Streamlined Deployment Solution for 40- and 10-Gbps Network Architecture Using Cisco Nexus 6000 Series Switches

Panduit and Cisco Simplify and Accelerate Implementation of Next-Generation 40- and 10-Gbps Network Architecture

Contents

What You Will Learn

Today's data center networks are faced with more complex cabling systems and architecture as bandwidth requirements increase. This document introduces products from Cisco and Panduit that address the associated needs. This document also describes these products deployed in today's data center networks. The first section of this document introduces the Cisco Nexus® 6000 Series Switches and typical deployment scenarios and use cases. The second section describes the cabling scenarios and the optics needed for the interworking of products from both companies. The last portion of the document summarizes some Panduit product offerings and next steps.

Introduction

Data center operators are constantly looking for technological innovations to gain a competitive advantage. The emergence of virtualization and cloud technologies has allowed many data centers to succeed at differentiating and creating advantage. Unfortunately these advances do not occur without operational consequences that were unintended or unforeseen. The result of this evolving IT landscape has many enterprises reconsidering all facets of the data center because next-generation technologies require levels of bandwidth and latency that most networks were not designed to support. In order to take advantage of the full potential of these technologies, enterprises need a network that can handle the strains that these new technologies introduce.

The foundation of the data center has always been the high-speed switching equipment and the cabling that ties all the devices together. As the migration from the physical dedicated architectures moves faster toward virtualization and cloud computing, the need for higher bandwidth, lower latency, and management simplification is critical. The Cisco Nexus 6000 Series Switches provide a solution to these issues now and also ensures investment protection for the future.

Cisco Nexus 6000 Series Switches

The Cisco Nexus 6004 and 6001 Switches are the first members of the Cisco Nexus 6000 Series platform. The Cisco Nexus 6004 and 6001 are main components of the Cisco® Unified Data Center architecture, complementing the existing Cisco Nexus family of switches. They are high-density 10 and 40 Gigabit Ethernet switches designed for a broad range of environments including physical and virtual computing, storage access, and high-performance computing (HPC). The Cisco Nexus 6004 and Nexus 6001 are well suited for middle-of-row (MoR), EoR (end-of-row), and aggregation device deployment for the data center. The one-rack-unit (1RU) size of the Cisco Nexus 6001 also makes it an excellent option as a ToR (top-of-rack) switch.

The Cisco Nexus 6004 is a 4RU switch offering 10- and 40-Gbps and Fibre Channel over Ethernet (FCoE) support at wire speed with line-rate nonblocking overall throughput of 7.68 terabits per second (Tbps). The Cisco Nexus 6004 (Figure 1) offers 96 ports of 40-Gbps Enhanced Quad Small Form-Factor Pluggable (QSFP+) connectivity in a fully populated system. The Cisco Nexus 6004 is equipped with eight expansion bays capable of accepting the 12-port expansion modules that can be used to increase the total number QSFP+ interfaces to 96. Because all the QSFP+ port can operate in either 40 Gigabit Ethernet or quad 10 Gigabit Ethernet mode, the total system port count is 96 40 Gigabit Ethernet ports or 384 10 Gigabit Ethernet ports. Just as with the Cisco Nexus 5500 platform switches, all ports on the Cisco Nexus 6000 Series also support no-drop FCoE traffic.

The Cisco Nexus 6004 delivers low latency and low jitter, independent of packet size and services enabled. Using cut-through technology, port-to-port latency with the Cisco Nexus 6004 is approximately 1 microsecond. The Cisco Nexus 6004 delivers 96 ports of line-rate 40 Gbps or 384 ports of line-rate 10 Gbps using breakout cables. The Cisco Nexus 6004 is based on the Cisco NX-OS Software Linux-based operating system. The Cisco NX-OS is built on a high-availability architecture, delivering an integrated Layer 2 and Layer 3 feature set targeting data center applications.

Figure 1: Cisco Nexus 6004 Switch: Port View

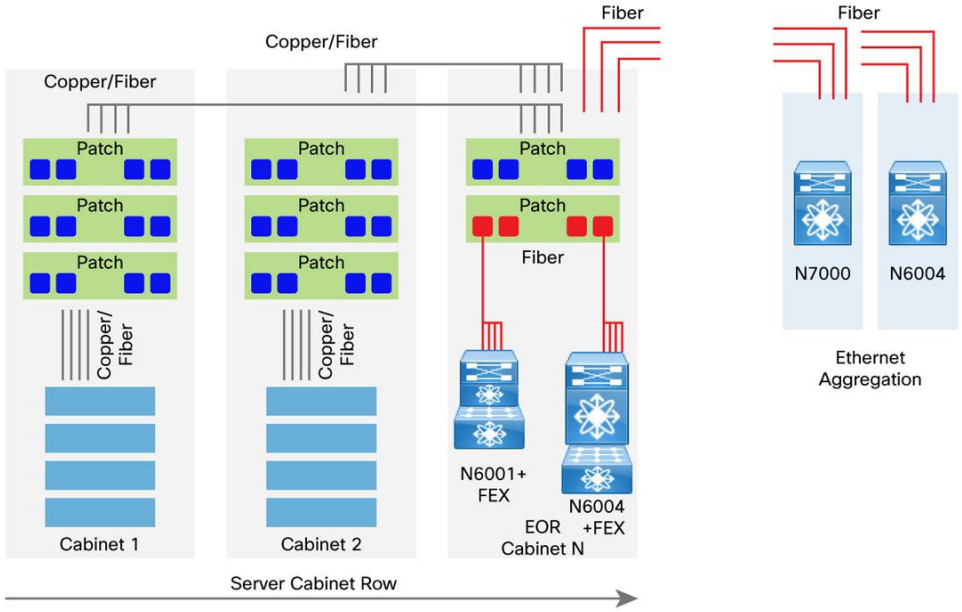
The Cisco Nexus 6001 (Figure 2) is a 1RU fixed switch built to provide 1 and 10-Gbps and FCoE server access connectivity. The Cisco Nexus 6001 offers 48 ports of 10 Gbps (SFP+) and 4 ports of 40 Gbps (QSFP+). The Cisco Nexus 6001 is well suited for data center ToR, EoR, and Cisco Unified Computing System™ (Cisco UCS®) fabric interconnection. Integrated line-rate Layer 2 and Layer 3 along with no-drop FCoE on all ports make the Cisco Nexus 6001 excellent for deployments in enterprise, service provider, and commercial environments. The Cisco Nexus 6001 offers 48 ports of 10 Gbps with SFP+ optics, and each of the four QSFP+ interfaces can be used as either a single 40 Gigabit Ethernet port or quad 10 Gigabit Ethernet ports. The variable-direction airflow of the product also make it well suited for both network and server-rack deployments.

Figure 2: Cisco Nexus 6001 Switch

Cisco Nexus 6000 Deployment Scenarios

The Cisco Nexus 6004 and 6001 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 fabric extender with a Cisco Nexus 6004 or 6001 parent switch as shown in Figure 3. Connectivity from the Cisco Nexus 6004 or 6001 to the aggregation layer Cisco Nexus 7000 or 6000 Series Switch is performed through fiber optic cabling (OM3 or OM4).

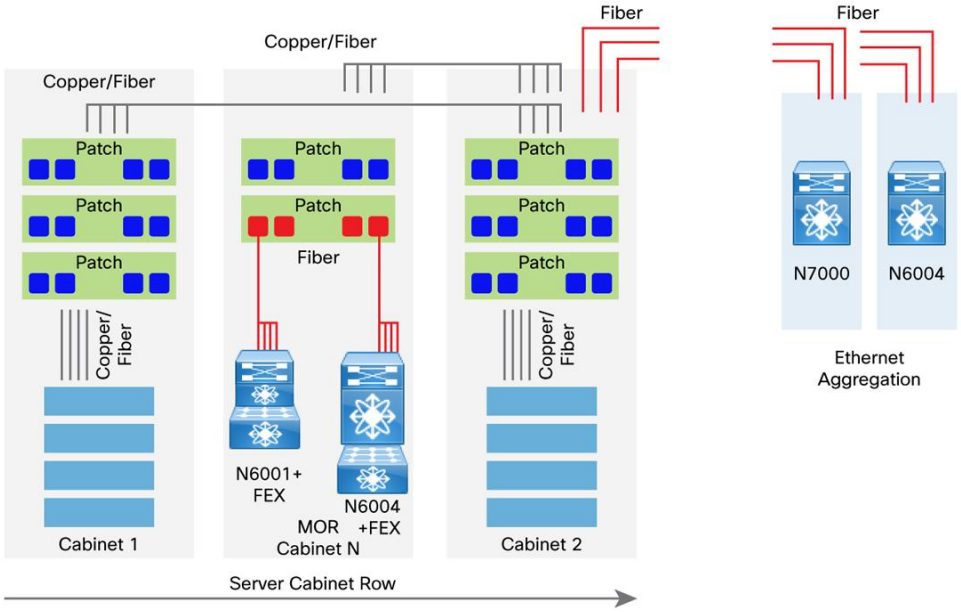
Figure 3: EoRow Design Using Cisco Nexus 6004 and 6001



The EoR design could consist of either a Cisco Nexus 6001 or 6004 Switch.

