SFPXA3.5MBL

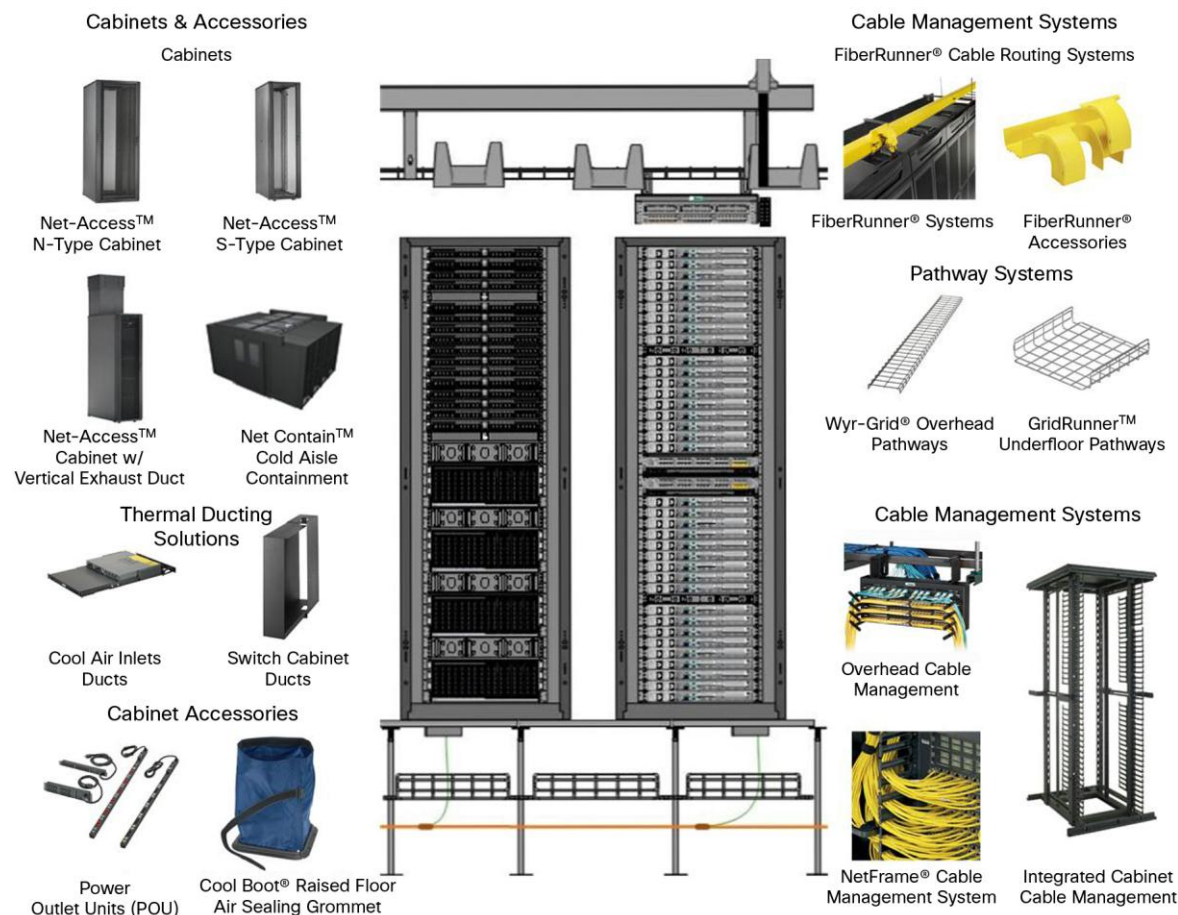
Panduit Unified Physical Infrastructure Solution

Panduit offers a complete solution for the infrastructure supporting Cisco 10-40-100Gbps switching platforms.

Panduit Cabinet and Cable Management Solutions

Panduit cabinet and cable management solutions help enable 10, 40, and 100Gigabit Ethernet switching platforms such as the Cisco Nexus9000Series. Panduit cabinet and rack solutions support both two-post and four-post applications with sizes ranging from 42RU to 52RU. The cabinet solution also includes cable management and thermal management within and outside the cabinet. Panduit Thermal Ducting Solutions are specifically designed to work with the equipment used in a Cisco Nexus 9000 Series deployment. Panduit Pre-configured Infrastructure Solutions simplify and accelerate deployment, enhance thermal performance, and decrease energy use. Figure 22 shows some of the features of Panduit cabinet and cable management component options that could make up its solutions.

