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Cable Management Solutions for Brocade High Density Port Blades

Solution Design Guide

Contents

Purpose of This Document

Using QSFP optics to connect to device ports may not be familiar to many Fibre Channel users. This document provides customers deploying FC16-64 high density port blades with general guidelines for proper optical fiber cable management.

Audience

This guide is for technical IT architects and Storage Area Network (SAN) administrators who are directly responsible for SAN design and/or infrastructure management based on the Brocade® Gen 5 Fibre Channel SAN FC16-64 blades.

Objectives

Provide best practices in cable deployment and management to avoid many unforseen challenges SAN designers face when implementing cable solutions. While not intended as a definitive cable design document, it does introduce concepts and guidelines to help you avoid potential issues that can result from poor cable implementation practices.

This guide describes:

- Overview of the FC16-64 high density FC port blade and QSFP optics
- Structured high-density cable management solutions based on MPO/MTP® connectors and patch panels
- Best practice guidelines and recommendations for optical fiber cabling
- Part numbers for optical cables and patch panels and vendor contact information

Terminology

Below are some commonly used terms that you will find throughout this guide.

Term	Description
QSFP Transceiver	Quad-SFPs (QSFP) are transceivers that support up to four channels or ports from a single optic.
QSFP Cable	A fiber cable supporting up to four independent, bi-directional channels.
LC	Lucent Coupler supporting single-channel SFP, SFP+, or XFP transceivers
MPO/MTP	Industry acronym for Multi-fiber Push-On connector; MTP is a trademarked name of an MPO connector with design enhancements to improve mechanical and optical performance. MTP is often used synonymously with MPO. **NOTE** The terms MPO and MTP may be used in this document in combination or interchangeably to represent but are understood to be compatible designs.
Patch Cord	Single or multiple strand of fiber cables used for connectivity.
RU	Rack Unit (4.4 centimeters/1.75 inches)

Related Documents

- Best Practices Guide: Cabling the Data Center (PN: GA-BP-036-01)
- Brocade FC16-64 Port Blade QuickStart Guide
- Brocade DCX 8510-8 Backbone Hardware Reference Manual
- Brocade DCX 8510-4 Backbone Hardware Reference Manual

Document History

Date	Version	Description
March 2015	1.0	Initial Release

About Brocade

Brocade® (NASDAQ: BRCD) networking solutions help the world's leading organizations transition smoothly to a world where applications and information reside anywhere. This vision is designed to deliver key business benefits such as unmatched simplicity, non-stop networking, application optimization, and investment protection.

Innovative Ethernet and storage networking solutions for datacenter, campus, and service provider networks help reduce complexity and cost while enabling virtualization and cloud computing to increase business agility.

To help ensure a complete solution, Brocade partners with world-class IT companies and provides comprehensive education, support, and professional services offerings. (www.brocade.com)

Preface

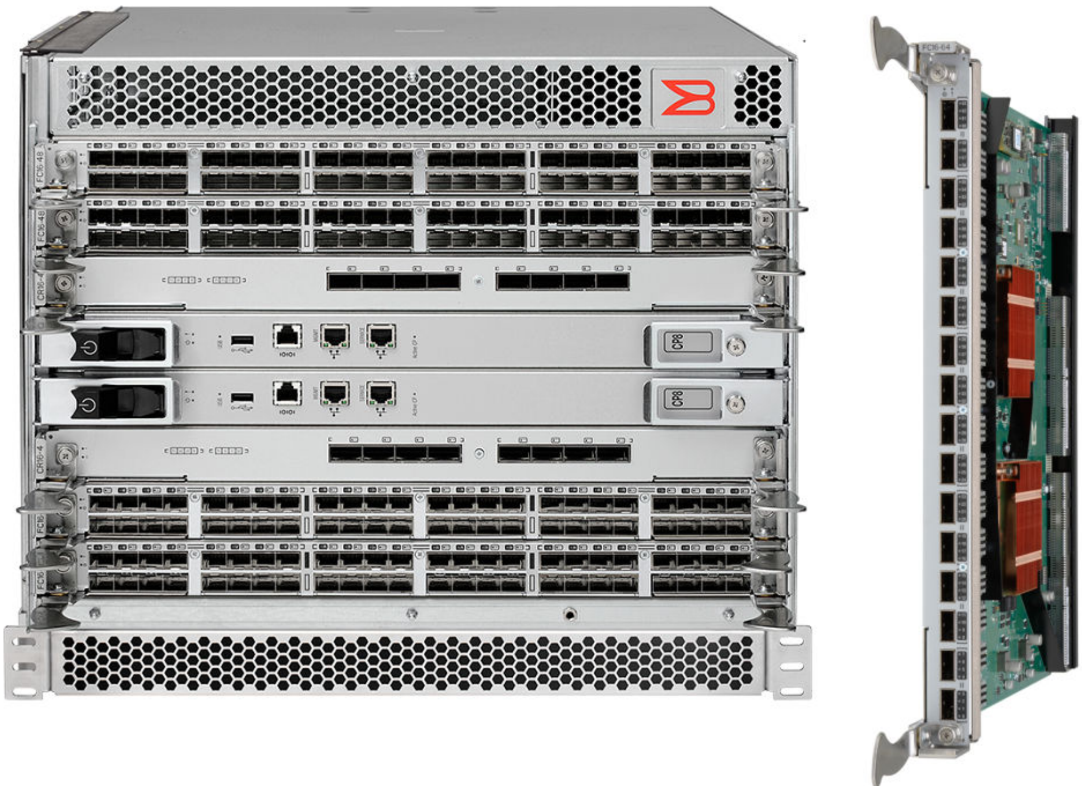
Brocade's FC16-64 high density port blade for the DCX 8510 Backbone family was designed to support a large number of device ports with simplified cable connectivity. The FC16-64's QSFP optics reduce the number of cables from 64 per each blade down to 16, significantly reducing cable management challenges from previous high density port blade designs. The QSFP form factor has been widely deployed across the networking industry for Ethernet (40Gb and 100Gb speeds) as well as Fibre Channel (4 x 16Gb Brocade UltraScale Inter-Chassis Links) connectivity, making cabling options readily available. This document provides customers deploying FC16-64 high density port blades with general guidelines for proper optical fiber cable management.

Overview

The Brocade® FC16-64 high density 64-port Fibre Channel blade combines industry-leading port density, performance, scalability, and reliability to maximize the benefits of SAN and server consolidation. The FC16-64 enables mid to large enterprise customers to deploy high density modular chassis-based solutions that minimize physical footprint without compromising performance.

High-density Fibre Channel port blades increase chassis density by 33% over a chassis populated with 48-port blades, enabling the DCX 8510-8 to scale up to 512 ports and the DCX 8510-4 to scale up to 256 ports with 16 Gbps performance.

FIGURE 1 Brocade DCX 8510-4 with four FC16-64 FC port blades with a blade to the right



To reduce investment cost, energy consumption and cabling requirements, Brocade is using a space efficient, 4-channel QSFP (Quad Small Form-factor Pluggable) optic on the FC16-64 blade that enables high density port configurations as well as improved serviceability and simplicity of use (Figure 2). These QSFPs retain all of the performance and functionality of the standard SFP+ and still support individual, per port LED indicators for easy troubleshooting and diagnostics.

FIGURE 2 Quad SFP (QSFP) with pull tab

The following table provides an overview of the differences between standard SFP+ optics and QSFPs. The QSFP leverages the same technology as standard SFPs but combines four channels into one optic to better support high density SAN solutions.

Specification	SFP+	QSFP
Speed Grade	2/4/8/16Gb	4/8/16Gb
Operating Distance	Same	Same

Availability of SWL Transceivers	Yes	Yes
Availability of LWL Transceivers	Yes	No
Regulatory Compliance	Same	Same
Dimensions – Fiber pitch	5.25 - 6.25mm	0.25mm
Dimensions – Width	13.55mm	18.35mm
Dimensions – Depth	56.40mm	Excluding pull-tab: 68.00 mm Including pull-tab: 132.00 mm
Patch cord compatibility	LC-LC patch cord	MPO/MTP-MPO/MTP or MPO/MTP-LC breakout patch cords
Optics Supplier	Brocade	Brocade

Brocade requires the use of OM-3 or OM-4 fiber cables with the FC16-64's QSFP optics in order to attain FC standards for connectivity distance. Refer to "Appendix D: Equipment List" for cable manufacturer and part number details.