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 6004 or 6001 devices (Figure 4).

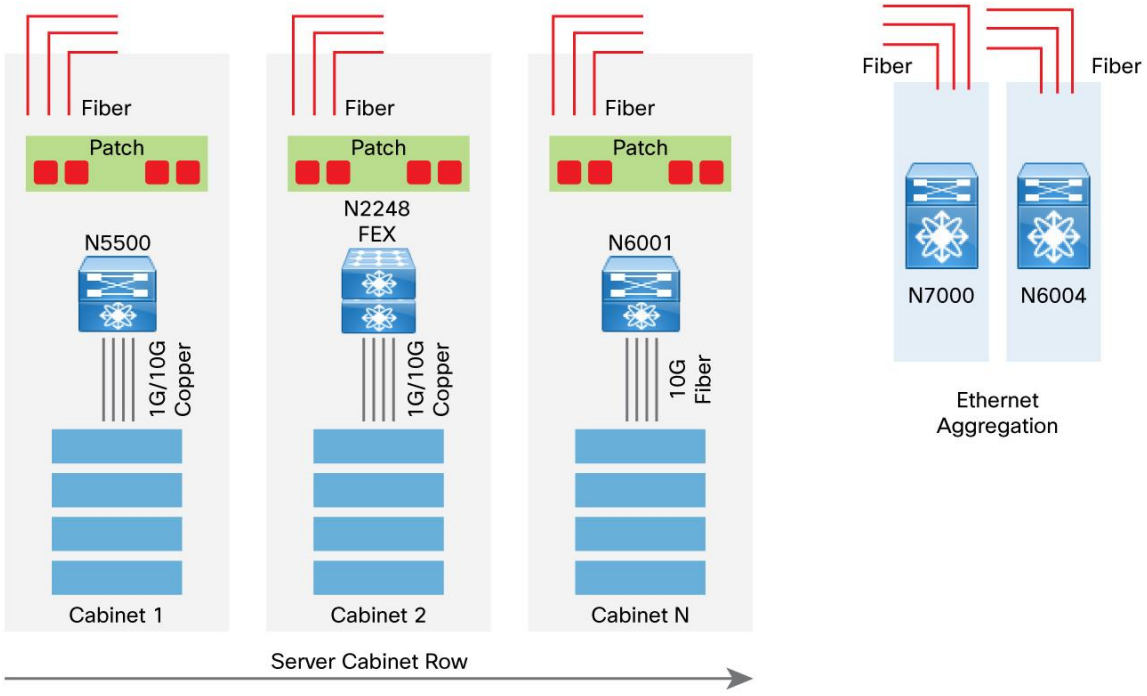
Figure 4: Middle-of-Row (MoR) Design Using Cisco Nexus 6004 and 6001



With an EoR or MoR design using the Cisco Nexus 6000 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 6000 Series, 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 5500 platform, Cisco Nexus 2000 Series Fabric Extenders, and Cisco Nexus 6001. In ToR designs, the servers in the cabinet connect directly to either a Cisco Nexus 6001 Switch or a Cisco Nexus 2000 Series Fabric Extender. The Cisco Nexus 2000 Series Fabric Extender would have a parent switch that is a Cisco Nexus 6004 or 6001, Cisco Nexus 5500 platform, or Cisco Nexus 7000 Series Switch. 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. (Figure 5).

Figure 5: Top-of-Rack (ToR) Design using Nexus 6004 and Nexus 6001



For the ToR design in Figure 5, the Cisco Nexus 2248 will connect to the parent switch in the aggregation layer (Cisco Nexus 7000 Series or Cisco Nexus 6004).

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

	Host Facing					Network Facing	
Fabric Extenders	**100MBASE-T**	**1000MBASE-T**	**1-Gbps SFP**	**10-Gbps SFP+**	**10GBASE-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					✓	✓	

	Host Facing					Network Facing	
Fabric Extenders	**100MBASE-T**	**1000MBASE-T**	**1-Gbps SFP**	**10-Gbps SFP+**	**10GBASE-T**	**10-Gbps SFP+**	**4 x 10-Gbps QSFP+**
Cisco Nexus 2232TM-E					✓	✓	
Cisco Nexus 2248PQ			✓	✓			✓

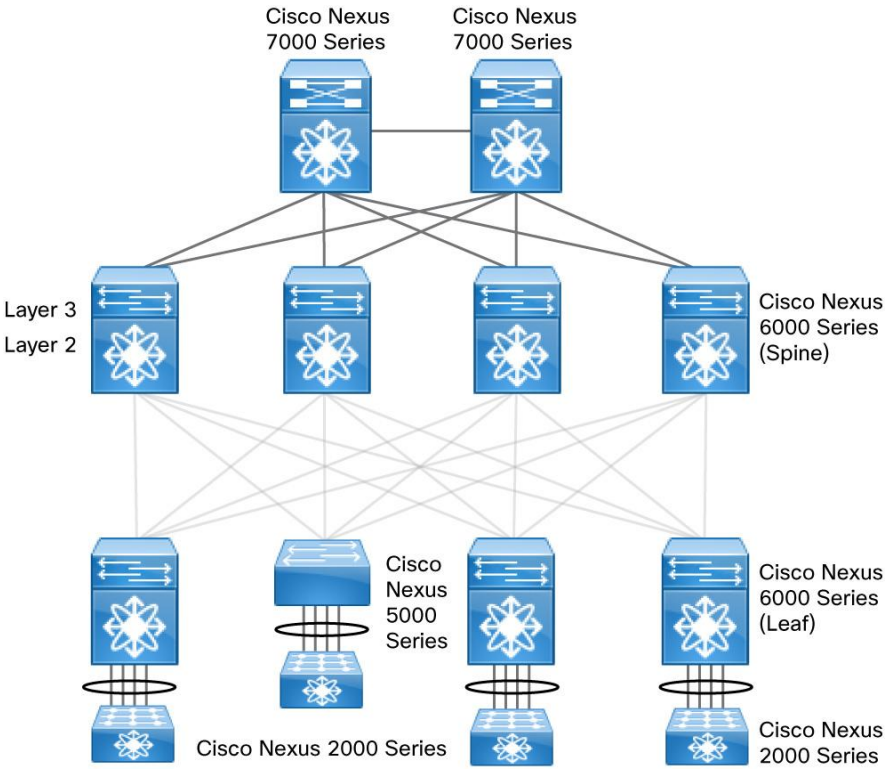
Cisco Nexus 6000 Series Use Case

The Cisco Nexus 6000 Series is a strong fit for the data center use cases described here.

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

To meet the growing demands of 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 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 nonblocking, low-latency fabric, forwarding packets between leaves at Layer 2. The leaf switches provide connectivity to servers. Use of a highly meshed 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 6, the Cisco Nexus 6004 is deployed as a leaf-and-spine switch.

