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Pretium® Solutions

Corning Cable Systems Optical Cabling Solutions for Brocade

Building high-density, high-port-count, structured cabling solutions to scale storage area networks to thousands of ports

BROCADE

Contents

Executive Summary: Optical Cabling Solutions for the SAN

As port density and port counts increase in Brocade products, end-users require structured cabling solutions from Corning Cable Systems to effectively scale storage area networks (SANs). The data center backbone (DCX) product, supporting up to 768 ports, requires routing over 1,500 fibers within a single 19 in rack or cabinet. By using an MTP® Connector-based cabling infrastructure with optical cable harnesses that transition a single 12-fiber MTP Connector to six LC duplex connectors as seen in Figure 1, the bulk cable volume in the cabinet vertical manager decreases by over 75 percent, significantly reducing cable congestion as seen in Figure 2. This move from the traditional low-density, duplex patch cord cabling solution to a high-density MTP Connector-based cabling solution enables the physical layer to be implemented in a manner that provides manageability, flexibility and scalability in the data center.

With Fibre Channel speeds increasing to 8.5 Gigabits/second, the need for cabling solutions to support extended distances in the data center is required. Corning Cable Systems Pretium® 550 Solutions laser-optimized 50 µm fiber provides supported distances of up to 210 m for an 8 Gigabit Fibre Channel link. Pretium 550 Solutions has been designed for applications beyond 4 Gigabit Fibre Channel (4GFC) and enables longer links at higher speeds than any other commercially available multimode fiber. While standard performance 50 µm optical multimode (OM2) fiber has worked well for SANs up to 4GFC, Brocade recommends using Corning Cable Systems Pretium 300 Solutions OM3 50 µm fiber or Pretium 550 Solutions OM3+ 50 µm fiber to extend 8GFC links beyond 150 m.

The business case for deploying cabling solutions in the data center has three primary considerations.

- **Scalability:** TIA-942 compliant structured cabling and high-density, MTP Connector-based cabling solutions enable Fibre Channel SANs to scale to thousands and even tens of thousands of fiber optic ports.
- **Manageability:** Deploying structured cabling and modular high-density cabling solutions improves troubleshooting and reconfiguration of ports during moves, adds and changes (MACs), as compared to low-density point-to-point links.
- **Distance:** As the size of data centers grows to hundreds of thousands of square feet (tens of thousands of square meters), link distances are increasing and will require the use of laser-optimized multimode fiber. For channels with extreme distances or channel insertion loss, single-mode fiber solutions are available.

Figure 1: MTP to LC Duplex Harness

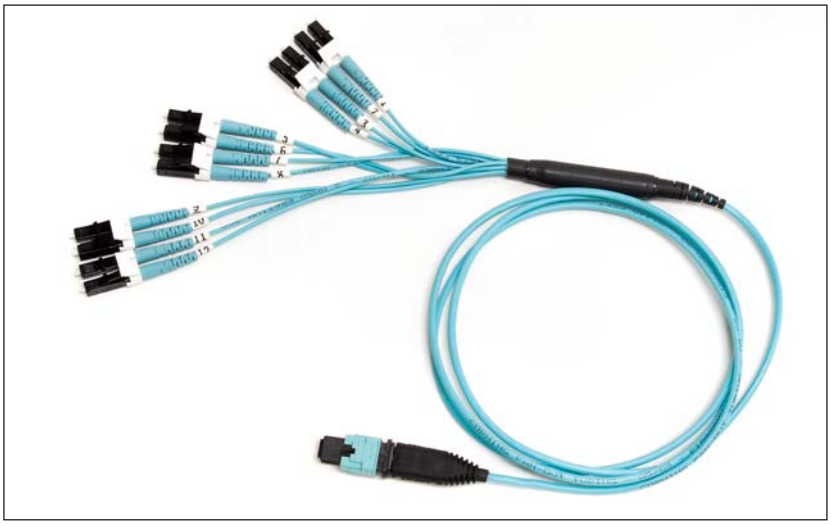

Figure 2: 384-Port DCX with Corning Cable Systems Cabling Solution

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The Problem

When first generation 1GFC SANs consisted of tens of ports, cable infrastructure and management was not a consideration or problem. With many customers deploying 8GFC SANs with tens of thousands of ports, implementation of point-to-point links leads to spaghetti cabling that is difficult to troubleshoot, reconfigure and scale. Without a main distribution area (MDA), cabling the SAN and data center becomes an unmanageable problem. Additionally, as distances, connectivity, and data rates increase, the resulting supportable link distances decrease, and may cause limitations with traditional standard performance 62.5 µm OM1 or standard performance 50 µm OM2 multimode fiber. Corning Cable Systems OM2 solutions are tested using the EMBc method and are suitable for use in laser-based systems. While Corning Cable Systems OM2 solutions enable 8GFC distances of 105 m with 1.5 dB total connector loss, Corning Cable Systems OM3 Pretium® 300 and Pretium 550 Solutions enable distances of 150 and 210 m, respectively.

The Answer

Corning Cable Systems and Brocade have jointly tested high-density optical fiber cabling systems to deliver a solution that enables SANs to scale to tens of thousands of ports and extend 8GFC links to hundreds of meters over OM3 fiber (Pretium 300 Solutions) or kilometers over single-mode fiber. Designed to comply with TIA 942 - Telecommunications Infrastructure Standard for Data Centers – the MDA becomes the hub of a star network. Easing configurability and troubleshooting, structured cabling enables consolidation of equipment types and localization of work efforts.

Structured cabling in data centers increases link-loss budgets due to the addition of connector pairs in the MDA. These losses can be minimized with low-loss connectivity solutions, thereby enabling extended channel distances. New generations of multimode fiber such as OM3 and OM3+ enable longer distances at higher data rates. If 8GFC channel distances exceed 210 m or the channel link budget, single-mode fibers will meet the needs of sprawling data centers.

SAN Cabling Infrastructure and Management

Structured Cabling Business Drivers

Fiber optics has become an essential ingredient in scaling SANs and data centers from thousands of square feet to hundreds of thousands of square feet. Table 1 summarizes the generations of SANs over the last decade and into the next decade. Within ten years, the number of ports in large enterprises has grown 1,000 times and the pattern seems destined

Table 1: Generations of SANs

SAN Generation	Release Date	# of FC Ports in a SAN	Area of Data Center ft² (m²)	Speeds	Structured Cabling/ Multifloors
1st	1998	10s	1,000s (100s)	1GFC	None
2nd	2002	100s	10,000s (1,000s)	2GFC	Some
3rd	2005	1,000s	100,000s (10,000s)	4/10GFC	Common
4th	2008	10,000s with NPIV**	100,000s* (10,000s)	8/10GFC	Very Common
5th	2011	100,000s with NPIV**	100,000s* (10,000s)	16GFC/ 10GFCoE	Required

** Square footage is often limited by power and cooling requirements.*
*** NPIV = N_Port_ID Virtualization or virtual N_Ports.*
Source: Brocade

to continue. At the same time, the size of the SAN has grown 100 times and the speeds of the Fibre Channel links have increased eight or 10 fold. This dramatic growth in speed and size requires new techniques to scale the data center. At the physical layer, customers need to deploy structured cabling to keep cabling manageable over time and increased distances.

Based on the TIA-942[1] standard, structured cabling scales multiple networks in the star topologies shown in Figures 3 and 4. The hub of the star network is the main distribution area (MDA), which includes the main cross-connect (MC) for the data center, containing a large quantity of patch panels that are usually housed in 19-in racks or cabinets. A single 19-in rack can hold over 1,500 LC duplex ports, so tens of thousands of ports can be contained in a fairly small footprint. Requiring no cooling because of its passive nature, the patch panels in the MDA are the central distribution point in the data center for telecommunication networks, local area networks (LANs) and SANs. The MDA is the heart of the data center and the arteries are fiber optic cables that carry information to the equipment that stores and processes information.