The below MTP terminated cables (Figure 3) provide the same flexibility in connectivity as standard LC cables:

- MTP- 4 x LC breakout cable assembly: Provides the FC16-64 port blade with the ability to connect to FC16-32 and FC16-48 port blades, switches, host, or storage devices utilizing LC connectors or patch panels.
- MTP-MTP cable assembly: Allows one FC16-64 port blade to connect to an MPO/MTP patch panel or another FC16-64 port blade as an ISL.

FIGURE 3 MPO/MTP to LC breakout cable (left) and MPO/MTP to MPO/MTP cable (right)

Planning

As port density per director and per rack increases, having an appropriate cable management plan is key during servicing or scaling of a fabric and eases troubleshooting. The cable management plan should include current and future SAN design requirements. Cables can be managed in a variety of ways, such as by routing cables below the chassis, to either side of the chassis, through cable channels on the sides of the cabinet, or by using patch panels. When planning a cable management solution and the cable routing path, take into account the location of the rack's power strip and the DCX 8510 power supplies to eliminate cable interference when servicing the power supplies and cords.

The cable management plan may involve wiring a new data center or upgrading the cabling in an existing data center.

- If an existing data center is being upgraded, evaluate, capture, and understand the present cabling infrastructure thoroughly.
- Document the current (if any) and projected network topologies using an application such as Microsoft Visio or Excel. Focus on the physical aspects, especially equipment interfaces. Document the various cable types and counts present, proposed, and projected, approximate routed distances to distribution areas and equipment, present and anticipated equipment port counts. Additionally, document any areas of concern, and any established internal cabling standards.
- Plan to accommodate for current and future growth. Build in flexibility, so that the patching structure will allow a device to connect to any other device in the data center. This will permit devices to be located anywhere within the data center.

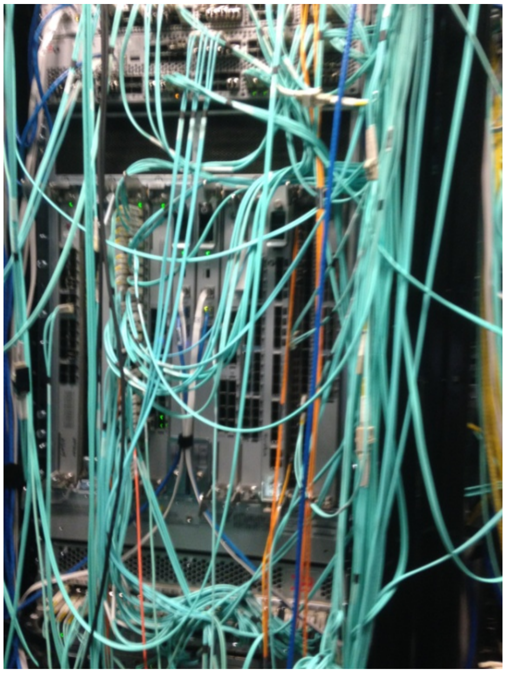
Challenges with Unstructured High Density Solutions

All three growth factors—volume, performance, and distance—have placed enormous strain on IT organizations, requiring miles of cable infrastructure to interconnect servers, storage, and Fibre Channel fabrics for fast, reliable data and application delivery. Unfortunately, many organizations still rely on traditional point-to-point cable solutions, reactively deploying cables one at a time to suit immediate needs.

The resulting cable clutter inhibits intelligent, pragmatic growth, contributing to an inefficient growth strategy that will only worsen over time. The tasks of verifying proper connectivity, troubleshooting, and managing device change also become more complex and time-consuming, and can lead to planned or unplanned downtime of critical business applications.

This inefficient approach also contributes to the overheating of data centers—particularly within raised flooring and around the racks where cable clutter primarily occurs—requiring additional resources to cool the systems.

FIGURE 4 Cable clutter



Using a Structured Approach

Cable management solutions designed specifically for Brocade SAN infrastructures utilizing the Brocade DCX 8510 Backbone family enable a reliable, flexible, and highly efficient cable infrastructure throughout the data center.

Depending on their specific requirements, organizations can choose from various structured fiber-optic cable management solutions. By moving from traditional low-density, duplex patch cord cable solutions to high-density, structured cable solutions, organizations can implement the physical layer in a much more manageable and flexible manner while streamlining data center reconfigurations and simplifying management. These cable technologies are also more energy efficient, and help organizations to consolidate their IT infrastructures.

Cabling High Density and High Port Count Fiber Equipment

As networking equipment becomes denser and port counts in the data center increase to hundreds and thousands of ports, managing cables connected to these devices becomes a difficult challenge. Traditionally, connecting cables directly to individual ports on low port-count equipment was considered manageable. Applying the same principles to high port-count equipment made the task more tedious, eventually becoming nearly impossible to add or remove cables connected directly to the equipment ports.

Structured cabling uses optical fiber connector housings that are connected through permanent links of optical cabling, typically configured in a physical star topology from the various areas within the data center (Storage, Servers, SAN and Network). Utilizing pre-terminated MTP cabling from each of these areas to a central patching area provides an infrastructure where any port from any device can be connected to any other port.

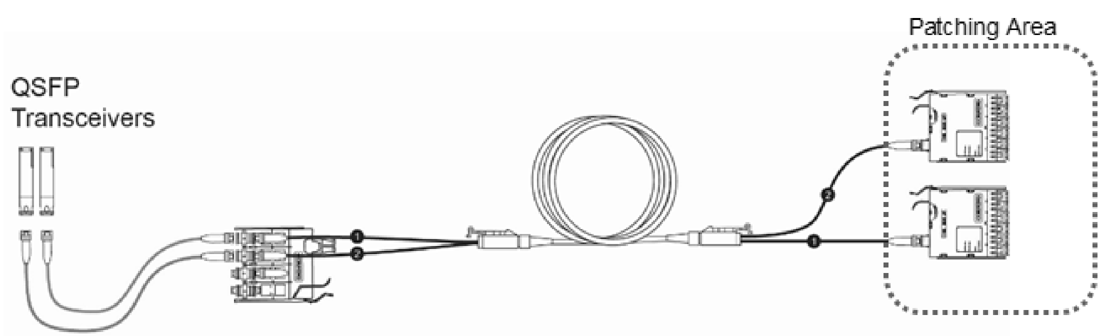
Typical component types utilized in optical cabling infrastructure are shown in the below table:

MTP Trunk Assembly		MTP terminated optical fiber trunk assemblies are typically 12-144 fibers and create the permanent fiber links between patch panels in a structured cabling environment. They are pre-terminated from the manufacturer with MTP connectors at a specified length and have a pulling grip for easy installation.
Connector Housing		Connector housings are physically mounted in a 19" rack or cabinet. They are typically offered in various sizes such as 1U, 2U, or 4U which refers to the amount of rack space required for mounting.
MTP-LC Module		MTP to LC modules are installed into the connector housings. They breakout the MTP connection from the trunk cables into LC connectivity. Thus, the trunk cables plug into the rear MTP of the module, and LC jumpers plug into the front of the module.
MTP Adapter Panel		MTP adapter panels (sometimes called bulkheads) are installed into the housings. They offer a connection point between the MTP trunks and MTP jumpers or breakout harnesses. Thus, the trunk cables will plug into the rear of the panel, and the MTP jumpers or harnesses will plug into the front of the panel.
MTP-LC Harness (breakout cable)		MTP-LC harness assemblies are used for breaking out the MTP connector into multiple LC connections.

MTP or LC Jumpers		LC and MTP jumpers serve to create the connection between device ports and the structured cabling.

When cabling high density, high-port-count MPO equipment, such as the DCX 8510 with FC16-64 blades, the recommendation is to pre-connect the director blades with MTP/MPO jumpers with connectivity to dedicated connector housings. From these housings, the MTP jumpers interconnect to MTP/MPO based structured cabling for breakout into LCs in another connector housing at the other end of the cabling link (see Figure 5).

FIGURE 5 Structured cabling example for MTP connectivity to LC breakout in Central Patching Area



Once fully cabled, the housing(s) in this central patching area, functions as if it were “remote” ports for the director ports. These dedicated patch panels for patching may be located in the same or adjacent cabinet as the director (typically in small data center footprints) or in a separate central patching area (typically in medium-large data center footprints). Using this strategy drastically reduces equipment cabling clutter and improves cable management.