Figure 6: Large-Scale Fabric: Leaf-and-Spine Architecture



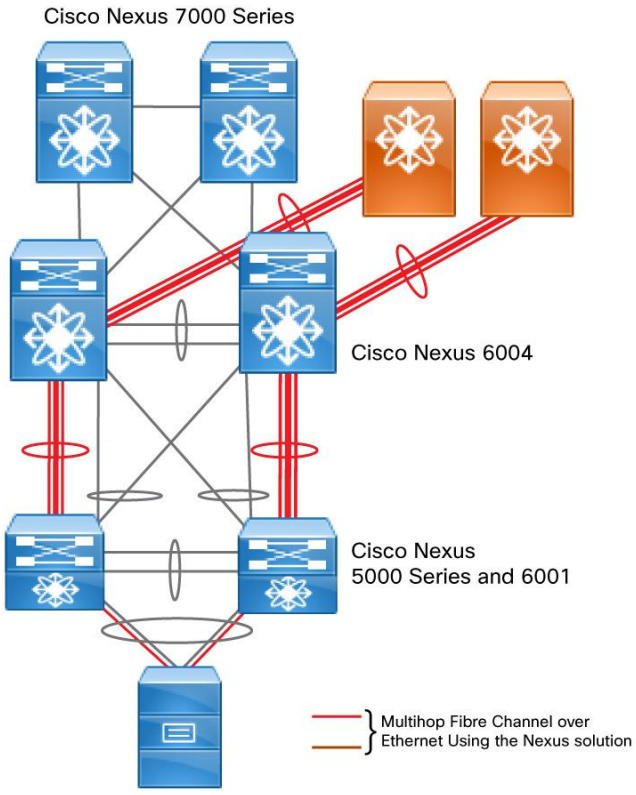
The topology in Figure 6 shows the Cisco Nexus 6000 Series used as a leaf node that connects to either the Cisco Nexus 5000 or 2000 Series or directly to the Cisco Nexus 2000 Series. Since the Cisco Nexus 6004 can also be used as a spine switch, it will connect to either a Cisco Nexus 5500 platform leaf switch or Cisco Nexus 6004 or 6001 leaf switch. The spine devices will then connect to the Cisco Nexus 7000 Series in the data center core. The deployment flexibility of the Cisco Nexus 6000 Series enables it to be used in both spine and leaf switch roles.

Multihop FCoE

Cisco Unified Fabric combines data center and storage networks to deliver a single high-performance highly available and scalable network. With the Cisco Nexus 6004, Cisco can support end-to-end data center convergence from the server to storage by delivering multihop FCoE capability in the data center. The FCoE function complements the existing FCoE function on the Cisco Nexus 5500 switch platform. With this broad selection of standards-based FCoE switches, Cisco provides unified fabric support to both the access and core network layers, supporting all storage traffic (Fibre Channel, FCoE, Small Computer System Interface over IP [iSCSI], and network-attached storage [NAS]) over simplified infrastructure based on lossless 10 and 40 Gigabit Ethernet.

For the topology in Figure 7, the Cisco Nexus 6004, with support for FCoE on both 10 and 40 Gigabit Ethernet, can connect to the storage infrastructure or converged network adapters (CNAs) using FCoE-capable Ethernet ports. For northbound connectivity, the Cisco Nexus 6004 can connect to the Cisco Nexus 7000 Series or Cisco Nexus 6004 in the aggregation layer. The multihop FCoE extends the flexibility and scalability of convergence further into the data center while preserving investments in Fibre Channel SANs.

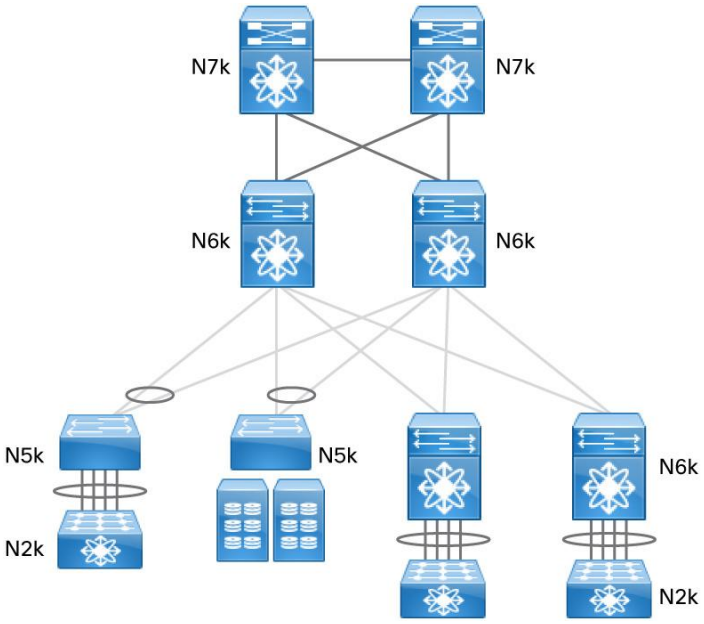
Figure 7: Multihop FCoE



Fabric Extender Architecture: High-Density Fabric Extender Aggregator

Cisco Fabric Extender Technology (FEX Technology) enables customers to build a single, modular fabric that extends from Cisco Nexus switches, to Cisco UCS servers, to adapters (Cisco Adapter FEX), and to virtual machines (Cisco Data Center Virtual Machine FEX [VM-FEX]). 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 6004 can be used as a high-density fabric extender aggregation platform for the Cisco Nexus 2200 platform products (Figure 8).

Figure 8: Fabric Extender Aggregation



The Cisco Nexus 2000 Series Fabric Extenders can be physically located at the top of the rack, and the Cisco Nexus 6004 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 6004 is compatible with integrated transceivers and Twinax cabling solutions, which deliver cost-effective connectivity for 10 Gigabit Ethernet to servers at the rack level, eliminating the need for expensive optical transceivers. For the option shown in Figure 8, the Cisco Nexus 6004 is deployed as a high-density 10 and 40 Gigabit Ethernet fabric extender aggregator connecting to both the Cisco 5000 and 2000 Series ToR, the Cisco Nexus 2000 Series ToR, or the Cisco Nexus 5000 Series ToR switch.

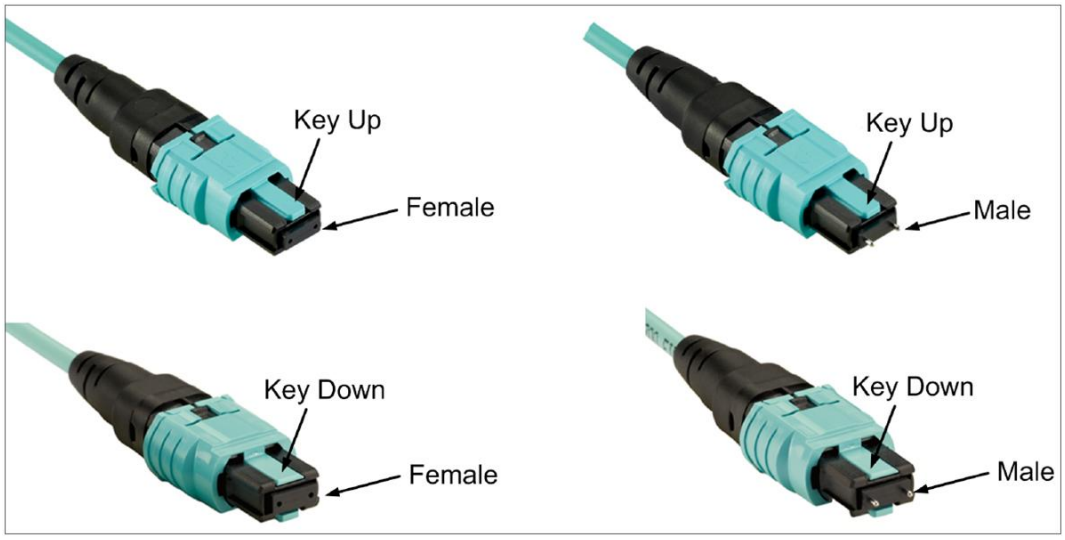
PanMPO Connector

The PanMPO Connector is Panduit's revolutionary MPO connector that protects your fiber infrastructure investment and improves operational efficiency to save time and money. This connector allows you to change polarity and gender on your fiber cable assemblies and this unique, patented connector helps ease the migration from 10 Gigabit Ethernet to 40 Gigabit Ethernet while keeping the installation in compliance. Figure 9 shows the four connector options.

The PanMPO Connector offers these benefits:

- Easily converts between male and female gender, and between key-up and key-down polarity for a standards-compliant 10, 40 and 100 Gigabit Ethernet installation
- Allows connector changes to be made in the field, as needed, avoiding rip-and-replace costs and disruptions
- Eliminates the need to carry inventory of four different types of MPO patch cords
- Allows you to order with confidence because if you order the wrong cables, you can change the polarity or gender to have the correct cables
- Available on trunks, harnesses, interconnects, and reference cords

Figure 9: PanMPO Connector Options: Four Configurations with Just One Connector



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 6004. Typical wiring solutions that include products from Cisco and Panduit are described.