[1]*TIA-942 April 2005, http://global.ihs.com.*

Figure 3: Full Data Center Topology (TIA-942)

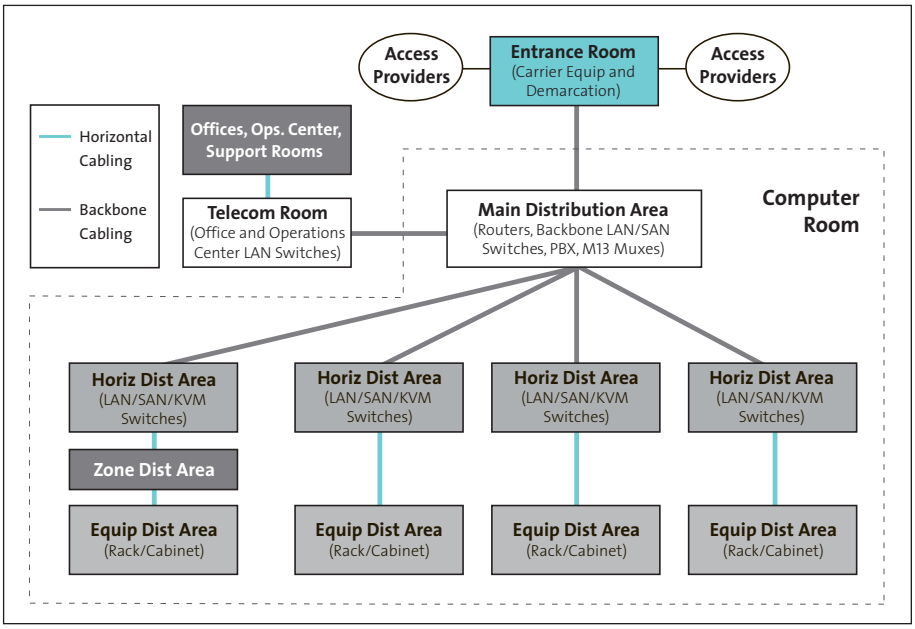
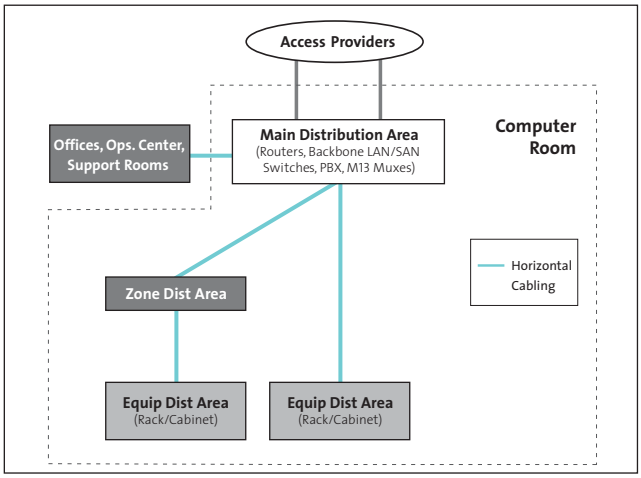


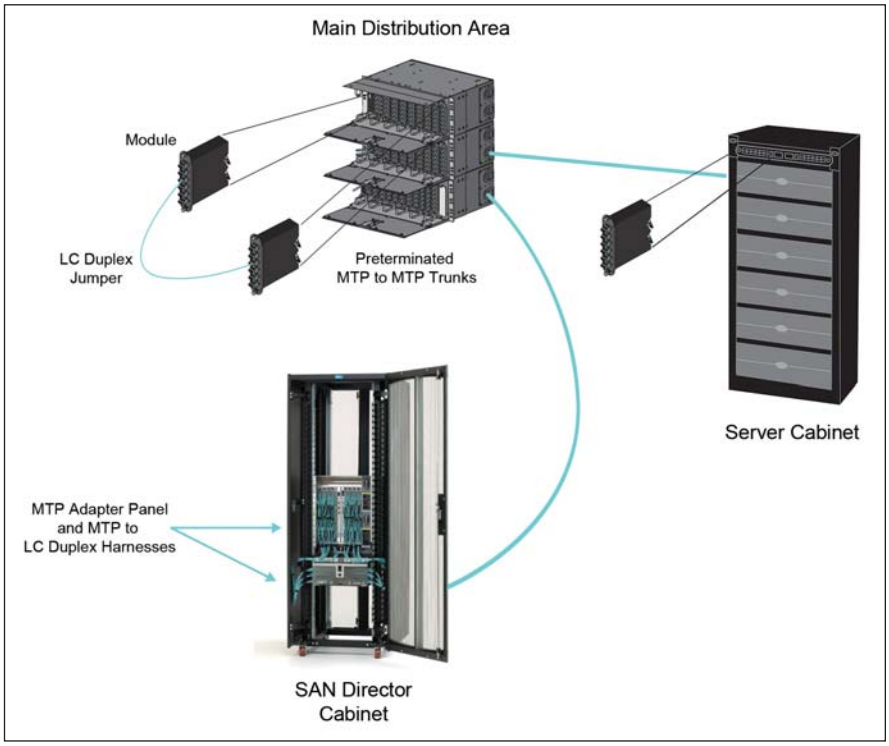
Figure 4: Collapsed Data Center Topology (TIA-942)



Following TIA-942 best practices, the MDA uses backbone or horizontal cabling to extend connectivity to the equipment distribution areas (EDAs) in the server, storage and switch environments of the data center. The use of high-density, MTP®-terminated cabling between the EDAs and the MDA provides reduced congestion and improved manageability, scalability, and modularity in the data center infrastructure. The main solution proposed in this paper pertains to the connectivity at the EDA containing the SAN director(s), shown in Figure 5. MTP-terminated Plug & Play™ Universal Systems trunk cables and MTP Connector to LC duplex harnesses provide connectivity between the LC duplex ports on the director and the MTP Connector ports in the MDA. With the use of MTP connectivity, the space required for passive optical patching at the SAN director is significantly reduced. Utilizing Corning's Zero-U or U-Space Systems, passive patching of over 768 Fibre Channel ports can be supported in either 4U patch panels or zero-U MTP adapter brackets.

As discussed previously, when implementing a TIA-942 compliant structured cabling topology, the number of connections within a channel can increase, as compared to a point-to-point link. For a channel providing connectivity between the SAN director and servers or storage devices, there are at least four locations with connections resulting in insertion loss. An example of a complete channel is shown in Figure 5, depicting cabling between the MDA and the SAN director cabinet, and between the MDA and a server; connectivity is achieved via a passive cross-connect with jumpers in the MDA. With this implementation, there are multiple connection points within the channel, including two MTP Connector to LC duplex modules at the main cross-connect in the MDA.

Figure 5: Example Connectivity Between SAN Director and Server



The connections in the MDA patch panels are the key to the configurability of the structured cabling system. These patch panels provide a means for any port in the data center to connect to any other port within the data center. Corning Cable Systems Plug & Play Universal Systems components are factory-tested; for system link loss, an optical source and power meter can be used to measure and verify loss performance of any link. Corning Cable Systems Zero-U and U-Space Systems include an innovative port mapping architecture and components with synchronized labeling. These features streamline the installation, documentation and administration of moves, adds and changes (MACs) in the SAN.

As shown in Figure 5, the suggested link configuration in this paper has one MTP Connector mating and three MTP Connector to LC duplex modules. Table 2 shows the maximum insertion loss specifications for MTP Connector matings and MTP Connector to LC duplex modules.

Table 2: Plug & Play Universal System Multimode Insertion Loss Performance

	Standard-Loss	Low-Loss
MTP Mated Pair	0.5 dB	0.35 dB
MTP to LC Duplex Module	0.75 dB	0.5 dB

Note: Low-loss performance available with Pretium® 300 and Pretium 550 Solutions.