Cabling Standards

Industry cabling standards are designed to protect the end user, providing a firm foundation for establishing a coherent infrastructure, and guidelines for maintaining high levels of cable performance. Cabling standards define cabling specifications looking out to the next several years, thus supporting future needs for higher speed transmissions. Standards enable vendors to use common media, connectors, test methodologies, and topologies, and allow planners to design a cabling layout in the data center without worrying about compatibility issues.

There are a number of standards organizations and standards. The best-known cabling standards are listed below:

Data Centers Specific Standards

- United States -- ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers
- Europe -- CENELEC EN 50173-5 Information Technology- Generic Cabling Systems- Part 5: Data Centers
- International -- ISO/IEC 24764 Information Technology- Generic Cabling for Data Centre Premises

General Commercial Building Cabling Standard

- United States -- ANSI/TIA-568 Generic Telecommunications Cabling for Customer Premises
- Europe -- EN 50173-1 Performance Requirements of Generic Cabling Schemes
- International -- CSA ISO/IEC 11801:2009 Information Technology: Generic Cabling for Customer Premises

Cabling Administration Standards

- United States -- ANSI/TIA-606 Administration Standard for the Commercial Telecommunications Infrastructure

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NOTE
Cabling standards are reviewed and changed every five to ten years, which allows them to keep pace with technology advances and future requirements. Standards may be purchased online from IHS at http://global.ihs.com/.

Establishing a Naming Scheme

Once the logical and physical layouts for the cabling are defined, apply logical naming that will uniquely and easily identify each cabling component. Effective labeling promotes better communications and eliminates confusion when someone is trying to locate a component. Labeling is a key part of the process and should not be skipped. A suggested naming scheme for labeling and documenting cable components is suggested below (examples appear in parentheses):

- Building (SJ01)
- Room (SJ01-5D11)
- Rack or Grid Cell: Can be a grid allocation within the room (SJ01-5D11-A03)
- Patch Panel: Instance in the rack or area (SJ01-5D11-A03-PP02)
- Workstation Outlet: Instance in the racks or area (SJ01-5D11-A01-WS02)

- Port: Instance in the patch panel or workstation outlet (SJ01-5D11-A03-PP02_01)
- Cable (each end labeled with the destination port)

(Building and room may be excluded if there is only one instance of this entity in the environment.)

Once the naming scheme is approved, start labeling the components. Be sure to create a reference document that will become part of the training for new data center administrators.

NOTE
Additional recommendations can be found in the standard ANSI/TIA-606 Administration Standard for the Commercial Telecommunications Infrastructure.

Cable Management Setup and Configuration

A cable management solution using an MPO/MTP patch panel allows for easy management of high density cabling, even for a Brocade DCX 8510-8 with up to eight FC16-64 port blades. The traditional method of cabling blades with SFP ports uses MTP-LC modules to break-out the MTP trunk assemblies into LC ports for jumper connectivity into the SAN director. Or, for improved cabling, MTP-LC harnesses are used to transition the MTP connector to LC leads that connect into the SAN director ports. Larger installations with multiple units may require multiple patch panels to accommodate the transition from the MTP connectivity to the traditional LC connectivity, which can use up to an additional 10 RU of valuable rack space. With the use of QSFP transceivers on the FC16-64 blades, cabling density can be further optimized through the use of MTP patchcords from the structured cabling directly into the SAN director ports, with break-outs to LCs at the other end of the cabling link. Structured cabling solutions available from multiple leading vendors allow for higher consolidation of cabling into a compact patch panel, cabling and connectivity. Below are examples of several vendors' solutions for cable management configurations for the FC16-64. Please consult with your preferred cabling provider to learn about solutions available from alternative vendors.

NOTE
Part numbers for the various design options are shown in Appendix D

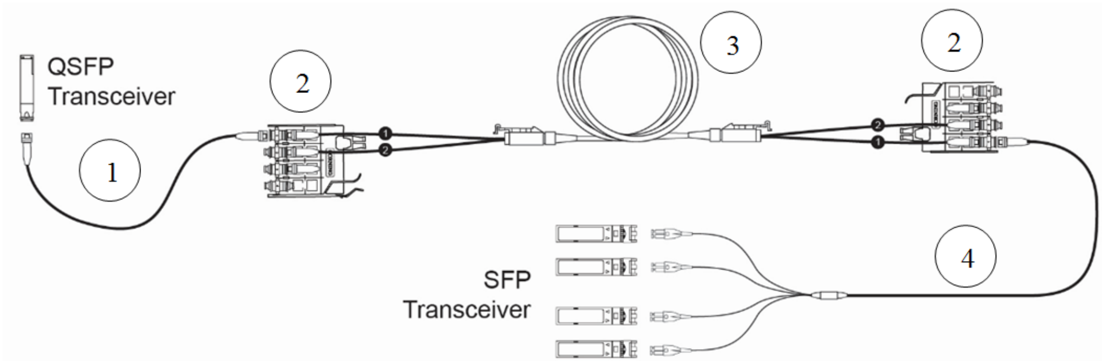
Corning

Corning provides a structured cabling solutions for the DCX 8510 FC16-64 blades that can be deployed in either point-to-point trunk implementations or utilizing a cross-connect for port replication. In both of these designs, density is maximized using Corning's Pretium EDGE Solutions with MTP-based connectivity. MTP jumpers are installed from each of the QSFP ports on the FC16-64 blade to MTP adapter panels in an EDGE patch panel. Utilizing high-density EDGE housings and 6-port MTP adapter panels, a full DCX 8510-8 can be supported with one 2U EDGE housing, and a full DCX 8510-4 can be supported with one 1U EDGE housing.

Point-to-Point Structured Cabling Options

As shown in Figure 7 , from the housing at the director cabinet, MTP terminated trunk assemblies are installed to the end equipment cabinets and landed in MTP adapter panels in an EDGE housing or bracket at this end as well. From each MTP port in the housing, an 8-fiber MTP to LC harness assembly is installed and the 4 x LC UniBoot legs of the assembly installed to the SFP ports at the host or storage equipment. This design would be utilized where the 4 SFP ports are located on the same device in nearby proximity for clean cable management, and would all be operating on the same fabric via a single QSFP port at the director).

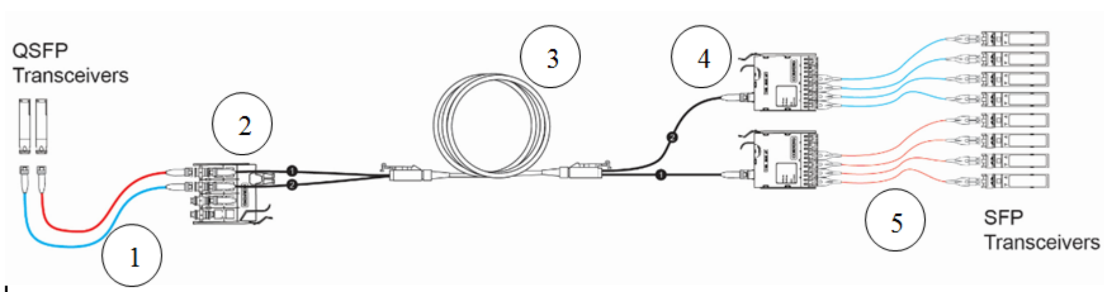
FIGURE 6 Connectivity Line Diagram for Point-to-Point Structured Cabling with 8-fiber Harness



As most servers have a single dual-port HBA and to support redundancy over separate fabrics, the typical installation would require that the (4) 16GFC channels transmitting from each QSFP port on the FC16-64 blade be broken out to different/multiple servers, rather than all four channels terminating at the same device. The LC harness legs from the design could be ordered with longer LC legs in order to split them between multiple devices; however this often results in messy or congested cable/jumper management at the servers.

For servers, or other end equipment, where the 4xLC ports are not located in close proximity on a single device or are being split between multiple devices, a more manageable approach would be to land the MTP terminated trunk assemblies into MTP to LC modules, where individual LC jumpers can be used for each of the 4 x LC ports, as shown in Figure 7 .