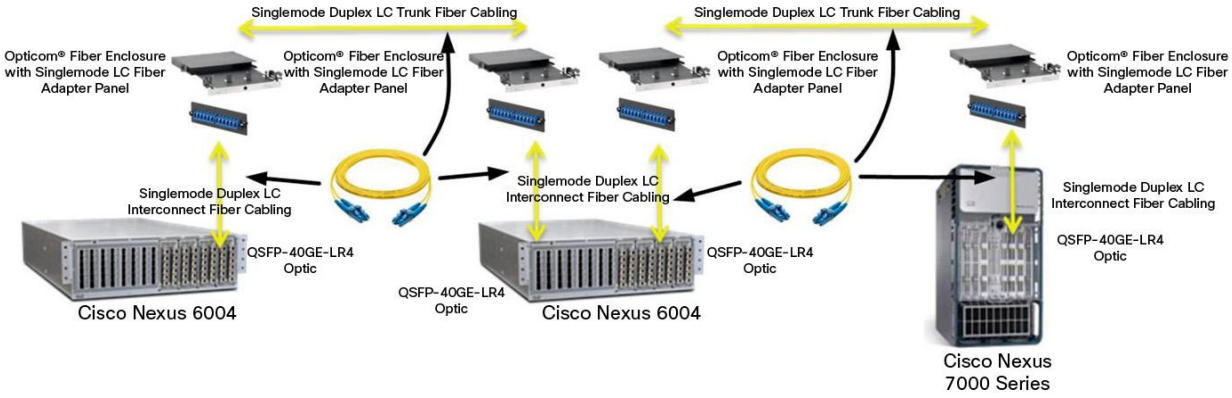
The wiring scenarios described here can be used in a Cisco Nexus 6000 Series deployment.

Fiber Cabling Options

Cisco Nexus 6004 to Cisco Nexus 6004 or Cisco Nexus 7000 Series Using QSFP+ to QSFP+ optics with Single-Mode Cabling

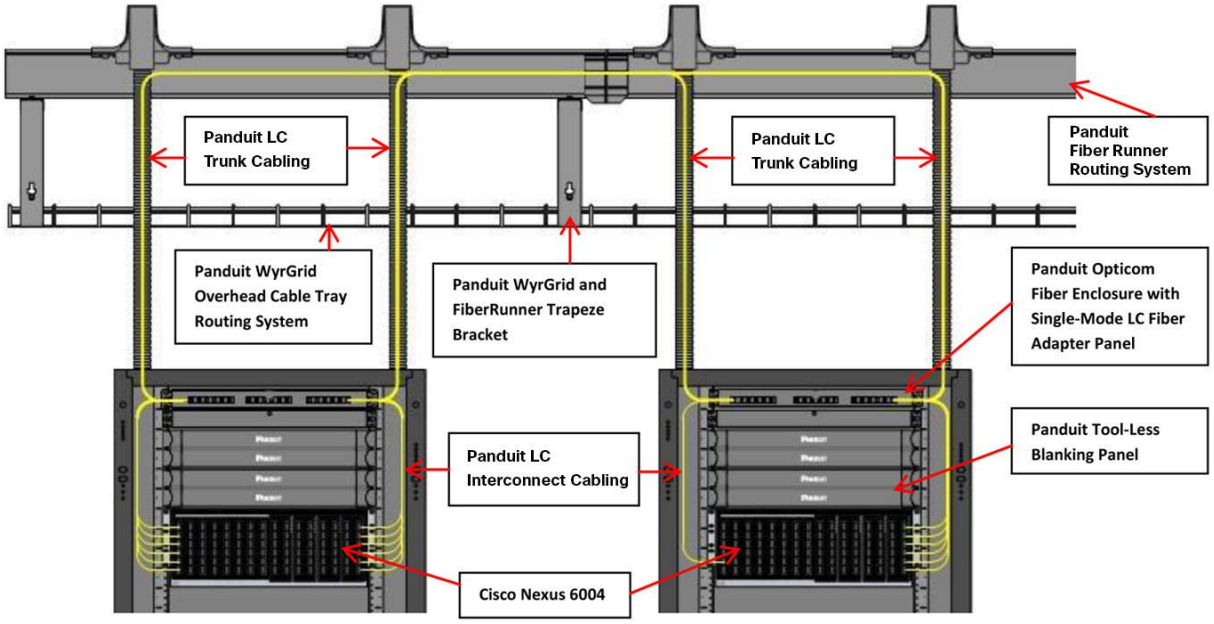
Figure 10 shows this scenario.

Figure 10: Cisco Nexus 6004 Single-Mode Cabling Components



This scenario displays a wiring option for a Cisco Nexus 6004 to another Cisco Nexus 6004 or to a Cisco Nexus 7000 Series Switch using single-mode fiber. With QSFP-40G-LR4 optics, this scenario is capable of distances of up to 10 km. In the scenario, the Cisco Nexus 6004 would use a QSFP+ optic which connects via a single-mode interconnect fiber cable to the front of the LC fiber adapter panel within the Opticom fiber enclosure. The single-mode LC trunk fiber cable would connect to the rear of the LC fiber adapter panel in the port that corresponds to the port to which the cable in the front of the panel has been connected. The LC trunk fiber plugs into the back of the adapter panel on the remote end. The single-mode interconnect fiber connects to the front of the adapter panel in the corresponding port and then to the next Cisco Nexus device. Each LC fiber adapter panel can be loaded with up to 12 LC single-mode duplex fiber cables that snap into the patch panels and enclosures for easy network deployment or moves, additions, and changes. Figure 11 shows how the connections would be made using a front view.

Figure 11: Cisco Nexus 6004 to Cisco Nexus 6004 Single-Mode Cabling Diagram



For the topology in Figure 11, Table 2 lists the Cisco and Panduit optics and cabling options with corresponding part numbers.

Table 2: Cisco Nexus 6004 Single-Mode QSFP+ Optics and Cabling Products

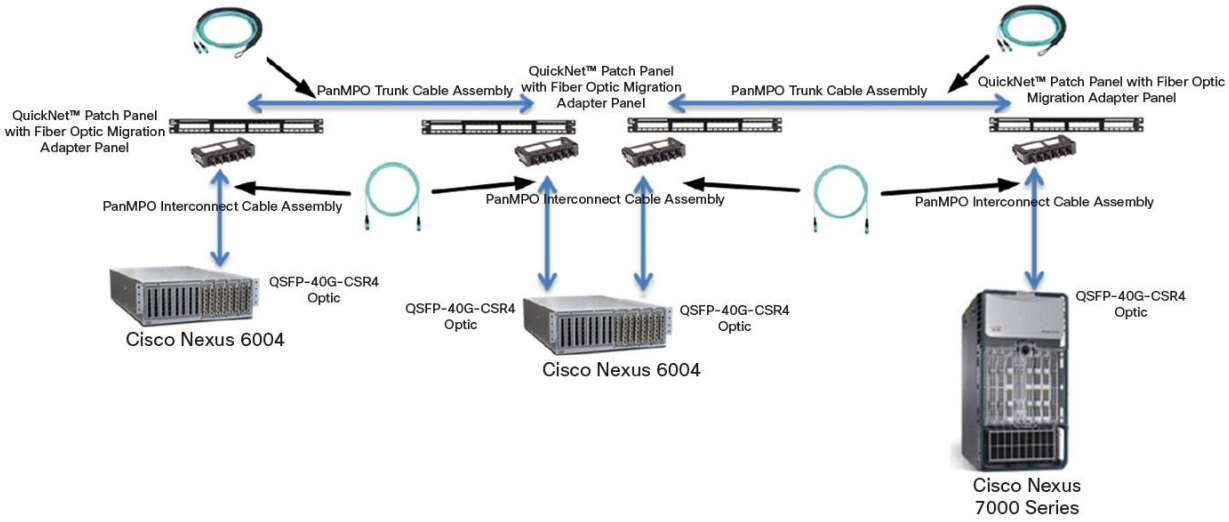
Cisco Product Description	Cisco Part Number
40GBASE LR4 QSFP, 10-km SMF	QSFP-40G-LR4
Panduit Product Description	**Panduit Part Number**
Opticom Rack-Mount Fiber Enclosure	FRME1U
LC Fiber Adapter Panel - Singlemode	FAP12WBULCZ
Singlemode Fiber Cabling - OptiCore Interconnect/Trunk Cable - Various Lengths	F9E10-10M*Y

* Insert distance for correct Panduit product number (for example, 1 meter cable is F9E10-10M1Y).