With Corning Cable Systems standard performance Plug & Play™ Universal Systems, each module has a maximum insertion loss of 0.75 dB, and each MTP® Connector mating has a maximum insertion loss of 0.5 dB, yielding a maximum total connector insertion loss of 2.75 dB. To support extended distances for 8GFC limiting transceiver configurations with multiple connection points, Plug & Play Universal Low-Loss Systems should be used. In the suggested configuration, Corning Cable Systems low-loss performance system would have a maximum total connector insertion loss of 1.85 dB. Fiber Channel Physical Interface - 4, FC-PI4, specifies a maximum total connector insertion loss at 1.5 dB and 2.4 dB for 8GFC. 8GFC with a 1.85 dB total connector insertion loss supports a distance up to 140 m on Corning's OM3 fiber. To ensure optimal performance, all system components, including patch cords, should be of the same performance tier. Contact Corning Cable Systems Engineering Services for link distance and loss guidance on specific data center designs.

Scaling Data Centers

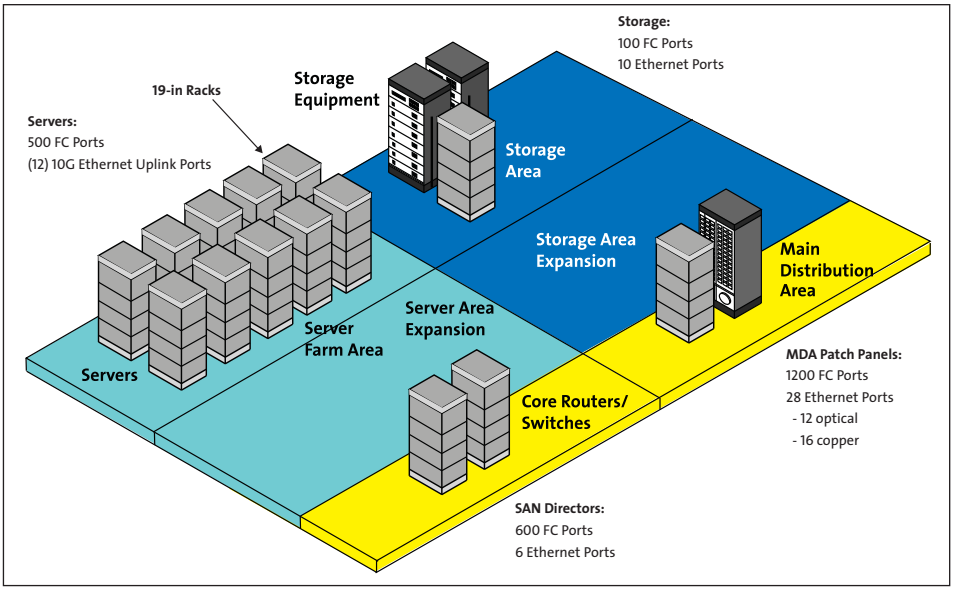
The greatest benefit of structured cabling arises when the data center and SAN scale to the next level. TIA-942 mandates a star topology as shown in Figures 3 and 4 with cabling radiating outward along the spokes shown to the horizontal, zone or equipment distribution areas. The backbone and horizontal cabling is typically high-density cables factory terminated with MTP Connectors, as shown in Figure 6.

Figure 6: Plug & Play Universal Systems 96-Fiber Trunk Cable with MTP Connectors

The use of an MTP Connector-based infrastructure in a star topology not only minimizes pathway congestion, but also enables the data center to scale quickly. MTP connectivity also accommodates future technologies such as parallel optics that is expected for 32, 64 and 128GFC, and 40 and 100 Gigabit Ethernet. With the use of this infrastructure, MACs can be made easily without disruption of the main cabling of the data center.

The following example details the implementation of a structured cabling topology in support of 250 servers with dual 8GFC host bus adapters (HBAs) and dual 1GbE network interface cards (NICs), as well as storage devices. The server LAN connectivity is achieved via copper cabling to 48-port edge switches with optical fiber cabling to distribution switches in the MDA. Both the server and storage SAN connectivity is achieved via optical fiber cabling to the SAN director via passive cross-connects in the MDA. Figure 7 depicts an example of the above described network.

Figure 7: Sample Data Center with Structured Cabling



The data center floor is divided into four main areas: server EDA, storage EDA, switch EDA and MDA. Additional Ethernet links are included for management traffic that is connected to the MDA. Table 3 shows the results of calculations for the number of backbone cables that would be required to support this connectivity. Routed to the MDA are (19) 144-fiber backbone cables that support 72 optical ports each. The cabling to the servers, storage devices and SAN directors are routed to the MDA for service of all of the Fibre Channel and Ethernet ports.

Table 3: Port Counts and Backbone Cables

Area	FC Ports	Ethernet Ports	Total Optical Ports	Backbone Cables 72 Ports/Cable
Server Area	500	12 (Optical)	512	7-FC, 1-Ethernet
Storage Area	100	10 (Copper)	100	2-FC
SAN Director area	600	6 (Copper)	600	9-FC
MDA	1200	12 (Optical), 16 (Copper)	1212	18-FC, 1-Ethernet

The overhead view of the optical cabling in Figure 8 illustrates how the cables are distributed to each area within the data center. There are 18 optical fiber backbone cables routed to the designated Fibre Channel patch panels and one optical fiber backbone cable is routed to the designated Ethernet patch panel. Corning's 4U patch panel (PCH-04U) holds 12 modules, providing a maximum capacity of 144 LC duplex ports when all modules are configured with 12 LC duplex connections per module. The back of each module accepts two 12-fiber MTP® Connectors; when used to full capacity, each 4U patch panel accepts two 144-fiber backbone cables, as seen in Figure 9. Allowing for 1U horizontal jumper management for each 4U patch panel, up to eight 4U patch panels can be installed in a 42U rack or cabinet, providing for up to (16) 144-fiber backbone cables in each rack or cabinet.

Figure 8: Backbone Optical Cable Layout

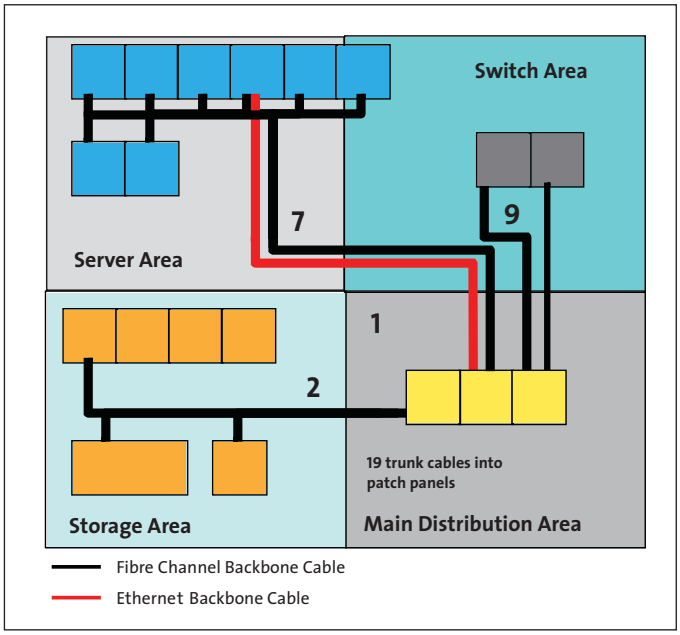
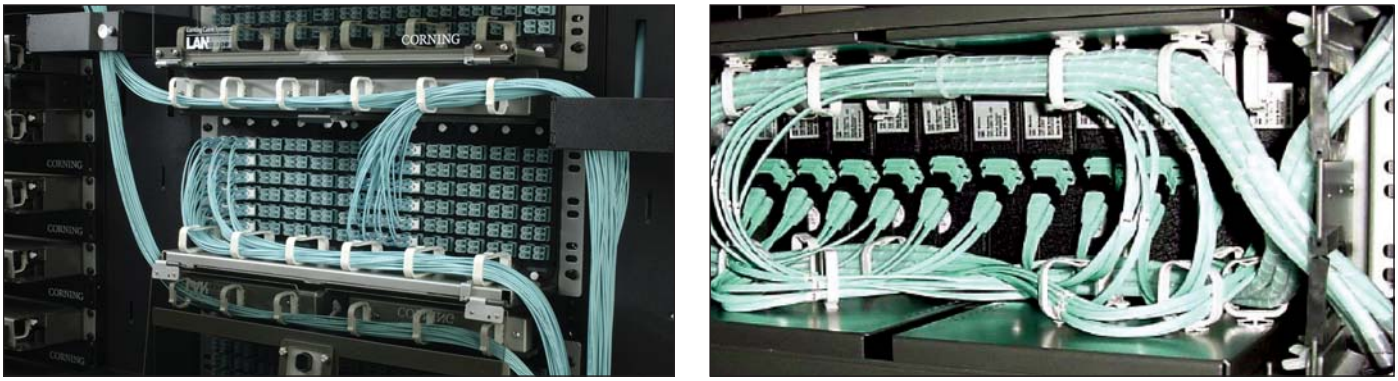