FIGURE 7 Connectivity Line Diagram for Point-to-Point Structured Cabling with Module break-outs



Cross-Connect Structured Cabling Options

Utilizing a cross-connect design enables port replication of the SAN director ports, which in turn provides for a flexible patching infrastructure where any SAN director port can be connected easily to any host, storage, or switch port. In this design, the director is pre-cabled with a high-density solution, moving the patching functions to a central patching field, which is typically designed for jumper management. By moving the patching function to this central patching area, risk of damage to director ports is eliminated as day-to-day moves, adds, and changes (MACs) occur only at this passive patching field, and not directly at the QSFP transceiver ports. Deploying MTP trunk assemblies from the director cabinets to the central patching area is typically accomplished with high fiber count trunk assemblies (rather than multiple low fiber count assemblies), reducing pathway spaces required as well as reducing installation time for this backbone structured cabling. With the 48 port FC16-48 blade, it would be common to utilize 96-fiber trunks so that each trunk is allocated to a blade for ease of servicing the director. In the case of the FC16-64 blade, (2) 96-fiber trunks could be deployed per blade, or a single 192-fiber trunk could be utilized per blade to maintain 1:1 assignment.

Design scenarios with the corresponding part numbers can be found at: http://csmedia.corning.com/CableSystems//Resource_Documents/application_engineering_notes_rl/AEN152.pdf

Data Center Systems

The 64-Channel FC16-64 Mimic Adapter Panel available through Data Center Systems (DCS) is a 10U, modular adapter panel that supports 64 LC connections distributed in 16 groups, each containing four channels. Segments are numbered with an overlay to map precisely with QSFP ports and FC channels on the face of the Brocade FC16-64 blades. Located at the Central Access Point (CAP), utilizing a DCS 10U, 8-Slot Modular Patch Panel Enclosure populated with eight DCS 64-Channel FC16-64 Mimic Adapter Panels, this solution provides a "mimic" of a fully populated DCX 8510-8 director chassis. Introducing the Mimic at the CAP improves manageability and mitigates risk associated with all MACs, by taking management of up to 512 ports away from the active director. Converting from the 16 QSFP ports on the face of each FC16-64 blade, to LC connectors required at the CAP can be accomplished in one of two ways:

- Solution 1 provides the least amount of mated pair and insertion loss (See cable port mapping diagram within Appendix B of this document):
  - Quantity (2) DCS 32 Channel - 96 Fiber OM4 Plenum trunks terminated with MTP/MPO connectors which plug into the FC16–64 blades
  - Quantity (1) DCS 64-Channel FC16-64 Mimic Adapter Panel
- Solution 2 provides customers that wish to implement MTP/MPO at the CAP (See cable port mapping diagram within Appendix C of this document):
  - Quantity (2) DCS 32 Channel - 96 Fiber OM4 Plenum trunks terminate with MTP/MPO connectors which plug into the FC16–64 blades
  - Quantity 1 DCS 64 Channel FC16-64 Mimic Cassette

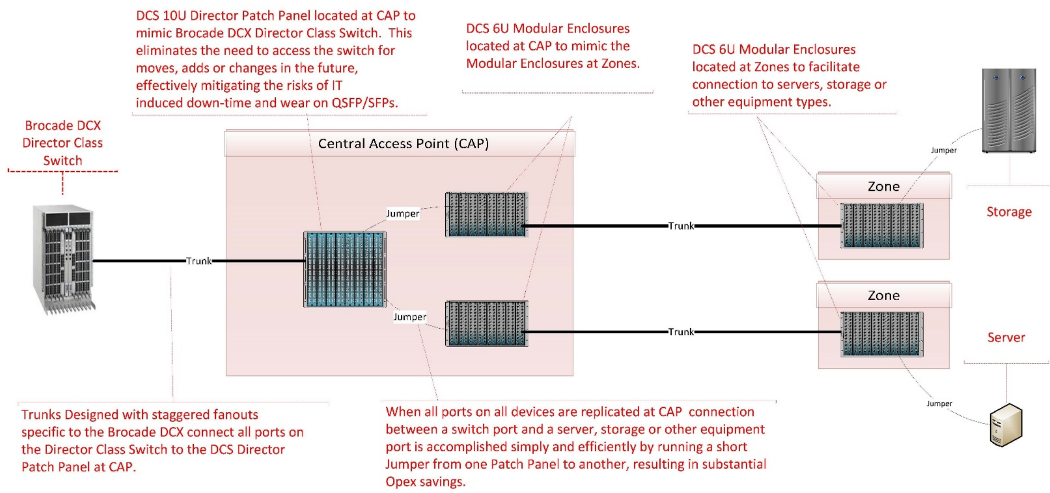
To further enhance management, DCS offers Mimic Adapter Panels and Cassettes with color schemes to distinguish between A and B fabrics as well as backup.

FIGURE 8 Data Center Systems Conversion cabling kit for DCX 8510

Cabling Solution Diagram

The cabling infrastructure, in particular director connectivity and patching can be one of the most confusing tasks that a data center manager has to deal with. Uptime on a director is imperative; therefore you should not have to waste any time trying to figure out the point of connectivity from one piece of equipment to the other during MACs. By implementing a recommended industry standard TIA-942 structured cabling infrastructure, all patching can easily be done at the CAP. The below diagram from Data Center Systems illustrates the how to create a more manageable cabling solution that simplifies the port identification on the patch panels within the CAP.

FIGURE 9 Sample structured cabling infrastructure



Methode Data Solutions

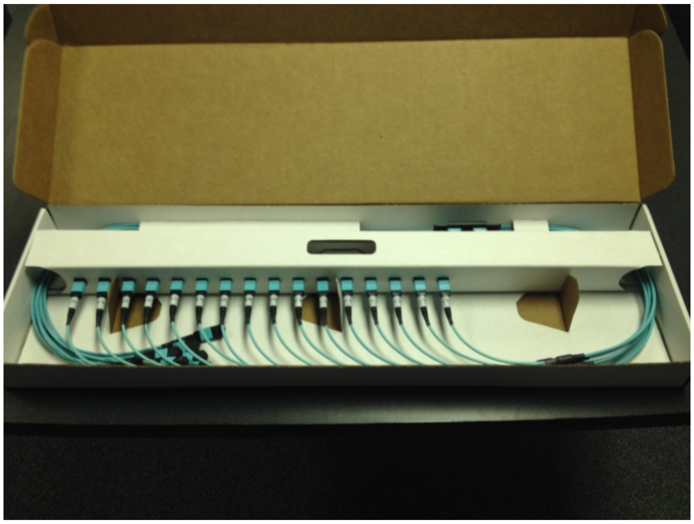
The *FAST CHANNEL-SWITCH CONNECT* Conversion Patch Panel (CPP) available through Methode Data Solutions Group, is a 2U height panel that supports up to eight coupler plates each containing eight MTP couplers. The *FAST CHANNEL-SWITCH CONNECT* Conversion Patch Panel is designed to mount directly below the DCX 8510 director to enable conversion from the 16 MPO/MTP ports on the face of the FC16-64 blades to the MPO/MTP trunks routed to the main distribution area (MDA). The connections required to support a fully populated 8-slot director with 512 ports at the patch panel are reduced from 128 connections (16 MPO connections x eight blades) to 64 connections by using *FAST CHANNEL-SWITCH CONNECT* 2 x 1 MTP conversion harnesses, allowing connectivity for a fully populated DCX 8510-8 chassis or two DCX 8510-4 chassis. Each harness is made up of two 12 fiber MTP connectors configured in the QSFP + pin-out, connected to one 16 fiber MTP configured with a 16 fiber pin-out.

CONNECTOR P2 CONNECTOR P3

FIGURE 10 2 x 1 MTP conversion harness

CONNECTOR P1

FIGURE 11 FAST CHANNEL-SWITCH CONNECT Conversion cabling kit with pre-measured cabling harness for DCX 8510



Using the *FAST CHANNEL-SWITCH CONNECT* 2 x 1 MTP conversion harnesses shown above allows for a reduction of 50% in cabling over the use of per port, LC connection cabling options.

Equipment Requirements

The following items are required to implement this LC cable management solution for a 64-port MTP patch panel solution utilizing the Brocade DCX 8510 with eight FC16-64 port blades:

- 64-port MTP-MTP FAST CHANNEL-SWITCH CONNECT Conversion Patch Panel
- 64 – 2 x 1 MTP conversion harness cables (custom lengths to minimize cable slack)
- Roll of Velcro & scissors or pre-cut Velcro cable wraps
- Labeling kit

Cabling Solutions

Once the cable labeling scheme has been defined, as described in the “Establishing a Naming Scheme” section in this document, label the ports on the MTP patch panel using the cable to port mapping table listed in Appendix A. It is important to map the DCX 8510 slot and port number to the patch panel/shelf/port number on the MTP patch panel.