Cisco Nexus 6004 to Cisco Nexus 6004 or Cisco Nexus 7000 Series Using QSFP+-to-QSFP+ PanMPO Connectivity for Multimode Connectivity.

Figure 12 shows this scenario.

Figure 12: Cisco Nexus 6004 to Cisco Nexus 6004 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 12 shows a wiring option for connecting a Cisco Nexus 6004 to another Cisco Nexus 6004 and to a Cisco Nexus 7000 Series 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 support 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 6004 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 Female PanMPO connectors. The trunk cabling will then always be Male PanMPO-to-Male PanMPO trunk cables. The use of this cabling methodology throughout the data center 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 up to key up) cabling for both the interconnect and trunk cables. This approach standardizes the type of cable used throughout the data center, eliminating the need for several different interconnect cable types, as would be necessary if you used other polarity methods in the infrastructure.

Table 3 shows the Cisco and Panduit optics and cabling options with corresponding part numbers for a QSFP+-to-QSFP+ multimode connection. Figure 13 shows a PanMPO cabling scenario.

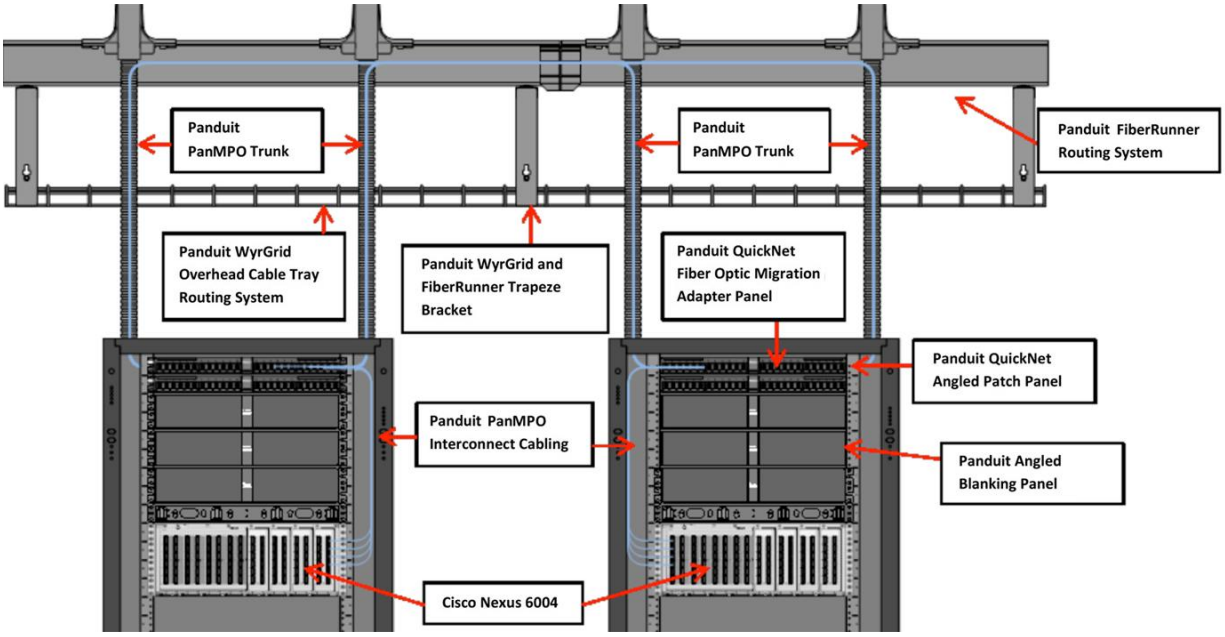
Table 3: Cisco Nexus 6004 PanMPO to PanMPO Multimode QSFP+ Optics and Cabling Products

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 FHPX126LM001N).

Figure 13: Cisco Nexus 6004 PanMPO to PanMPO Cabling Diagram



Choosing Between Single-Mode and Multimode Fiber

The decision to deploy single-mode or multimode fiber depends primarily on two factors: reach and cost. Single-mode fiber transceivers and connectors are much more expensive than the multimode equivalents. Although the total system cost for single-mode fiber is much higher, this type is often deployed in long-reach applications that are beyond the capability of its multimode counterpart. A single-mode deployment uses QSFP+ single-mode optics, which use coarse wavelength-division multiplexing (CWDM) technology to multiplex four different wavelengths on a single pair of fiber. Standard multimode QSFP+ optics use parallel optics and require four pairs of fibers and thus the use of MPO 12-strand fiber. Table 4 provides a high-level list of differences between the two options.

Table 4: Multimode Compared to Single-Mode Cabling Options

Multimode		Single Mode	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Lower total system cost (transceivers and connectors)	Shorter reach	Higher bandwidth capabilities (WDM) and longer reach	Higher total system cost (transceivers and connectors)

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

The Cisco Nexus 6004 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 6004 has a total of 384 10-Gbps interfaces per switch.

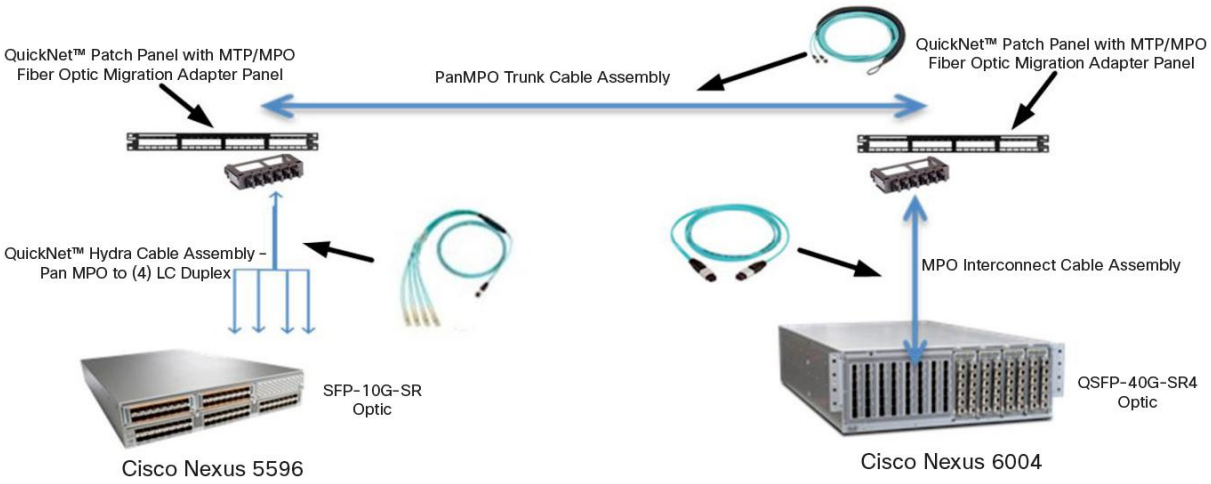
Through the use of a PanMPO to LC breakout cable, the Cisco Nexus 6004 can connect to the Cisco Nexus 5500 platform or directly to the Cisco Nexus 2000 Series Fabric Extenders. The cable required here would be PanMPO on one end, connecting to the QSFP+ optics in a Cisco Nexus 6004, and it then would break out into four individual fiber pairs links on the other end. These breakout cables terminate with LC duplex connectors.

Cisco Nexus 6004 to Cisco Nexus 5000 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 14 shows this scenario.

Figure 14: Cisco Nexus 6004 PanMPO to LC Duplex Hydra Cabling Components



This scenario shows a wiring option connecting a Cisco Nexus 6004 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 6004 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 5 lists the Cisco Nexus 6004 PanMPO to LC Hydra optics and cabling products.