Figure 9: PCH-04U Front and Rear Views



With over 1,100 ports per rack, the MDA can scale to over 11,500 ports in just ten 19-in racks or cabinets. With each 144-fiber backbone cable having a nominal diameter of 0.66 in, a 24 in x 3 in cable tray at 100 percent fill ratio can hold 144 backbone cables that support over 10,000 ports. This compares well to 1,352 Cat 6 ports with a 0.23-in cable diameter or 2,064 Cat 5E ports with a 0.185-in diameter cable. Using high-density Corning Cable Systems trunk cabling in the backbone infrastructure, users can scale their SANs to over 10,000 ports with cables from a single cable tray.

Scaling the simple 600-port storage area network to thousands of ports involves replicating the design to expansion areas as shown in Figure 10. If each server cluster requires 500 SAN ports, over 3,000 SAN ports would be required to support the expanded configurations shown.

The configuration of a data center is as varied as the human intellect. Virtually any configuration can be imagined and implemented. The trick is to optimize the solution for a given implementation. In Figure 11, the MDA is located in the center of the data center floor, and server and storage areas are located in the perimeter of the floor plan, minimizing the distance between the MDA and any given EDA. In this example configuration, each server area required 2,500 SAN ports, while the storage areas required 500 SAN ports each. With over 12,000 Fibre Channel ports to the server and storage EDAs, and the matching ports to support the SAN directors, the SAN cabling infrastructure must be deployed in an efficient manner.

Figure 10: Scaling the Data Center

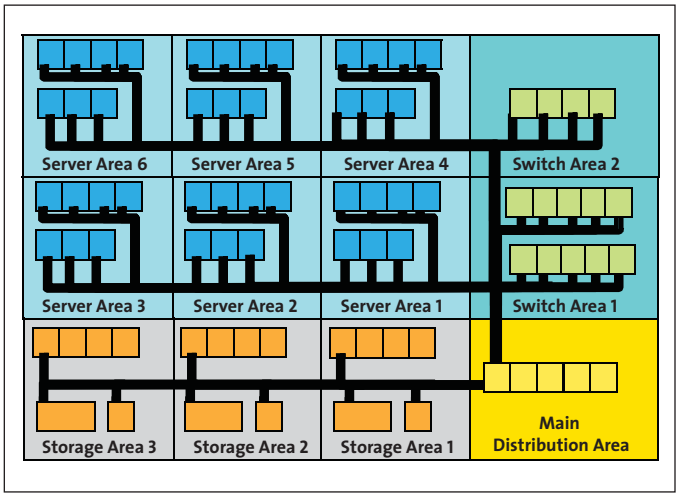
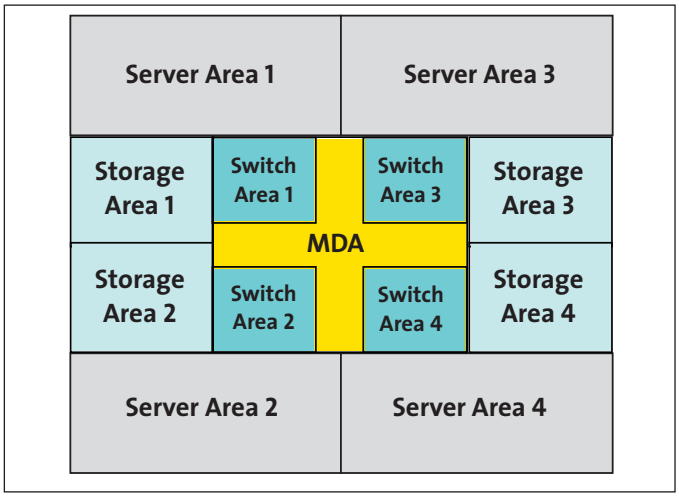