An optimal solution will use custom length cabling with cable lengths that have been pre-measured to fit the distance from the QSFP port to the corresponding patch panel connection.

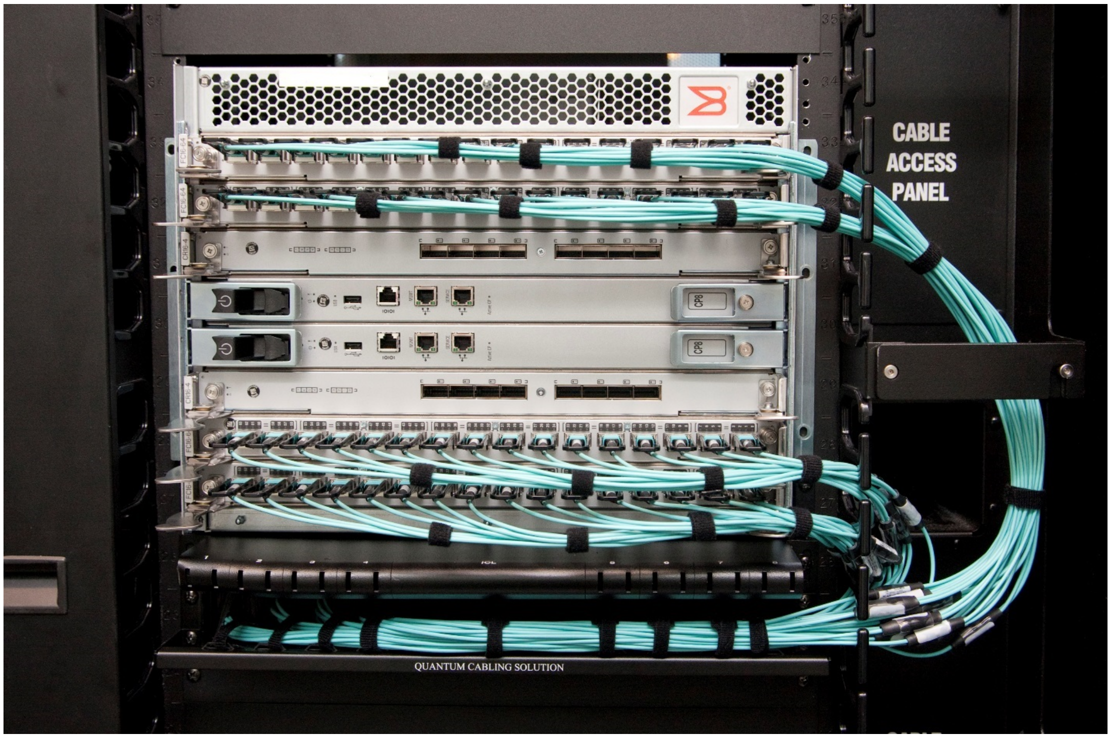
Alternatively, 1- or 2-meter cables can be used to connect the director ports to the ports on the patch panel if the patch panel is placed directly above or below the DCX. If this is not possible and the patch panel is at the top of the rack, a 3-meter length cable is recommended.

Install the patch panels below the cable comb with a 1 rack unit gap between the cable comb and the patch panel. For additional details, refer to the installation guide that ships with the patch panels.

DCX 8510 Cabling Installation (Front Side, Director Ports to Patch Panel)

1. For a DCX 8510-8 chassis with vertically mounted blades, start cabling from the bottom QSFP port group (e.g. ports 0-3), working up the blade to the top QSFP port (60-63). In this way, cables can be installed on top of the waterfall as the cables drop down, rather than trying to work below the cascading cables. Similarly, for a DCX 8510-4 with horizontally-mounted blades, start at the right and work to the left for cabling that will be routed on the right side.
2. Bundle the cables using Velcro cable wraps in groups of eight to match the ASIC or trunk boundaries (0-31, 32-63). This will facilitate servicing of the system through easy identification of the cable path.
3. Work up to the top port.
4. Connect each cable to an MPO/MTP patch panel port using the numbering schema defined in Appendix A.
5. If a different methodology is chosen, it is important to be consistent across all port blades and patch panel ports. This will minimize the confusion as to which director ports are allocated to which MPO/MTP patch panel ports. Allocate 30-centimeters (12-inches) of slack at the patch panel to enable the patch panel’s top and middle shelf to be raised into the up position for servicing.
6. Route the cables down to the bottom of the DCX 8510 chassis (8-slot) and then to the left/right and to the cable management area at the side of the enclosure/rack and then down. If using a cabling harness, all harnesses/cables are routed straight down and into the patch panel, reducing the cable management required on the sides of the rack. On a 4-slot director chassis, cables can be routed to the right of the chassis (Figure 8).
7. NOTE: On an 8-slot director, do not route cables from Slot 1-4 towards the right as this could cause the fiber cables to be damaged if ICL cables are used in the configuration.

FIGURE 12 256-port wrapped/bundled and completed cabling solution



Cabling Installation (Back Side, From Devices to Patch Panel)

When connecting cables from outside devices to the backside of the patch panel, the MPO cables can be connected to the back of the patch panel, paying attention to the defined cable number schema (refer to appendix B and C).

FIGURE 13 Device to Patch Panel Trunk Cabling

NOTE
As a best practice, cables from the same vendor should be used when implementing a trunked cabling solution.

Servicing High Density Solutions

When servicing during an anomaly due to the cable density, identifying and servicing individual fiber cables at a port level can be a challenge. The QSFP transceivers used in the FC16-64 port blade are fitted with a pull-tab to aid in installation and removal. The steps below with will ease the servicing process.

Connecting a cable to an empty QSFP

1. Remove the QSFP optic from the port. Hold the QSFP pull-tab firmly and gently pull the QSFP away from the connected port.
2. Verify the chosen optical cable supports QSFPs.
3. Connect the cable to the QSFP.
4. Insert the QSFP into the port. Hold the pull-tab on the QSFP firmly and insert the QSFP into the port and slide it back into the port until the transceiver clicks (locks into place).

Removing a cable from a populated QSFP

1. Remove the QSFP from the port.
   a. Make sure the patch cable is not wrapped around the pull-tab.
   b. Loosen any cable ties used for holding the cables in place.
   c. Hold the QSFP pull-tab firmly and gently pull the QSFP away from the connected port.
2. Disconnect the cable from the QSFP.

Best Practices for Managing the Cabling

Whether implementing, upgrading, or maintaining cabling in the data center, establish a set of guidelines that are thoroughly understood and supported by the staff. Here are some cable management pointers.

During Installation

- Avoid over-bundling the cables or placing multiple bundles on top of each other, which can degrade performance of the cables underneath.
- Keep fiber and copper runs separated. The weight of the copper cables can crush fiber cables that are placed underneath.
- Consider using cables that are resistant to bend loss.
- Avoid mounting cabling components in locations that block access to other equipment (power strip or fans) inside and outside the racks.
- Keep all cable runs under 90 percent of the maximum distance supported for each media type as specified in the relevant standard. This extra headroom is for the additional patch cables that will be included in the end-to-end connection.
- Install higher cable types (OM3 or OM4 only) that will meet current and future application requirements.
- Cabling installations and components should be compliant with industry standards.
- Don’t stress the cable by doing any of the following:
    - Applying additional twists
    - Pulling or stretching beyond its specified pulling load rating
    - Bending it beyond its specified bend radius, and certainly not beyond 90º
    - Creating tension in suspended runs
    - Stapling or applying pressure with cable ties
- Avoid routing cables through pipes and holes. This may limit additional future cable runs.
- Label cables with their destination at every termination point (this means labeling both ends of the cable).
- Test every cable as it is installed and terminated. It will be difficult to identify problem cables later.
- Locate the main cabling distribution area nearer the center of the data center to minimize cable distances.
- Do not route cables such that they block equipment cooling fans and restrict airflow.
- Use thin and high-density cables wherever possible, allowing more cable runs in tight spaces. Ensure the selected cables meet standard specifications.
- Dedicate outlets for terminating horizontal cables, that is, allocate a port in the patch panel for each horizontal run.
- Include sufficient vertical and horizontal managers in your design; future changes may involve downtime as cables are removed during the changes.
- Utilize modular cabling systems to map ports from equipment with high density port counts; as described in the earlier section titled “Cable Management Setup and Configuration”.