Table 5: Cisco Nexus 6004 PanMPO to LC Hydra Optics and Cabling Products

Cisco Product Description	Cisco Part Number
Cisco 10G Fabric Extender Transceiver, LC duplex connector	FET-10G (N6k to N2K only)
Cisco 40G Fabric Extender Transceiver, LC duplex connector	FET-40G (N6k to N2K only)
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

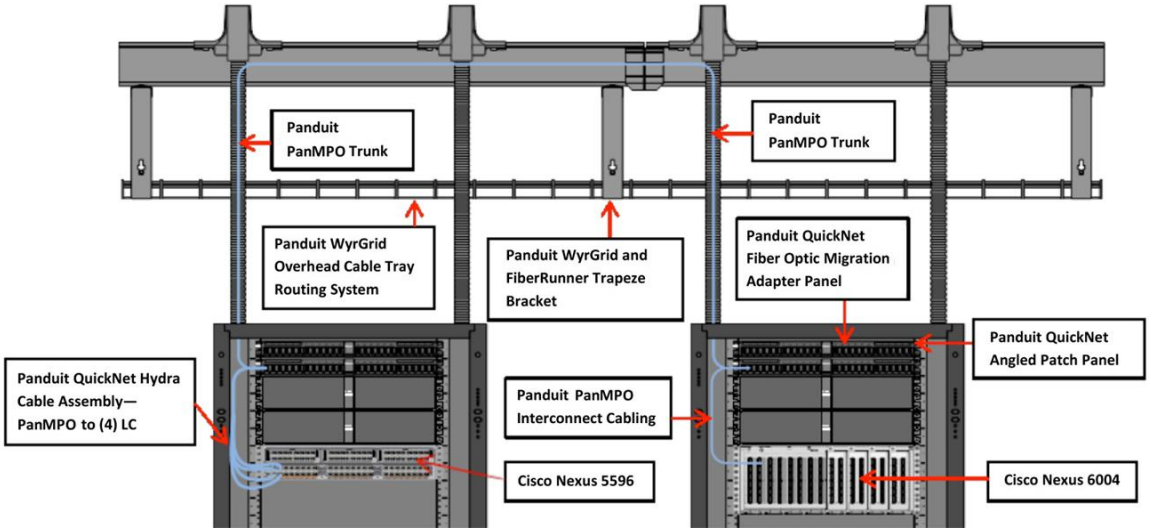
Panduit Product Description	Panduit Part Number
QuickNet 24-Port Patch Panel	QPP24BL
QuickNet Fiber Optic Migration Adapter Panel	FQMAP65CG
QuickNet PanMPO Interconnect Cable Assembly (OM3) (Configured with Female to Female, Method B*)	FXTRP7N7NBNM**
QuickNet PanMPO Trunk Cable Assembly (OM3) (Configured 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 FHPX126LM001N).

Figure 15 shows a Cisco Nexus 6004 to Cisco Nexus 5596 using PanMPO to LC Hydra cabling.

Figure 15: Cisco Nexus 6004 PanMPO to LC Hydra Cabling Diagram



Copper Cabling Options

QSFP+ Direct-Attach Copper Cabling

Figure 16 shows a wiring option for a Cisco Nexus 6004 to another Cisco Nexus 6004 and a Cisco Nexus 6001 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 16: Cisco Nexus 6004 QSFP+ 40Gbps Direct-Attach Copper Cabling Diagram

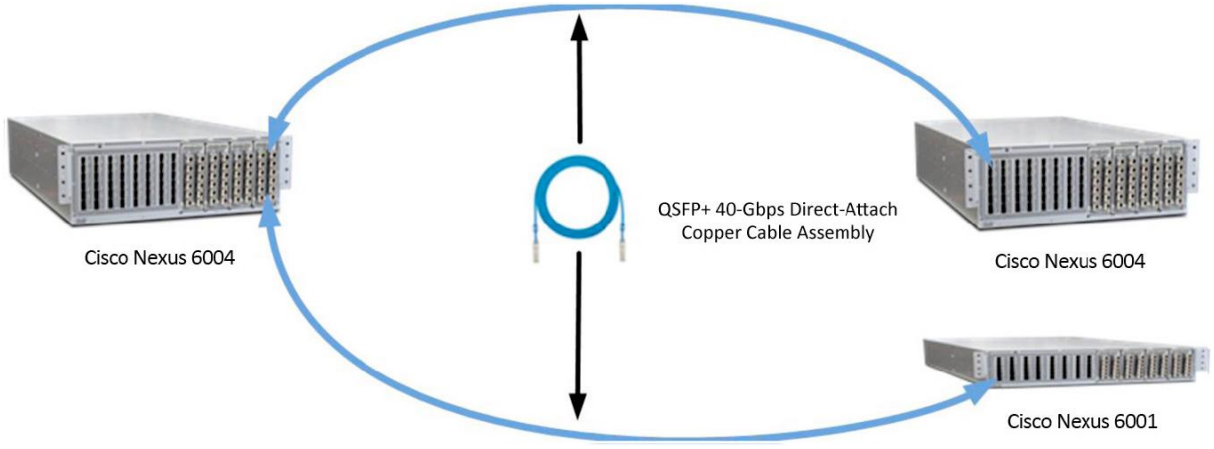


Table 6 lists the Cisco Nexus 6004 QSFP+ and SFP+ direct-attach copper cabling products.

Table 6: Cisco Nexus 6004 QSFP+ and SFP+ Direct-Attach Copper Cabling Products

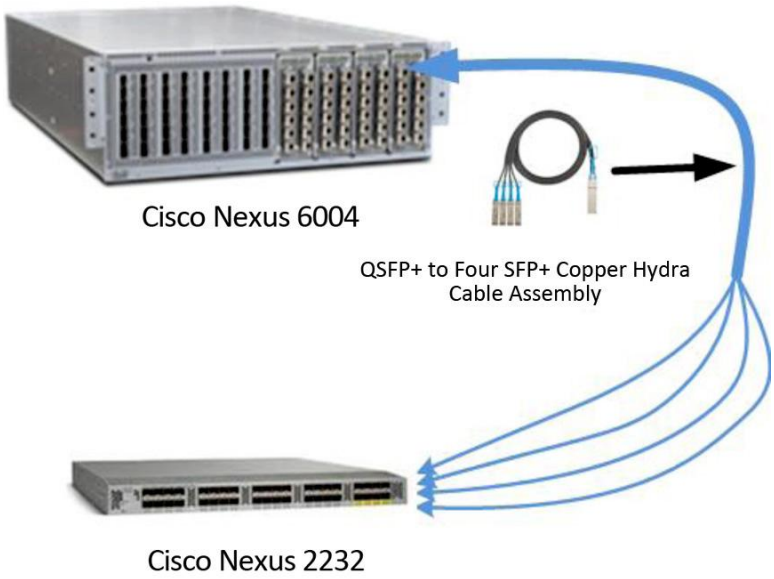
Cisco Product Description	Cisco Part Number
Twinax Passive SFP+, 1.5m	SFP-H10GB-CU1-5M[1]
Twinax Passive SFP+, 2m	SFP-H10GB-CU2M[1]
Twinax Passive SFP+, 2.5m	SFP-H10GB-CU2-5M[1]
40GBASE-CR4 direct-attach QSFP copper cable, 1 meter	QSFP-H40G-CU1M
40GBASE-CR4 direct-attach QSFP copper cable, 3 meter	QSFP-H40G-CU3M
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 17 shows this scenario.

Figure 17: Cisco Nexus 6004 QSFP+ to SFP+ Hydra Cabling Diagram



This scenario shows a wiring option for connecting a Cisco Nexus 6004 to a Cisco Nexus 2232 using a QSFP+ to four SFP+ copper hydra cable assembly. By using passive copper cables cable, lengths up to 5 meters are possible. Active copper cables allow connectivity up to 10 meters. This connection option is typical in ToR, MoR, and EoR deployments, where the distance between switches is within 10 meters.

Table 7 lists the Cisco and Panduit cabling options with corresponding part numbers for QSFP+ to (4) SFP+ hydra cable assemblies.

Table 7: Cisco Nexus 6004 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

QSFP+ to SFP+ or QSFP+ to QSFP Using Fabric Extender Transceiver (FET)

For deployments that require fiber optic connectivity or distances beyond that of copper Twinax cables, the Cisco Nexus 6004 can connect with the Cisco Nexus 2200 platform fabric extenders using fabric extender transceivers (FETs). The Cisco FET-40G and FET-10G are low-cost optical transceivers that connect the Cisco Nexus 6004 to Cisco Nexus 2200 platform fabric extenders using OM3 or OM4 multimode fiber over distances up to 100 meters.