Figure 22: Panduit Cabinet and Cable Management Components



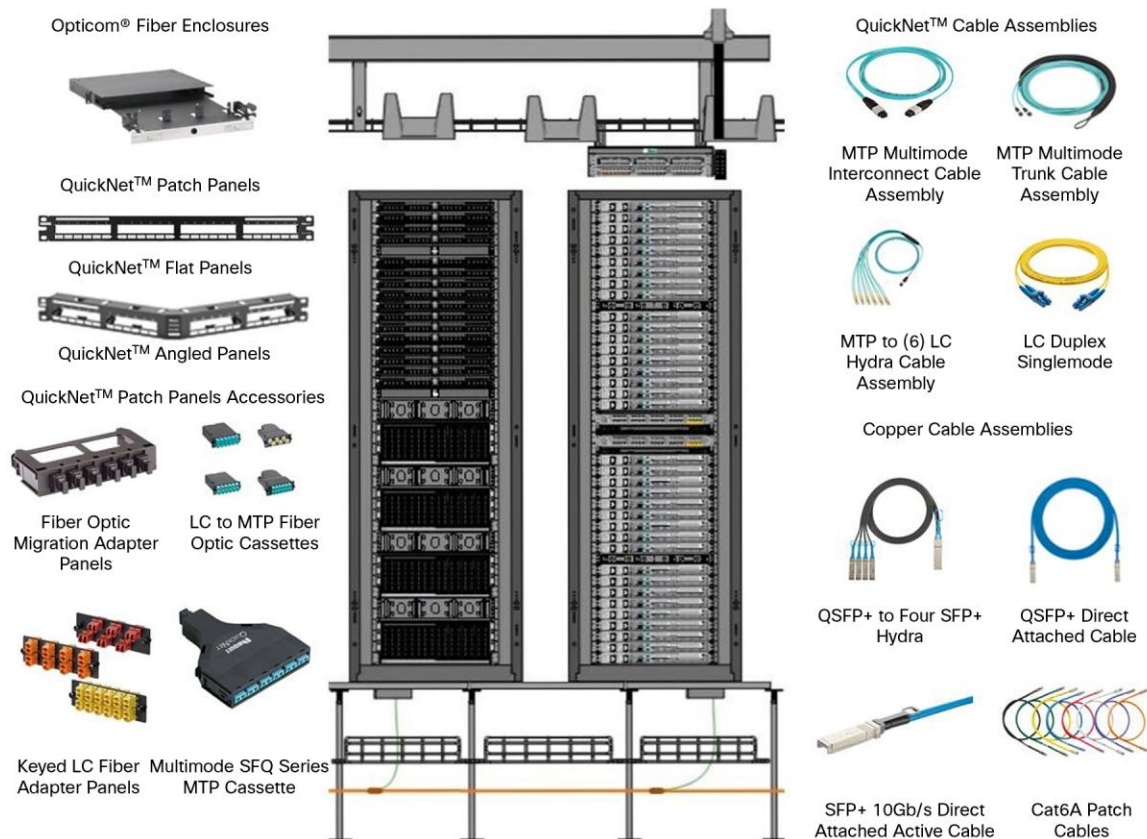
Panduit High-Speed Data Transport Solutions

Panduit fiber optic and copper cabling solutions for 10, 40, and 100Gigabit Ethernet support switching platforms such as the Cisco Nexus 9000 Series. The Panduit Signature Core Fiber Optic Cabling System is a new Panduit innovative, high-performance fiber that balances both modal and chromatic dispersion, allowing it to extend its reach beyond standard requirements. Panduit is leading the way in the relevant standard bodies to promote enhanced customer expectations through the use of this new technology. Panduit Signature Core extends the radius of fiber networks to meet customer implementation requirements.

Panduit copper technology incorporated into SFP+ 10-Gbps direct-attach copper (DAC) cable assemblies and TX6A 10Gig and TX6A-SD 10Gig UTP copper cable for 10GBASE-T provide enhanced performance characteristics. Both copper and fiber products can be incorporated into the Panduit QuickNet Cabling System, which offers factory-terminated and tested cable assemblies. This feature greatly accelerates the deployment of the solution and helps ensure expected performance.

Figure 23 shows some of the product options that can be used in a Panduit High-Speed Data Transport (HSDT) Solution for Cisco 9000 Series Switches.