Daily Practices

- Avoid leaving loose cables on the floor that create a major safety hazard. Use the horizontal, vertical, or overhead cable managers.
- Avoid exposing cables to direct sunlight and areas of condensation.
- Do not mix different cable types within a bundled group.
- Remove abandoned cables that can restrict air flow and contribute to possible increases in operational temperatures that can affect the longevity of the system.
- Keep some spare patch cables. The types and quantity can be determined from the installation and projected growth. Try to keep all unused cables bagged and capped when not in use.
- Use horizontal and vertical cable guides to route cables within and between racks. If “cable spool” devices are used in cable managers to avoid kinks and sharp bends in the cable, use caution not to wrap patch cords around these spools like a hose on a hose reel.
- Document all cabling components and their linkage between components and make sure that this information is updated on a regular basis. The installation, labeling, and documentation should always match.
- Use the correct length patch cable, leaving some slack at each end for end device movements.
- Bundle cables together in groups of relevance (for example, ISL cables and uplinks to core devices), as this will ease management and troubleshooting.
- When bundling or securing cables, use Velcro-based cable wraps every 1 to 2 meters. Avoid using zip ties as these apply pressure on the cables.
- Avoid routing cables over equipment and other patch panel ports. Route below or above and into the horizontal cable manager for every cable.
- Maintain the cabling documentation, labeling, and logical/physical cabling diagrams.

Summary

Although cabling represents less than 10 percent of the overall data center network investment, it can be expected to outlive most network components and be the most difficult and potentially costly component to replace. When purchasing the cabling infrastructure, consider not only the initial implementation costs, but subsequent costs as well. Understand the full lifecycle and study local industry trends to arrive at the right decision for your environment.

Choose the strongest foundation to support present and future network technology needs—comply with TIA/ISO cabling standards. Build in additional capacity, as it is much easier to install now than later. Use higher bandwidth grades of cabling to postpone having to re-cable as technologies advance. The cabling itself calls for the right knowledge, the right tools, patience, a structured approach, and most of all, discipline. Without discipline, it is common to see complex cabling “masterpieces” quickly get out of control, leading to increased support costs and increased down time.

Since each environment is different, there is no single solution that will meet all of your cable management needs. Following the guidelines and best practices highlighted in this paper will help to provide you with the information required for the successful deployment of a cabling infrastructure in your data center.

Appendix A: Cable to Port Mapping

NOTE
Print and paste the table on the rack door or a log book located near the rack for easy identification of devices.

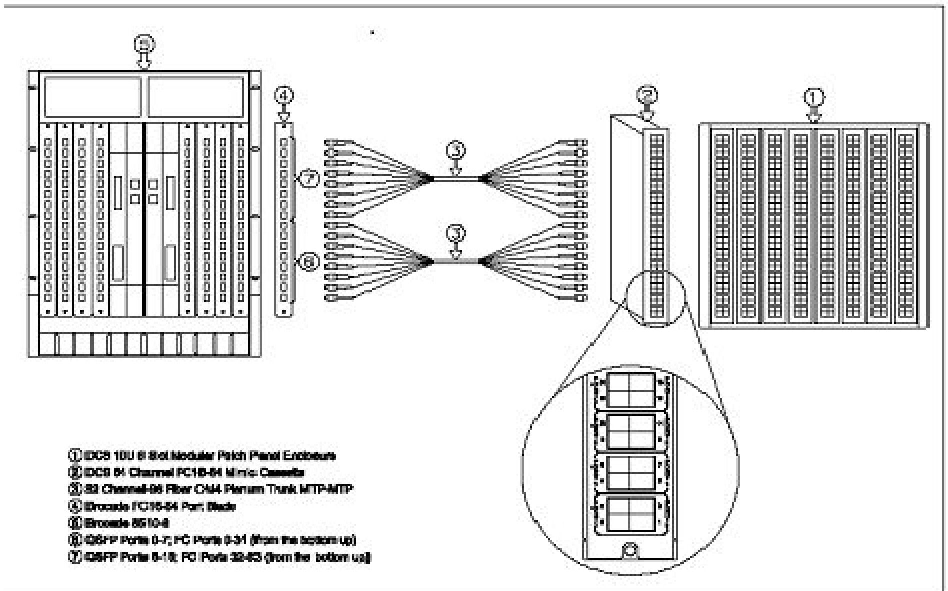
Director Slot/ Port #			MPO/MTP Shelf		Description
Slot	Port	16G link	Plate	Port	
Slot 1	0	0	Slot 1	1	
		1			
		2			
		3			
	1	4			
		5			
		6			
		7			
	2	8		2	
		9			
		10			
		11			
	3	12			
		13			
		14			
		15			
	4	16		3	
		17			
		18			
		19			
	5	20			
		21			
		22			
		23			
	6	24		4	
		25			
		26			
		27			
	7	28			
		29			
		30			
		31			

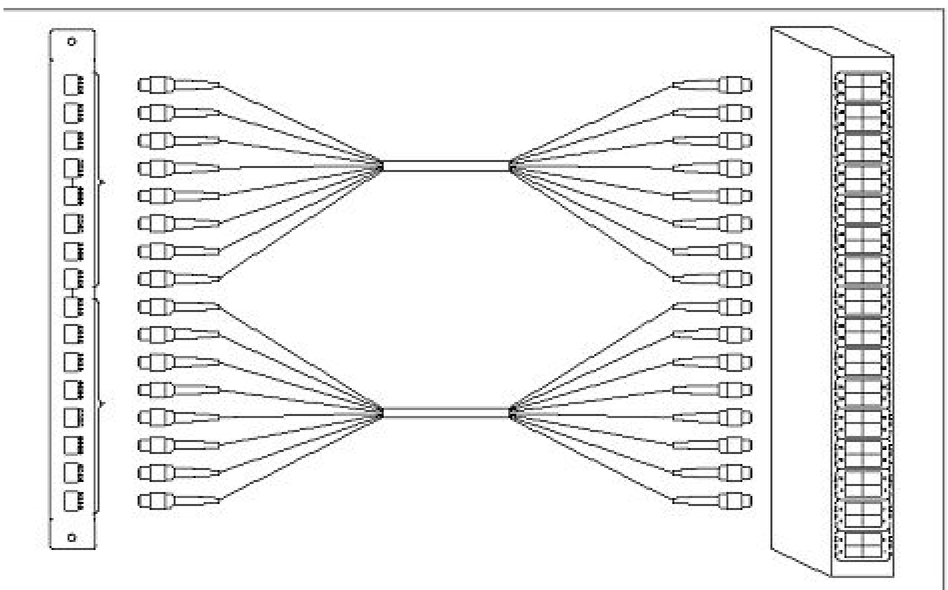
Director Slot/ Port #			MPO/MTP Shelf		Description
Slot	Port	16G link	Plate	Port	
Slot 2	0	0	Slot 2	1	
		1			
		2			
		3			
	1	4			
		5			
		6			
		7			
	2	8		2	
		9			
		10			
		11			
	3	12			
		13			
		14			
		15			
	4	16		3	
		17			
		18			
		19			
	5	20			
		21			
		22			
		23			
	6	24		4	
		25			
		26			
		27			
	7	28			
		29			
		30			
		31			

Director Slot/ Port #			MPO/MTP Shelf		Description
Slot	Port	16G link	Plate	Port	
Slot 1	8	32	Slot 1	5	
		33			
		34			
		35			
	9	36			
		37			
		38			
		39			
	10	40		6	
		41			
		42			
		43			
	11	44			
		45			
		46			
		47			
	12	48		7	
		49			
		50			
		51			
	13	52			
		53			
		54			
		55			
	14	56		8	
		57			
		58			
		59			
	15	60			
		61			
		62			
		63			