FET-40G to FET-10G (100-Meter Distance with OM3)

Figure 18 shows this option.

Figure 18: Cisco Nexus 6004 FET-40G to FET-10G Connectivity Options

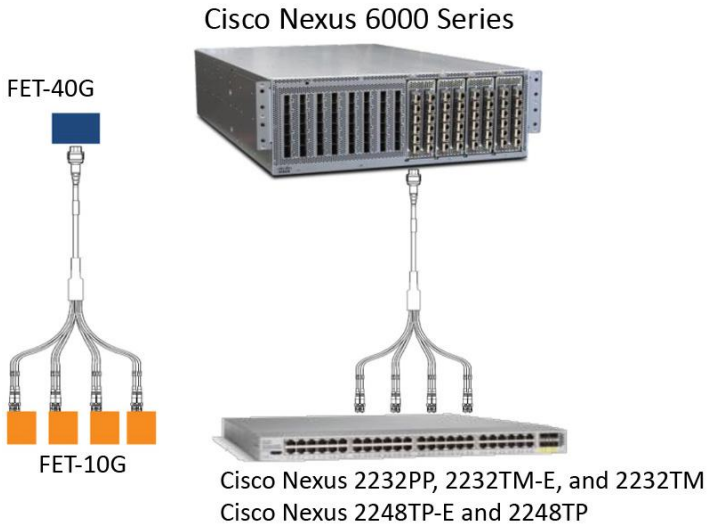


Table 8 lists the Cisco optics and Panduit cabling options with corresponding part numbers for FET-40G to FET-10G connectivity.

Table 8: Cisco Nexus 6004 FET-40G to FET-10G Optics and Cabling Products

Cisco Product Description	Cisco Part Number
Cisco 40G Fabric Extender Transceiver, MPO connector	FET-40G (N6k to N2k only)
Cisco 10G Fabric Extender Transceiver, LC duplex connector	FET-10G (N6k to N2K only)
Panduit Product Description	**Panduit Part Number**
QuickNet MPO 8-Fiber Hydra Cable Assembly (OM3) (Female MPO to 4 Duplex LC)	FX8HP5NLSQNM*

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

FET-40G to FET-40G (100-Meter Distance with OM3)

Figure 19 shows this scenario.

Figure 19: Cisco Nexus 6004 FET-40G to FET-40G Connectivity Options

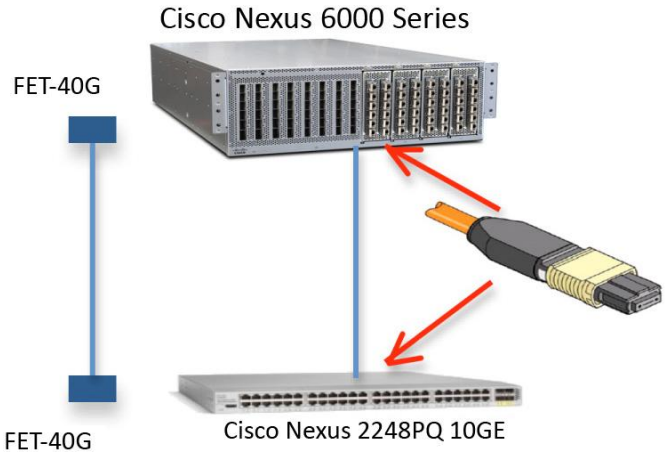


Table 9 lists the Cisco optics and Panduit cabling options with corresponding part numbers for FET-40G to FET-40G connectivity.

Table 9: Cisco Nexus 6004 FET-40G to FET-40G Optics and Cabling Products

Cisco Product Description	Cisco Part Number
Cisco 40G Fabric Extender Transceiver, MPO connector	FET-40G (N6k to N2K only)
Panduit Product Description	**Panduit Part Number**
QuickNet PanMPO Interconnect Cable Assembly (OM3) (Configured with Female to Female, Method B*)	FXTRP7N7NBNM**

* 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 FXTRP7N7NBNM001).

The Cisco FETs support link lengths up to 100 meters on laser-optimized OM3 or OM4 multimode fiber. They are supported on fabric links only from a Cisco Nexus 2200 platform to a Cisco parent switch.

The Cisco FET has the benefits of lower power use and lower cost and needs fewer cables for installation.

Panduit Unified Physical Infrastructure Solution

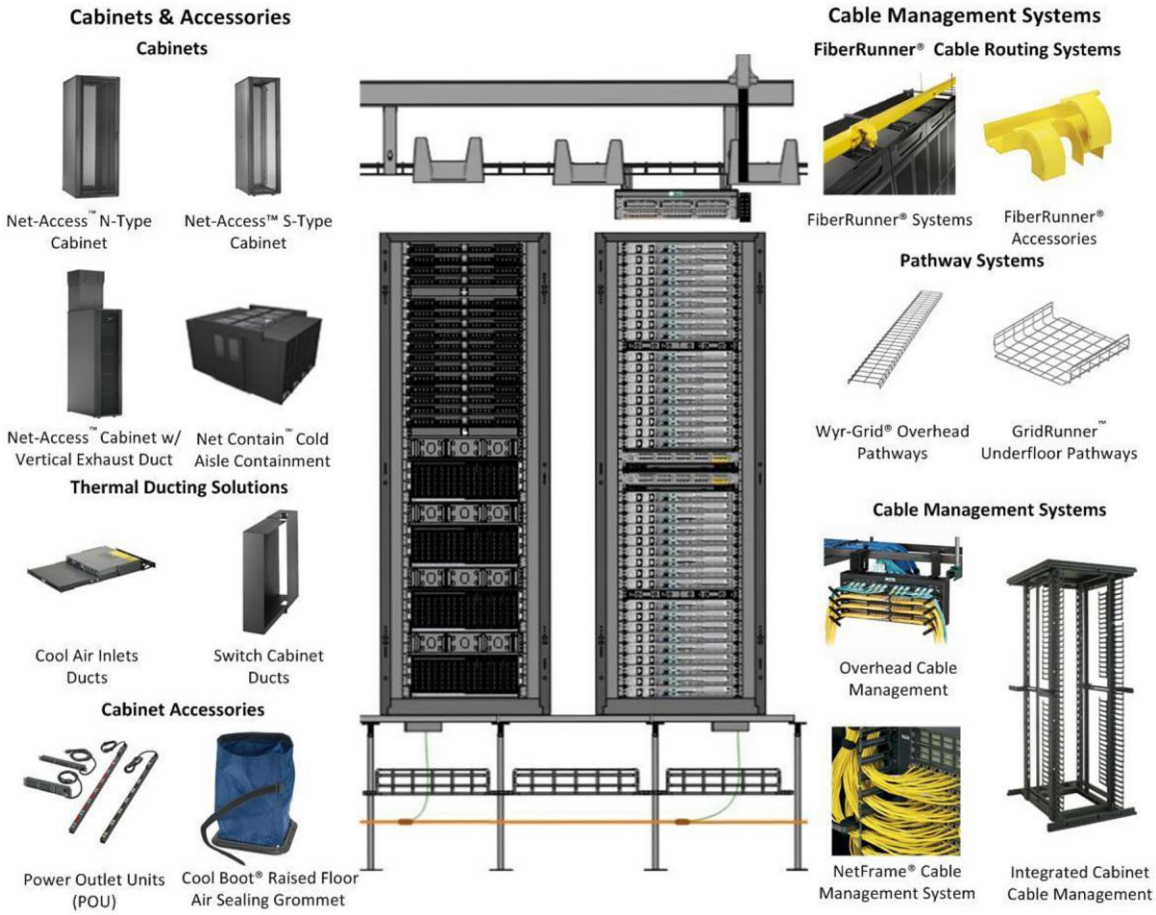
Panduit offers a complete solution for the infrastructure supporting Cisco 40-Gbps switching platforms.

Panduit Cabinet and Cable Management Solutions

Panduit cabinet and cable management solutions help enable 10- and 40-Gbps switching platforms such as the Cisco Nexus 6000 Series. 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 6000 Series deployment. Panduit Pre-configured Infrastructure Solutions simplify and accelerate deployment, enhance thermal performance, and decrease energy use.

Figure 20 shows some of the features of Panduit cabinet and cable management component options that could make up its solutions.