Figure 11: Alternative Layout with over 12,000 FC Ports

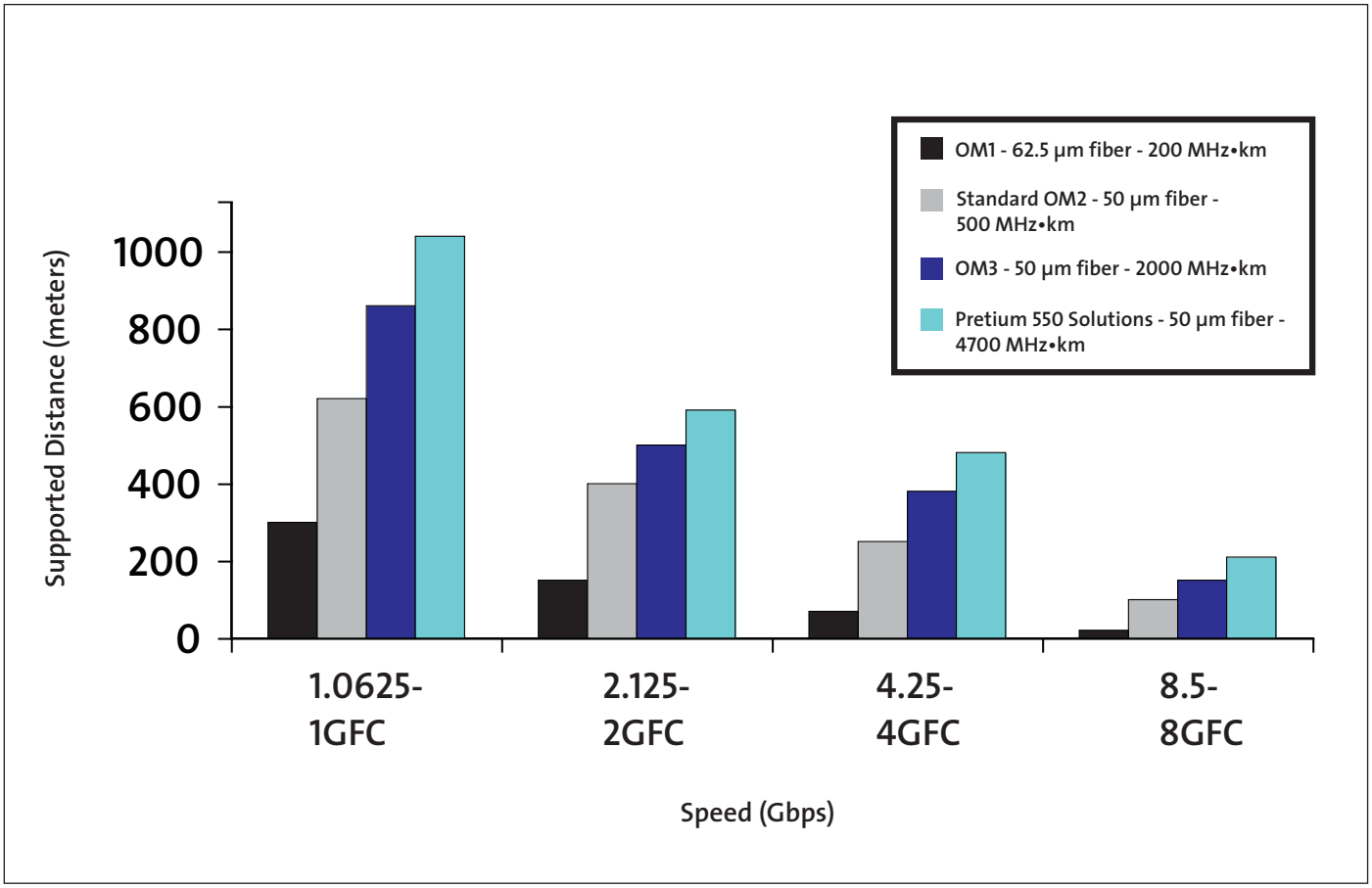


Fibre Channel Link Distances

Fibre Channel Physical Interfaces - 4 (FC-PI-4) has extended the link speeds of Fibre Channel to 8GFC. With every increase in speed, the supported multimode fiber end-to-end link distances (also referred to as channel) have decreased, as seen in Figure 12, except for 10GFC. When 1GFC was defined, the link distance was set to 500 m on OM2 fiber, and this exceeded the needs of almost any application. As the speed doubled, quadrupled and now octupled, the link distance on OM2 fiber has been reduced to 50 m and may not meet the needs of very large enterprise data centers. The increased channel insertion loss due to additional connector matings in the structured cabling environment result in additional reduction in the supportable link distances.

One solution to reducing this effect is to install OM3 fiber, which has a bandwidth length product (BWLP) of 2,000 MHz•km, four times greater than that of OM2 fiber. Corning Cable Systems Pretium® 300 Solutions (OM3 fiber) supports 150 m on 8GFC and meets the needs of the majority of data center applications. However, Corning Cable Systems' Pretium 550 Solutions fiber, which has a BWLP of 4,700 MHz•km, provides a supported distance of 210 m for 8GFC. If even longer distances are required, or if the channel link budget is exceeded, single-mode fiber solutions can span 10 or more kilometers at 8GFC.

Figure 12: Fibre Channel Link Distances



Distances based on total connector insertion loss of 1.5 dB.

The most peculiar aspect of the supportable distances shown in Figure 12 is that 10GFC does not follow the trend towards shorter supportable distances at higher data rates. The Base-2 protocols of Fibre Channel (1, 2, 4 and 8GFC) were designed to be easy to manufacture by keeping the BWLP of the link relatively constant. Figure 13 shows how the link BWLP has stayed fairly constant at various speeds because the distance of the link was reduced as the speed repeatedly doubled. The Institute of Electrical and Electronic Engineers (IEEE) set the link distance for 10 Gigabit Ethernet to 300 m, and 10GFC followed this strategy for compatibility. This has made the cost of 10GFC electronics expensive relative to Base-2 Fibre Channel protocols and restricted adoption in servers. Base-2 Fibre Channel has followed the low-cost curve and designed 8GFC to be easy to manufacture and test.

Connector Loss, Link Loss and Link Distance

Fibre Channel standards have traditionally been specified with 1.5 dB of connection loss (structured cabling end-to-end link insertion losses due to additional connector matings and decreased link distances as shown in Table 4). To ensure low bit error rates, installed link distances should be less than the link distances specified in the table. When the link distances and channel losses in Tables 4 and 5 are exceeded, the link could exceed the bit error rate of $1x10^{12}$ (one error in every one trillion bits) sent because of low optical power at the receiver. To support implementations with structured cabling, Tables 4 and 5 have been provided to define the supported distance and loss of channels with total connector losses of 1.5, 2.4 and 3.0 dB. Guidance is based on Corning Cable Systems connectivity solutions.

Figure 13: Bandwidth Length Product of Speeds, Protocols and Fibers

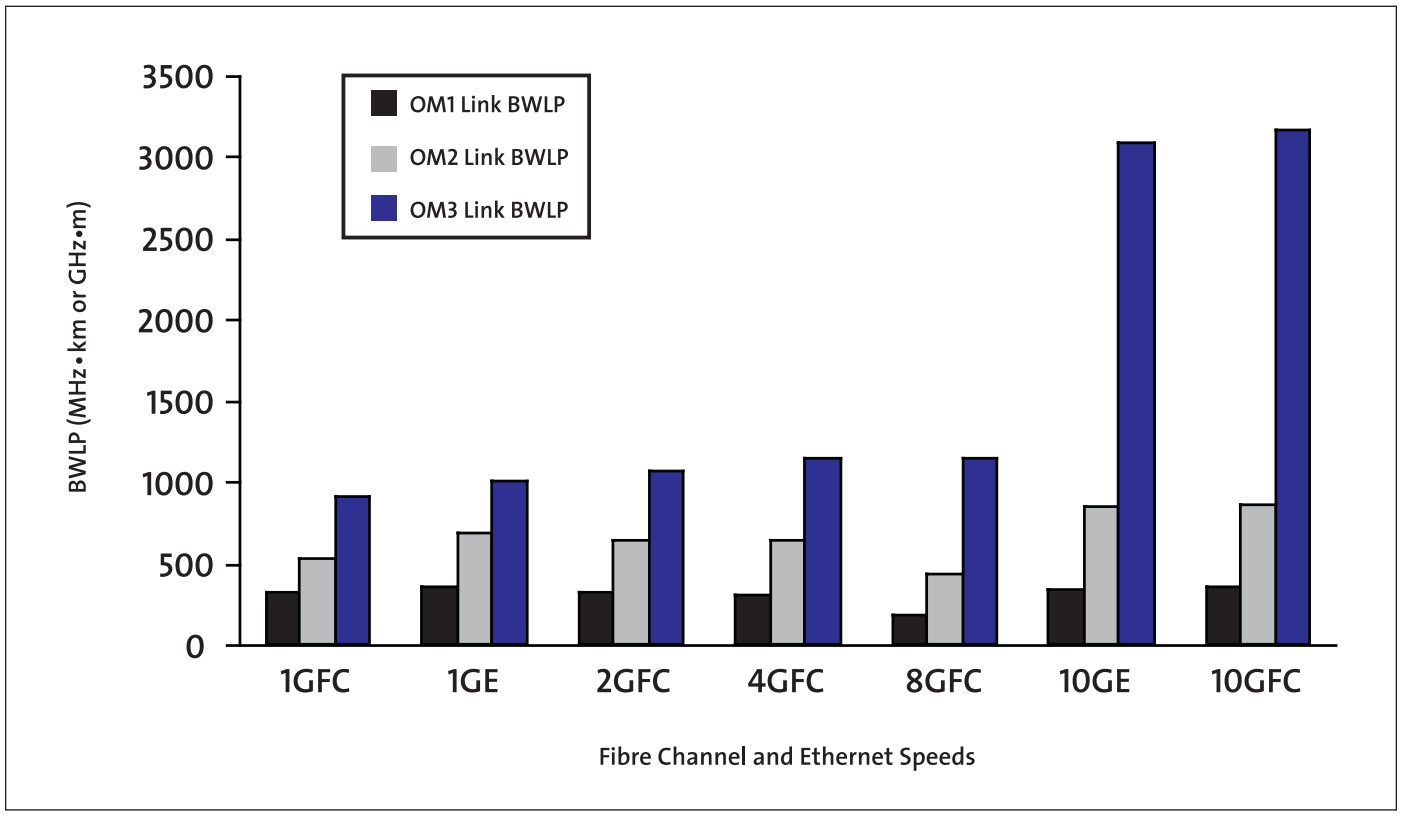


Table 4: Corning Cable Systems LANscape® Solutions Supported Link Distance (m/ft)