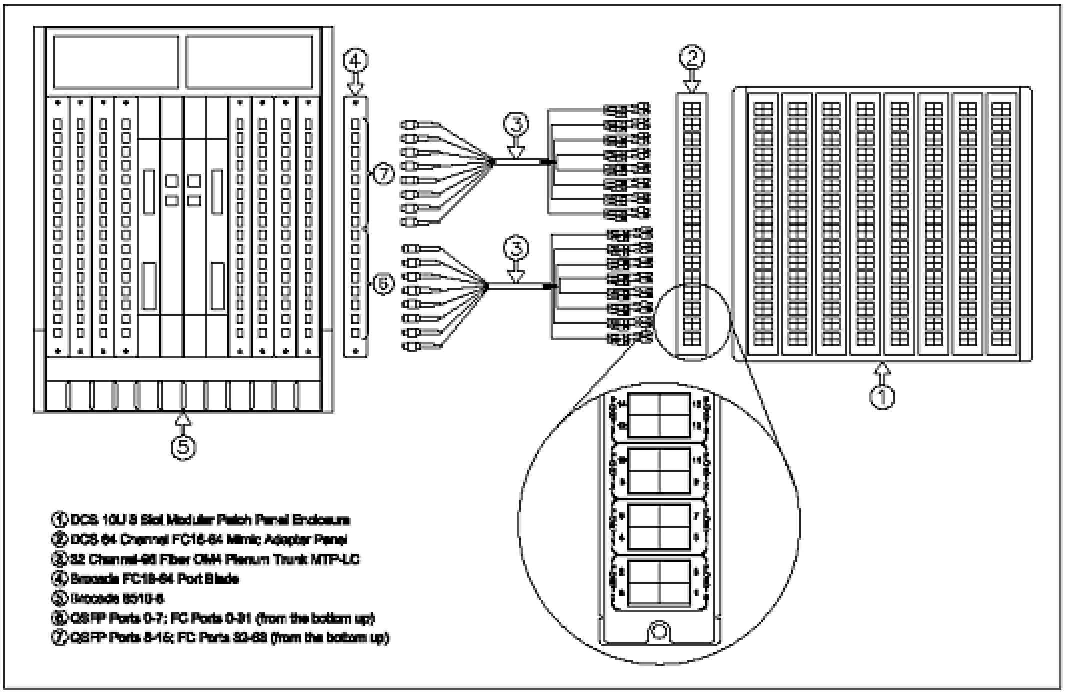
Director Slot/ Port #			MPO/MTP Shelf		Description
Slot	Port	16G link	Plate	Port	
Slot 2	8	32	Slot 2	5	
		33			
		34			
		35			
	9	36			
		37			
		38			
		39			
	10	40		6	
		41			
		42			
		43			
	11	44			
		45			
		46			
		47			
	12	48		7	
		49			
		50			
		51			
	13	52			
		53			
		54			
		55			
	14	56		8	
		57			
		58			
		59			
	15	60			
		61			
		62			
		63			

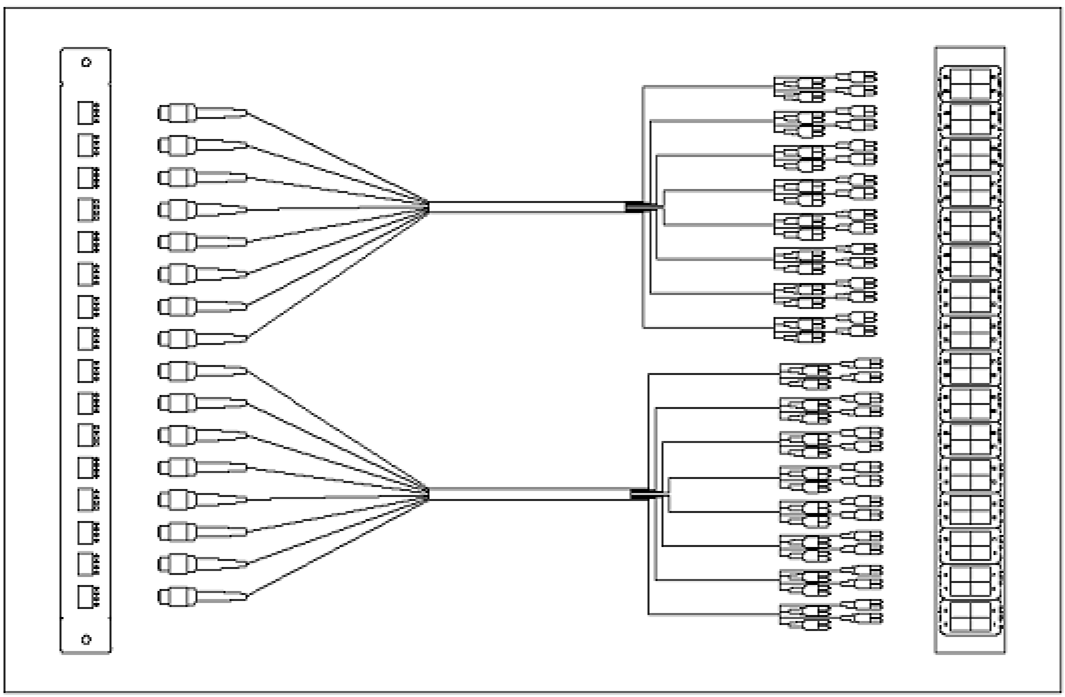
Appendix B: DCS MTP to MTP Port Mapping





Appendix C: DCS MTP to LC Port Mapping





Appendix D: Equipment List

Director Chassis

Chassis	Description
Brocade DCX 8510-8	Built for large enterprise networks, the 14U Brocade DCX 8510-8 has eight vertical blade slots to support up to 512 16Gb Fibre Channel ports
Brocade DCX 8510-4	Built for midsize networks or edge connectivity in larger networks, the 8U Brocade DCX 8510-4 has four horizontal blade slots to support up to 256 16Gb Fibre Channel ports.

Patch Cables for QSFP Connections

The QSFP patch cables listed below are for use in the FC16-64 FC port blade. These cables are used to connect end devices to patch panel ports and to connect ports between two local patch panels. The cable part numbers are provided as a reference only, and have not been tested or qualified by Brocade

Type	Description	Length	Corning P/N (Type B Polarity Assemblies part numbers listed below)		
			Device (QSFP) to Device (QSFP) (MTP non-pinned/ non-pinned)	**Patch Panel to Device (QSFP) (MTP pinned/ non-pinned)**	**Patch Panel to Patch Panel (QSFP) (MTP pinned/non-pinned)**
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	1M	J757512QE8-NB003F	J759312QE8-NB003F	J939312QE8-NB003F
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	3M	J757512QE8-NB010F	J759312QE8-NB010F	J939312QE8-NB010F
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	20M	J757512QE8-NB066F	J759312QE8-NB066F	J939312QE8-NB066F
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	50M	J757512QE8-NB066F	J759312QE8-NB164F	J939312QE8-NB164F
			Device (QSFP) to Device (SFP+) (MTP non-pinned to LC)	**Patch Panel to Device (SFP+) (MTP pinned to LC)**	
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	1M	H757908QPH-JB003F	H937908QPH-JB003F	

Type	Description	Length	Corning P/N (Type B Polarity Assemblies part numbers listed below)		
			Device (QSFP) to Device (QSFP) (MTP non-pinned/ non-pinned)	Patch Panel to Device (QSFP) (MTP pinned/ non-pinned)	Patch Panel to Patch Panel (QSFP) (MTP pinned/non-pinned)
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	3M	H757908QPH-JB010F	H937908QPH-JB010F	
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	20M	H757908QPH-JB066F	H937908QPH-JB066F	
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	50M	H757908QPH-JB164F	H937908QPH-JB164F	

Type	Description	Length	Amphenol P/N	Methode P/N
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	1M	943-99609-10001	FT-30020DD123D12371C001M
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	3M	943-99609-10003	FT-30020DD123D12371C003M
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	20M	943-99609-10020	FT-30020DD123D12371C020M
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	50M	943-99609-10050	FT-30020DD123D12371C050M
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	1M	943-99402-10001	QH-30000HD1TO7170C001M
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	3M	943-99402-10003	QH-30000HD1TO7170C003M
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	20M	943-99402-10020	QH-30000HD1TO7170C020M
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	50M	943-99402-10050	QH-30000HD1TO7170C050M

NOTE
Additional pinning/polarity configurations available. For design assistance, contact manufacturer.