Figure 20: Panduit Cabinet and Cable Management Components



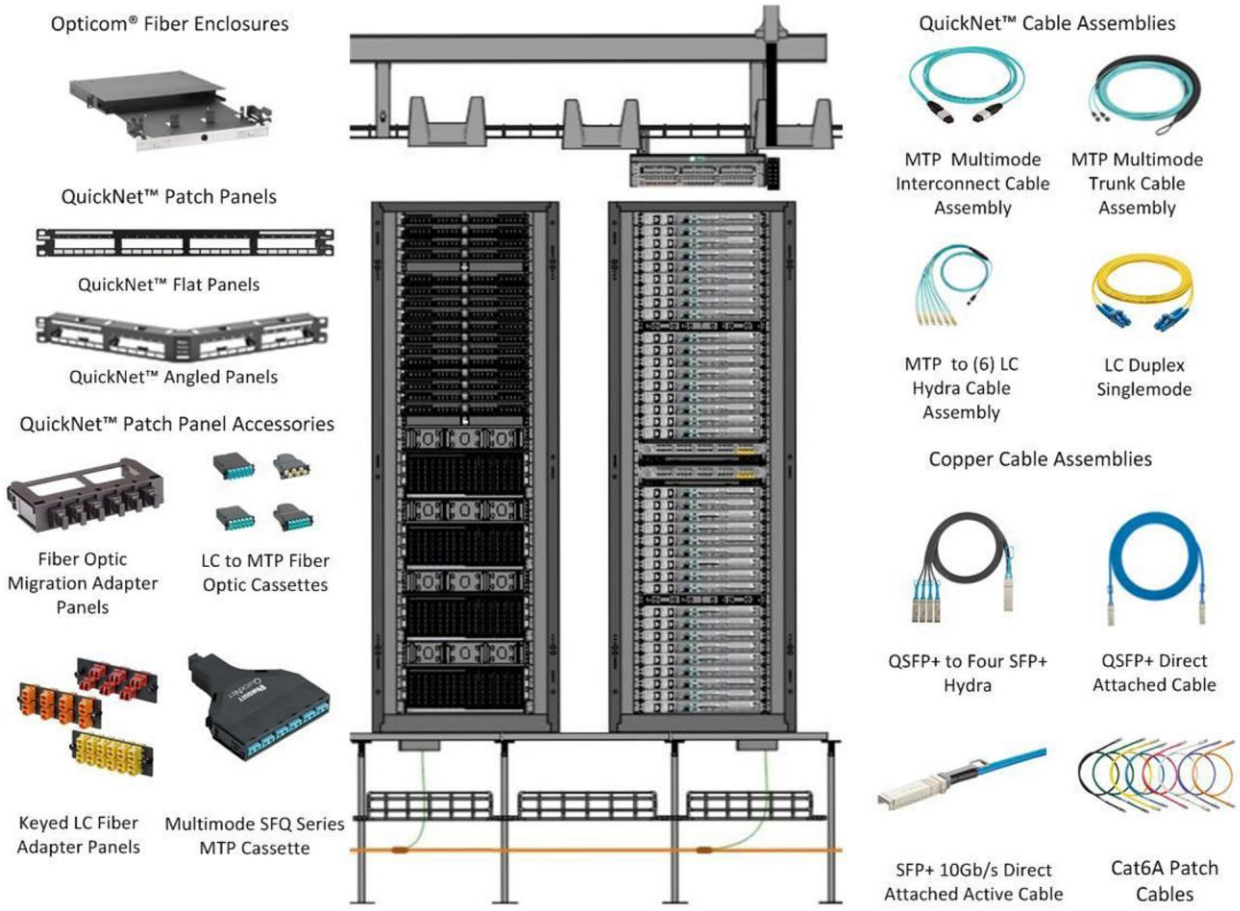
Panduit High-Speed Data Transport Solutions

Panduit fiber optic and copper cabling solutions for 10, 40, and 100 Gigabit Ethernet support switching platforms such as the Cisco Nexus 6000 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 21 shows some of the product options that can be used in a Panduit High-Speed Data Transport (HSDT) Solution for Cisco 6000 Series Switches.

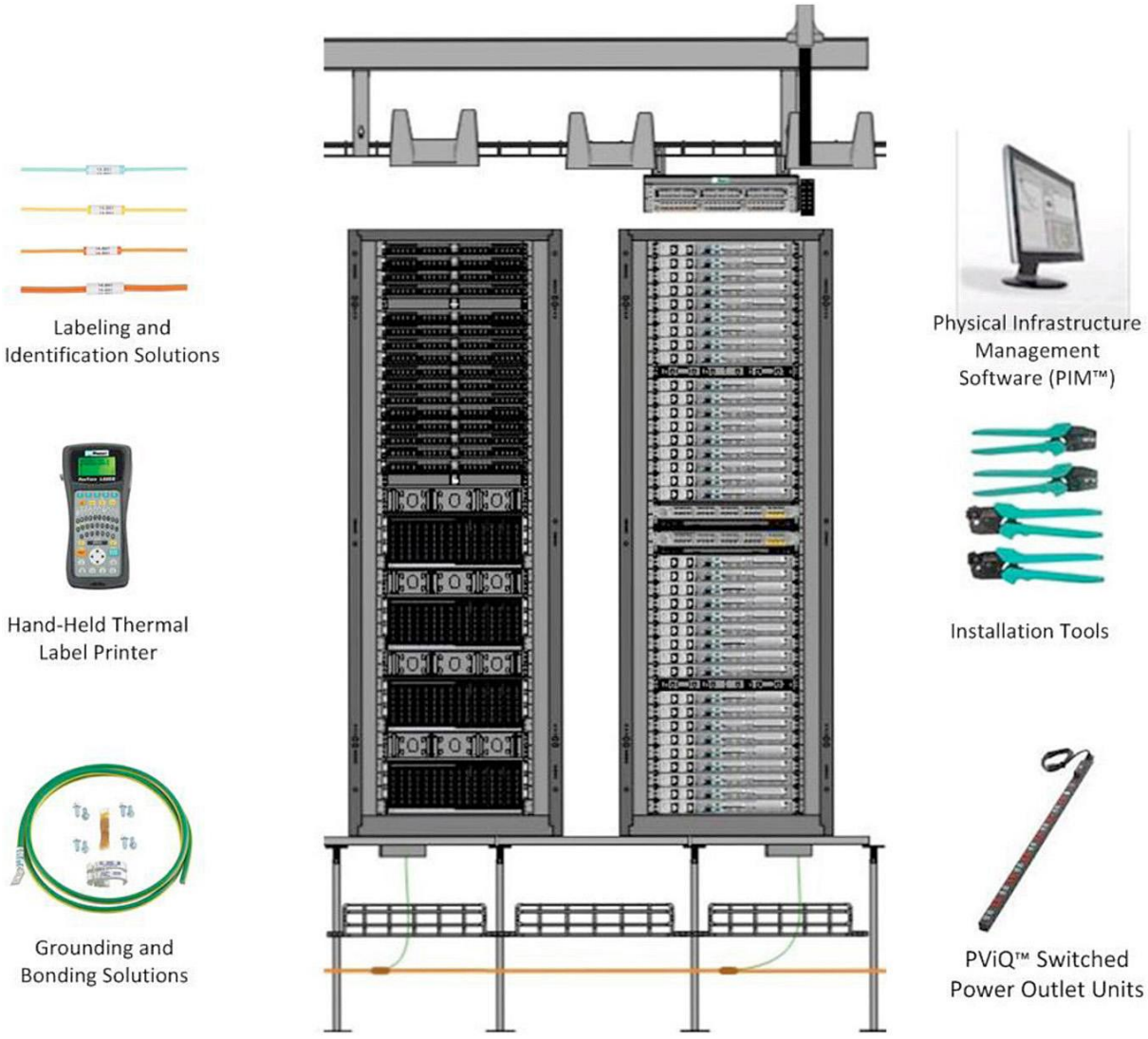
Figure 21: Panduit High-Speed Data Transport Components



Panduit Operation Management Solutions

Panduit operation management solutions help enable new technology such as Cisco 6004 10- and 40-Gbps switching platforms and include 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 22).

Figure 22: 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 IT and facility stakeholders to reconsider the network architecture they use. The Cisco Nexus 6000 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 6000 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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