OM1 Standard 62.5/125 µm	Link Distance with 1.5 dB of Connector Loss	Link Distance with 2.4 dB of Connector Loss	Link Distance with 3.0 dB of Connector Loss
1GFC	300/984	260/853	230/755
2GFC	150/492	120/394	100/328
4GFC	70/230	60/197	45/148
8GFC	21/69	0	0
OM2 50/125 µm Pretium® 150 Solutions			
1GFC	670/2198	560/1837	470/1542
2GFC	470/1542	370/1214	300/984
4GFC	280/919	220/722	170/558
8GFC	105/344	70/230	30/98
OM3 Laser-Optimized 50/125 µm Pretium 300 Solutions			
1GFC	860/2822	800/2625	660/2165
2GFC	500/1640	440/1444	350/1148
4GFC	380/1247	310/1017	240/787
8GFC	150/492	110/361	50/164
OM3+ Laser-Optimized 50/125 µm Pretium 550 Solutions			
1GFC	1040/3412	840/2756	690/2264
2GFC	590/1936	480/1575	370/1214
4GFC	480/1575	370/1214	280/919
8GFC	210/689	140/459	55/180

Link loss is the accumulated end-to-end loss from attenuation in the fiber and a series of connector matings or splice losses. If the user measures the loss from one end of the link to the other for the distances specified in Table 4, the user should measure a power loss of less than the channel loss shown in Table 5.

Table 5: Total Insertion Loss with Distance and Connector Loss

OM1 Standard 62.5/125 µm	Total Link Loss with 1.5 dB of Connector Loss	Total Link Loss with 2.4 dB of Connector Loss	Total Link Loss with 3.0 dB of Connector Loss
1GFC	2.98	3.65	4.08
2GFC	2.2	3.13	3.62
4GFC	2.09	2.69	3.39
8GFC	2.47	0	0
OM2 Standard 50/125 µm Pretium® 150 Solutions			
1GFC	4.21	4.66	4.91
2GFC	3.02	3.67	3.98
4GFC	2.47	3.16	3.59
8GFC	1.89	2.68	3.13
OM3 Laser-Optimized 50/125 µm Pretium 300 Solutions			
1GFC	4.82	4.91	5.08
2GFC	3.61	3.88	4.15
4GFC	2.92	3.4	3.74
8GFC	2.22	2.8	3.13
OM3+ Laser-Optimized 50/125 µm Pretium 550 Solutions			
1GFC	4.73	5.03	5.16
2GFC	3.93	3.93	4.23
4GFC	2.98	3.59	3.89
8GFC	2.18	2.84	3.17

As shown in Figure 5, the suggested configuration in this paper has one MTP® Connector mating and three MTP Connector to LC duplex modules. With Corning Cable Systems standard performance Plug & Play™ Universal Systems, each module has a maximum insertion loss of 0.75 dB, and each MTP Connector mating has a maximum insertion loss of 0.5 dB, yielding a total channel insertion loss of 2.75 dB. For channel configurations with many connection points,

Plug & Play™ Universal Low-Loss Systems are available to provide a lower link insertion loss. The low-loss performance system includes MTP® to LC duplex modules with a maximum loss of 0.5 dB and MTP mated pairs with a maximum loss of 0.35 dB. To ensure optimal performance, all system components, including patch cords, should be of the same performance tier. Contact Corning Cable Systems Engineering Services for link distance and loss guidance on specific data center designs.

Cabling of Brocade Products

To scale Fibre Channel fabrics to thousands of ports, the right product is required. Brocade has designed the data center backbone (DCX) to be the ideal product to scale SANs to tens of thousands of ports. With up to 768 ports in a dual-chassis configuration, the DCX still leaves 14U of a 42U rack available for other products. Corning Cable Systems has pre-engineered solutions designed to integrate with Brocade SAN directors with 16-, 32- or 48-port line cards. Two modular high-density cabling solutions are proposed for the DCX and 48000 SAN directors. Corning Cable Systems Pretium® Integrated Solutions includes the U-Space and Zero-U Systems, which include MTP connectivity with harnesses customized for optimal routing into Brocade SAN Directors. The U-Space System is deployed in a more traditional manner, where optical hardware is placed in the rack space with the director. The Zero-U System utilizes the cabinet vertical manager for placement of the optical hardware. Both solutions are optimized for high density, flexibility and ease of management; additionally, the Zero-U System provides the benefit of moving the rack space typically required for passive optical patching into the cabinet vertical cable manager.

Corning Cable Systems' U-Space System aligns MTP adapter panels to the director blades as shown in Figures 14 and 15. Each 96-fiber adapter panel has eight 12-fiber MTP adapters that correspond directly with the 48 LC duplex ports in the densest available DCX or 48000 blade. The solution utilizes eight MTP Connector matings per adapter panel and consumes four adapter panels in a 4U housing to provide connectivity to each half of a DCX or 48000 chassis, or 192 ports. The benefit

Figure 14: U-Space System Port Mapping

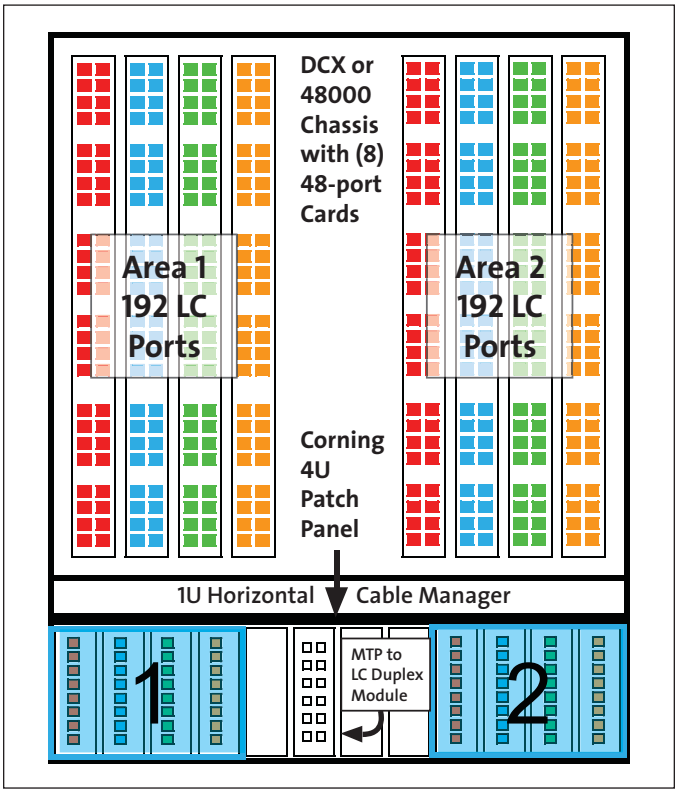
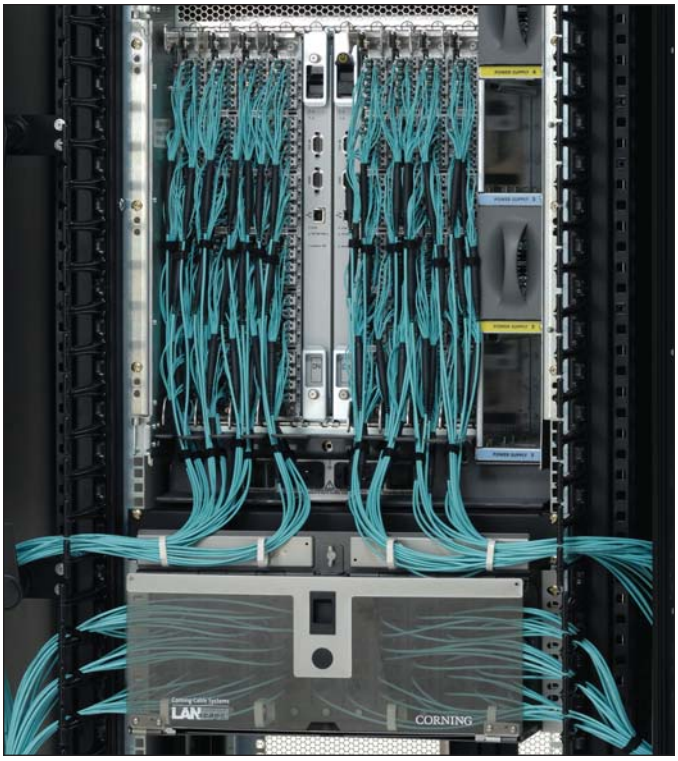