Type	Description	Length	Molex P/N	TE Connectivity P/N	Wave2Wave P/N
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	1M	106283-7001	MPB-NCNCJ40001M-NN	50-8120P-1M
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	3M	106283-7003	MPB-NCNCJ40003M-NN	50-8120P-3M
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	20M	106283-7020	MPB-NCNCJ400020M-NN	50-8120P-20M

Type	Description	Length	Molex P/N	TE Connectivity P/N	Wave2Wave P/N
QSFP-QSFP	OM4 - QSFP (MTP) to QSFP (MTP) optical cable	50M	106283-7050	MPB-NCNCJ400050M-NN	50-8120P-50M
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	1M	106283-5401	MPS-NCLCJ40001M-NC	51-8080P-1M
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	3M	106283-5403	MPS-NCLCJ40003M-NC	51-8080P-3M
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	20M	106283-5407	MPS-NCLCJ400020M-NC	51-8080P-20M
QSFP-4xSFP	OM4 - QSFP (MTP) to 4 SFP+ (LC) optical cable	50M	106283-TBD	MPS-NCLCJ400050M-NC	51-8080P-50M

NOTE
Verify the appropriate cable number and description with the cable manufacture before placing an order.

Patch Panels

Vendor	Type	Rack Unit	Number of Ports	Part Number
CommScope	MPO-MPO	1U	Up to 3 x 24 MPO panel adapters	760136473

Vendor	Corning	
Bill of Materials for Figure 6		
Item Number	**Part Number**	**Description**
1	J759312QE8-NBxxxF	12-Fiber MTP® Jumper, 50 µm multimode (OM4), MTP® (non-pinned) to MTP® (pinned), TIA-568 Type-B polarity, xxx ft
2	EDGE-CP48-E3	48 F MTP® Adapter Panel, 50 µm multimode (OM4/OM3) (4 port); mounts in EDGE Housings (example: EDGE-02U)
3	G757524QPNDDUxxxF	Pretium EDGE® Solutions Trunk Cable, 50 µm multimode (OM4), MTP® Connector (non-pinned) to MTP® Connector (non-pinned), 24 Fibers, pulling grip one side, xxx ft **NOTE** Trunks available in fiber counts from 12 to144 fibers)
4	H937908QPH-KBxxxF	Pretium EDGE® 8-fiber Harness, 50 µm multimode (OM4), MTP® (pinned) to LC UniBoot, xxx ft, 24-in LC legs

Vendor	Corning	
Bill of Materials for Figure 7		
Item Number	**Part Number**	**Description**
1	J759312QE8-NAxxxF	12-Fiber MTP® Jumper, 50 µm multimode (OM4), MTP® (non-pinned) to MTP® (pinned), TIA-568 Type-A polarity, xxx ft
2	EDGE-CP48-E3	48 F MTP® Adapter Panel, 50 µm multimode (OM4/OM3) (4 port); mounts in EDGE Housings (example: EDGE-02U) **NOTE** Panels available in 2, 4 and 6-port)
3	G757524QPNDDUxxxF	Pretium EDGE® Solutions Trunk Cable, 50 µm multimode (OM4), MTP® Connector (non-pinned) to MTP® Connector (non-pinned), 24 Fibers, pulling grip one side, xxx ft **NOTE** Trunks available in fiber counts from 12 to144 fibers).
4	ECM-UM12-05-93Q	Pretium EDGE® Solutions Module, 12 F, LC Duplex to MTP® Connector, 50 µm multimode (OM4)
5	797902QD120xxxF	Pretium EDGE® Solutions Jumper, 2 F, LC Uniboot to LC Uniboot, Riser, 50 µm multimode (OM4), xxx ft

Vendor	Type	Rack Unit	Number of Ports	Part Number
Data Center Systems	Enclosure: 10U x 8 Slot x 15.5" D ECO Modular Enclosure 1-4, 9-12 Overlay	10U	Up to 512	7510-0101-010
	MTP/MPO-LC Panel: 10U-8 64 Channel Black LC-Quad ECO Modular Adapter Panel FC16-64 QSFP 0-15/FC 00-63	10U	64	7110-0118-000
	Modular Cassette: 10U-8 64 Channel Black LC-Quad OM4 ECO Modular Cassette FC16-64 QSFP 0-15/FC 00-63	10U	64	7310 0105-000

Vendor	Type	Rack Unit	Number of Ports	Part Number
Methode	MPO-MPO Conversion Patch Panel (front and rear wire managers, blank coupler plates and mounting rails)	2U	Up to 64 (MTP)	QS-108111000
	MTP 2 x 1 MTP -- Harness Kit DCX 8510-8 Chassis			QCB-120144
	MTP 2 x 1 MTP -- Harness Kit DCX 8510-4 Chassis (1&2, bottom 2 blades/slots)			QCB-220244
	MTP 2 x 1 MTP -- Harness Kit DCX 8510-4 Chassis (3&4, top 2 blades/slots)			QCB-220344

Vendor	Type	Rack Unit	Number of Ports	Part Number
Wave 2 Wave	MPO-MPO Conversion Patch Panel	1U	5 slots	69EVO-1U00-5v2 1U00-5v2
	MPO-MPO Conversion Patch Panel (front and rear wire managers, blank coupler plates and mounting rails)	2U	14 slots	69EVO-1U00-5v2 1U00-5v2

Custom Director Trunks

Vendor	Type	Rack Unit	Number of Ports	Part Number
Data Center Systems	**Trunk**: 64 Fiber DCX FC16-64 0-31 OM4 Plenum Trunk LC-MTPf xxx Feet	NA	32 ports	TB1964F5-3236-XXXF
	Trunk: 64 Fiber DCX FC16-64 32-63 OM4 Plenum Trunk LC-MTPf xxx Feet	NA	32 ports	TB2064F5-3236-XXXF

Velcro Cable Wraps

Use Velcro-based tie wraps instead of plastic zip ties or metal tie wraps. Over-tightening plastic zip ties or metal tie wraps can cause sheathing and overstress the patch cables, causing signal loss and impacting performance. Velcro cable ties come in a roll or in predetermined lengths. Bundle groups of relevant cables with Velcro cable ties as you install the cables, which will help you identify cables later and facilitate better overall cable management.

Labelers

Labelers are used to print sticky labels for devices and cables. Here are some considerations when you choose a hand-held labeler:

- Should be capable of operating using batteries
- Can print labels on smooth, textured, flat, and curved surfaces
- The actual label material should resist solvents, chemicals, and moisture
- Labels are durable and resist fading
- Adhesive should be long-lasting

If you choose a labeler with bundled software, install it on a client workstation. You can then customize labels, print labels in batches, and store the formats for future printing.

Appendix E: FC16-64 Supported Connection Distances

Connection Type	Speed	Multi-Mode Max Distance		Comments
		OM3	OM4	
QSFP<>QSFP (0dB connector loss)	16Gb	100m	125m	Assumes point-to-point connection without patch panel
QSFP<>SFP (1dB connector loss)	16Gb	66m	100m	1dB represents maximum likely signal loss from a breakout cable
QSFP<>SFP (1.5dB connector loss)	8Gb	150m	190m	Uses industry standard figure for 1.5dB signal loss with a patch panel.

Appendix F: Cable Management and Patch Panel Vendors

Amphenol

Phone: 1-510-209-6831

www.amphenol.com

www.cablesondemand.com

CommScope

Phone: 1-800-344-0223

Email: support@systimax.com

http://www.commscope.com/Product-Catalog/#market-enterprise

Corning

Phone: 1-800-743-2671

www.corning.com/opcomm

Data Center Systems

Phone: 1-972-620-4997

Email: info@datacentersys.com

http://datacentersys.com

Methode

Phone: 1-888-446-9175

Email: sales.data@methode.com

www.methode.com/data

Molex

Phone: 1-800-833-3557

Email: onlinesales@arrow.com

Email for quotes outside the U.S.: iccsales@arrow.com

www.arrow.com (contact your local branch if you are already an Arrow customer)

TE Connectivity

Phone: 1-800-342-5267

Email: entwest@te.com

www.te.com/SAM

Wave2Wave Solution Corporation

Phone: 1-877-223-2296

Email: sales@Wave-2-Wave.com

www.wave-2-wave.com

Appendix G: Reference Materials

- *High-Density Fiber Adapter Panel Shelf Instructions*; CommScope Part Number:860499748
- TIA-568-C.0 — *GENERIC TELECOMMUNICATIONS CABLING FOR CUSTOMER PREMISES*
- TIA-568-C.3 — *OPTICAL FIBER CABLING COMPONENTS STANDARD*