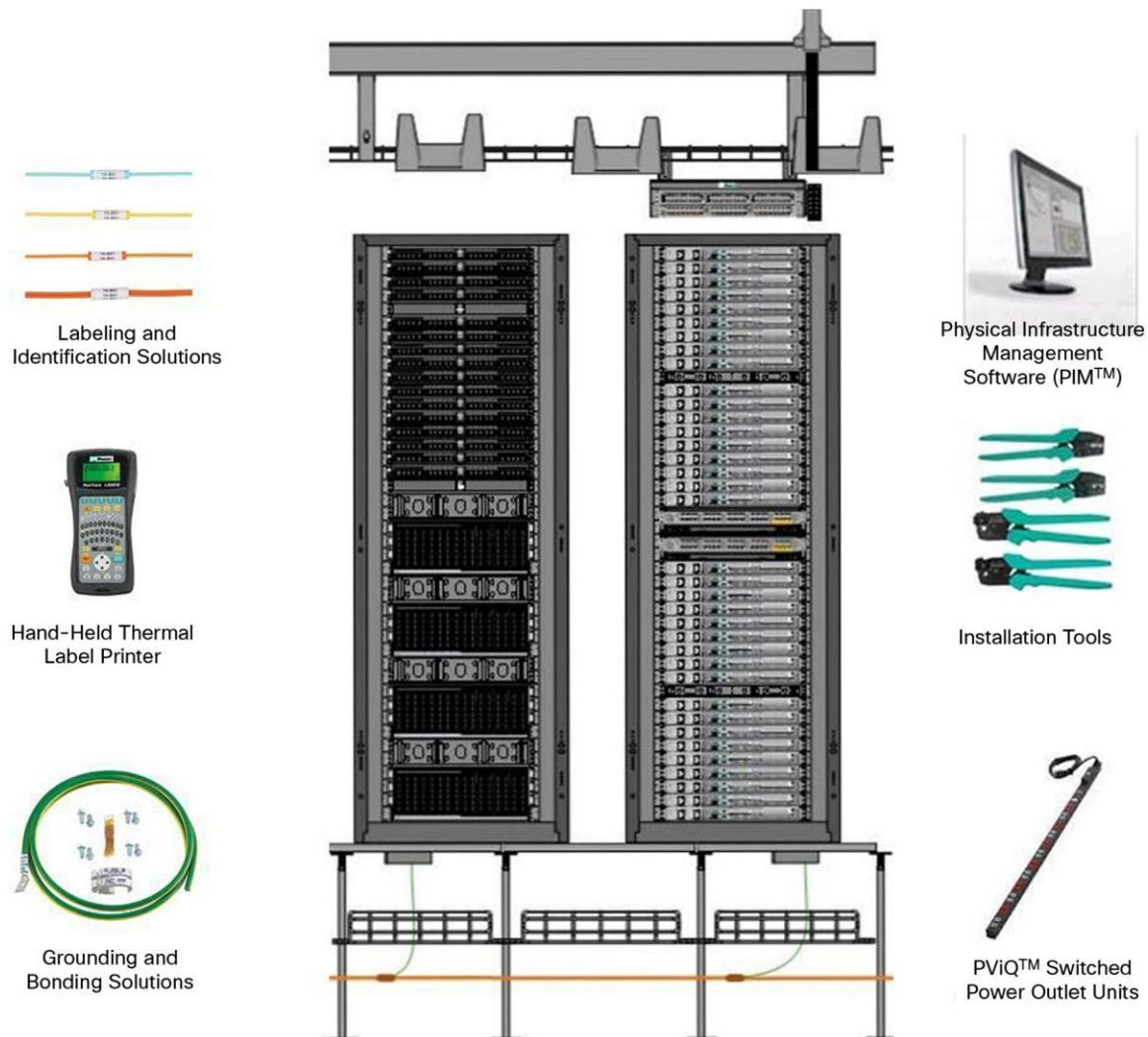
Figure 23: Panduit High-Speed Data Transport Components



Panduit Operation Management Solutions

Panduit operation management solutions help enable new technology such as the 10, 40, and 100Gigabit Ethernet switching platform of the Cisco 9000 series. This includes features for grounding, identification and labeling of products, installation tools, and Panduit Physical Infrastructure Manager (PIM) software and appliances. Panduit Advisory Services offer a broad array of assessment and optimization services to assist customers with the evaluation and deployment of Panduit Physical Infrastructure Solutions (Figure 24).

Figure 24: Panduit Operation Management Components



Conclusion

As virtualized environments are adopted by more enterprises, the pressure they apply on the network infrastructure will continue to cause datacenter stakeholders to reconsider the network architecture they use. The Cisco Nexus 9000 Series was created to optimize network performance to allow virtualized environments to function without the restrictions that traditional network architecture can impose. For a Cisco Nexus 9000 Series switching platform network to operate at the highest level, it requires a physical infrastructure built to help ensure superior performance. The Panduit Physical Infrastructure Solution gives Cisco the performance, flexibility, and reliability needed to operate without constraints.

For More Information

For more information, please contact Cisco at <http://www.cisco.com> or Panduit at <http://www.panduit.com>.



About Cisco

Cisco (NASDAQ: CSCO) is the worldwide leader in networking that transforms how people connect, communicate, and collaborate. Information about Cisco can be found at <http://www.cisco.com>. For ongoing news, please visit <http://newsroom.cisco.com>.

About Panduit

Panduit is a world-class developer and provider of market-leading innovative solutions that help customers optimize the physical infrastructure through simplification, agility, and operation efficiency. Panduit Unified Physical Infrastructure (UPI)-based solutions give enterprises the capabilities to connect, manage, and automate communications, computing, power, control, and security systems for a smarter, unified business foundation. Strong relationships with technology leaders complemented with its global staff and outstanding service and support make Panduit a valuable and trusted partner. For more information, please visit <http://www.panduit.com>.

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