Figure 15: Installation of U-Space System with 48-Port Line Cards



of this design solution is that the director line cards align with the adapter panels of the patch panel housing, providing flexibility when line cards need to be added or removed. Implementing this management-optimized solution provides ease of administering moves, adds and changes, as well as chassis scalability. With each panel aligning with a chassis line card, when a line card needs to be added, changed or removed, only the corresponding adapter panels are affected, minimizing risk of disturbing cabling to ports on neighboring line cards. To populate a full chassis, eight MTP® adapter panels are required; spare capacity in the rack mount patch panel can be populated with MTP to LC duplex modules, providing connectivity to chassis ports requiring single-fiber or low-port-count connectivity.

The importance of cable density becomes more apparent when the DCX is configured with two chassis in a single rack as shown in Figure 16, or when two 48000 chassis are installed in a single rack. Within a 42U rack or cabinet, the two chassis fill 28U of space and leave 14U available. Utilizing the U-Space System, 10U of rack space is used, with one PCH-04U used per chassis and installed with the integrated horizontal jumper management panel in the up or vertical position.

Brocade's DCX and 48000 directors support a variety of port count blades. Using Corning Cable Systems Plug & Play™ Universal Systems components in conjunction with the pre-engineered Corning harness solutions for the SAN, an infrastructure can be implemented that accommodates current and future expected blade configurations and allows for a simple migration path from 16- to 32- to 48-port line cards. While the 48 port blade maps to exactly eight 12-fiber MTP Connectors, line cards with port counts of 16 and 32 are not in multiples of 12-fiber increments. When using 12-fiber harnesses with line cards of these port counts, the last harness installed will have spare or unused fibers. For manageability, Brocade and Corning recommend the use of Corning Cable Systems Base-8 Modules and 8-fiber MTP Connector to LC duplex harnesses. The Base-8 Module (see Figure 17) converts 12-fiber MTP Connectors plugged into the rear of the module to 8-fiber MTP Connectors in the front of the module. For use with 16- and 32-port blades, the Base-8 Module replaces the 8-port MTP adapter panel (used with 48-port blades) in the PCH-04U housing. With four 12-fiber MTP Connectors into the module and six 8-fiber MTP® Connectors out

Figure 16: Dual-Chassis 48000 or Configuration

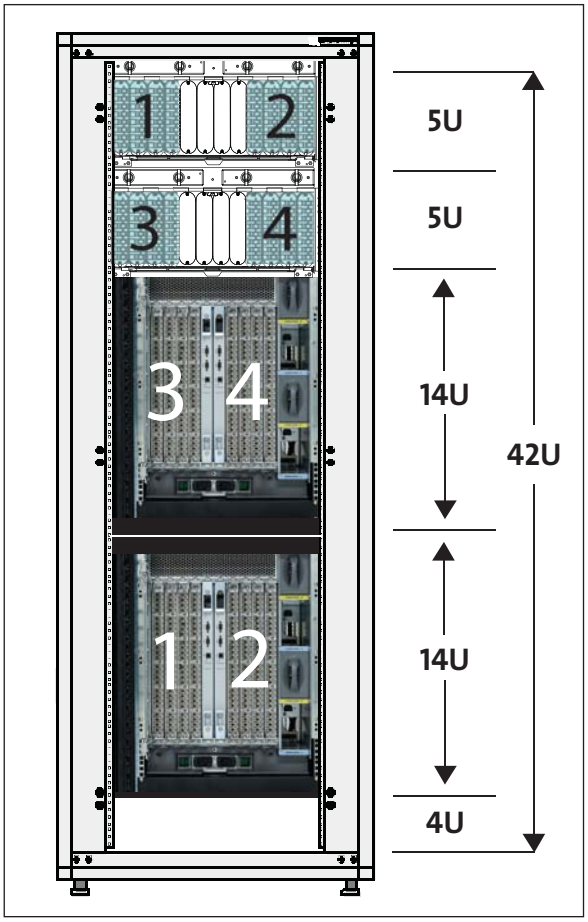


Figure 17: Base-8 Module

of the module, all fibers are utilized, eliminating unused, spare fibers in the cabling infrastructure. An 8-fiber harness completes the connectivity into the director where the MTP® Connector end of the 8-fiber harness plugs into the front of the Base-8 Module and the four LC duplex connectors plug into the director line card.

For ease of design, installation and administration of moves, adds and changes, Corning Cable Systems offers an innovative port-mapping architecture detailing the connectivity from each LC duplex port in the MDA to the local MTP Connector patching field, to each LC duplex port in the SAN director chassis. Figure 18 recommends how to map the LC duplex ports of various Brocade blades to the MTP Connector ports of the MTP adapter panels in the 4U SAN director patch panel. Figure 19 is a basic color-coded sample

Figure 18: Mapping Brocade Blades to MTP Connector Ports

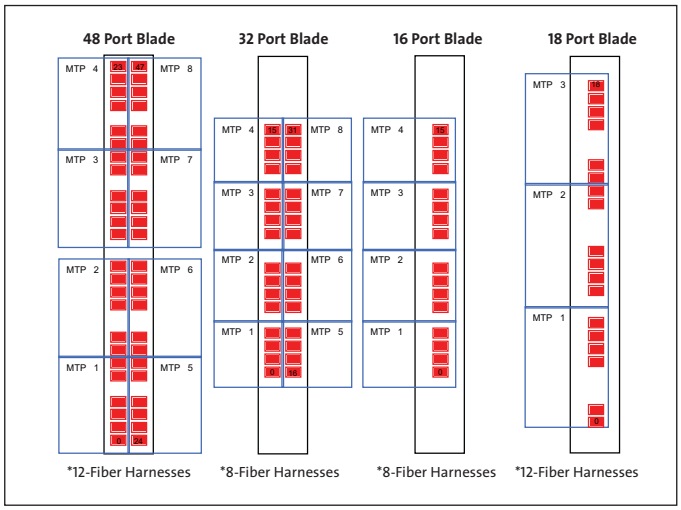
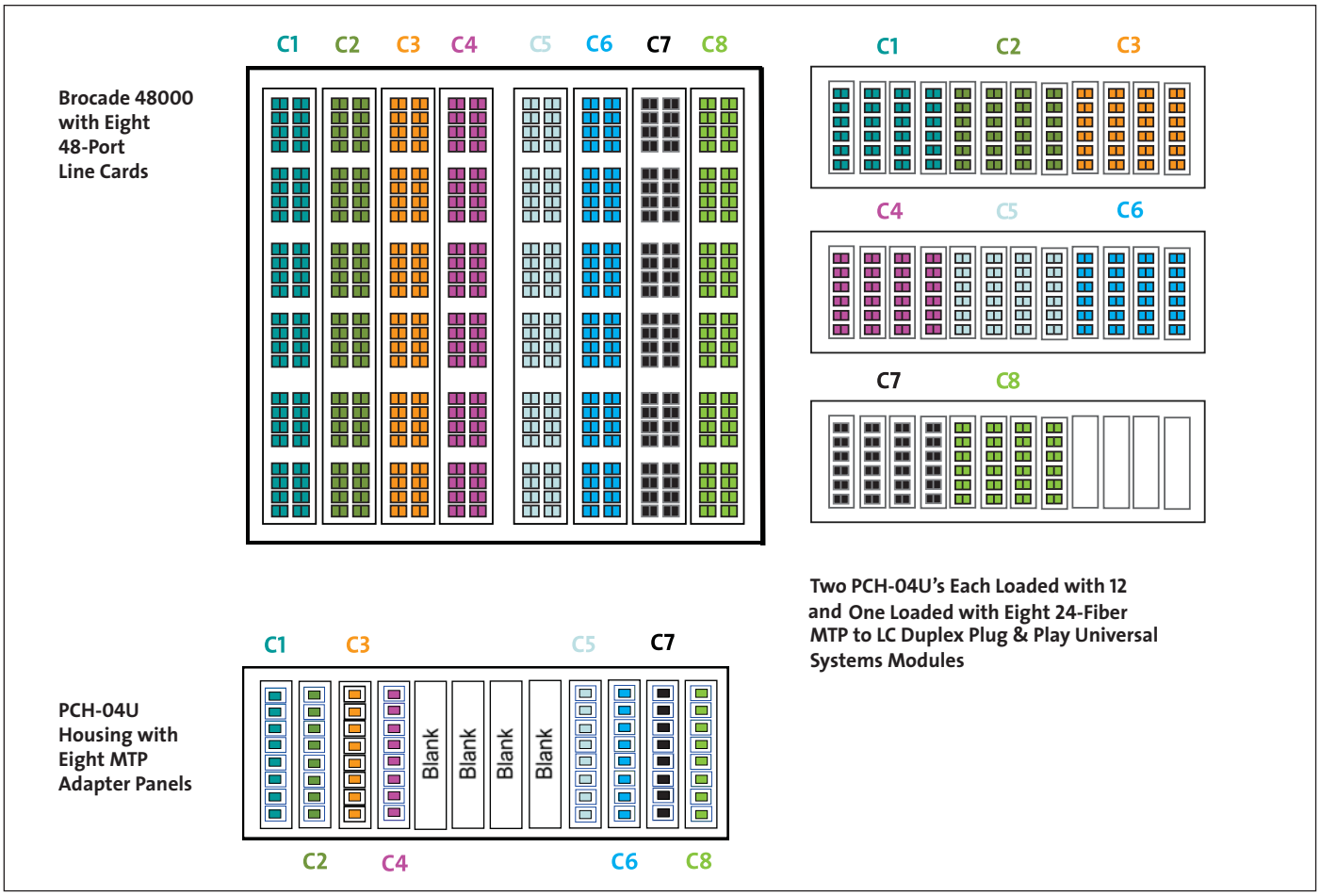


Figure 19: Port Mapping Brocade Line Cards to the MDA



of the entire Plug & Play™ Universal Systems port mapped from the SAN director all the way back to the main cross-connect in the MDA. For more detailed information, contact Corning Cable Systems and reference the Integrated Solutions Design Guide, LAN-899-EN.

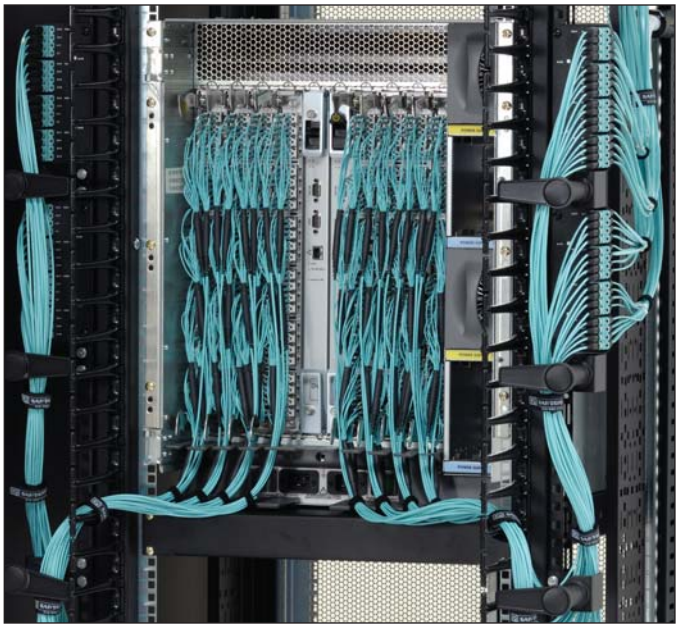
Figure 20 shows how three different port count 48000 blades are cabled. The first and second line cards have 16 and 32 ports, respectively while the third and fourth have 48 ports. As previously discussed, the optimal solution for the 16- and 32-port cards includes the U-Space System Base-8 Modules and 8-fiber harnesses to minimize spare, unused fibers. The remaining blades shown have 48 ports and utilize the U-Space System 96-fiber MTP® adapter panels and 12-fiber harnesses.

In addition to the U-Space System offering, Corning Cable Systems Zero-U System provides a pre-engineered high-density MTP Connector-based harness solution for the SAN. Additionally, the Zero-U System re-allocates the space required for passive optical patching from the traditional rack space to the cabinet vertical cable manager. The Zero-U System utilizes high-density MTP adapter brackets mounted in the vertical manager, combined with customized 12-fiber harnesses for optimized routing into the Brocade DCX or 48000. Figure 21 illustrates the Zero-U System when implemented with a 48000 chassis fully-loaded with eight 48-port line cards.

Corning Cable Systems Pretium® Integrated Solutions offers MTP connectivity with customized harness solutions for Brocade SAN Directors. Through the use of these harness-based Zero-U and U-Space Systems, a reduction in bulk cabling of up to 77 percent is realized when comparing the space consumed by a 12-fiber harness to six LC duplex patch cords. The pre-engineered solution also streamlines SAN design, installation and administration of MACs. For ease of ordering, Zero-U and U-Space System harnesses are available in "kits" to support the various Brocade port count line cards. Each harness kit includes the quantity of harnesses required to populate a single line card.

Figure 20: Cabling Various Director Blades with U-Space System

Figure 21: Installation of Zero-U System with 48-Port Line Cards



Specifications on the specific harnesses to be used in the Zero-U and U-Space Systems can be found at the following link:

http://www.corning.com/cablesystems/brocade/designguide

Additionally, this link can be used to access the Pretium® Integrated Solutions Design Guide, which includes example bills of materials for each solution.

Recommended Fiber

Brocade and Corning Cable Systems recommend using OM3 fiber. A large installed base of OM1 and OM2 fibers exists but these fibers should be avoided for links above 2GFC because of their limiting distance. OM1 fibers should not be used within the same passive link with OM2 or OM3 fibers because of the core mismatch. Table 6 details a summary of the various fiber types and BWLP performance. When superior performance is required, Corning Cable Systems Pretium 300 or Pretium 550 Solutions should be used.

Table 6: Corning Fiber Types

Fiber Type	Core Diameter (µm)	OFL BW (MHz•km) at 850 nm	EMBc (MHz•km) at 850 nm	Color of Cabling
OM1	62.5	200*	220**	Orange
OM2 (Pretium 150 Solutions)	50	700	950	Orange
OM3 (Pretium 300 Solutions)	50	1500	2000	Aqua
OM3 + (Pretium 550 Solutions)	50	1500***	4700	Aqua
Single-Mode	9	–	>1,000,000	Yellow

**OFL Bandwidth used for 1 & 2 GFC distance capabilities for OM1 fiber*
***RML Bandwidth, EMBc not specified for OM1 fiber*
****Currently, OM3+ has specified OFL bandwidth of 1500 MHz•km*

Solutions for Every Implementation

This paper has described how a DCX or 48000 with up to 768 ports in a single rack or cabinet can be cabled with Corning Cable Systems MTP® Connector-based Plug & Play™ Universal Systems and Zero-U or U-Space Systems. As part of a TIA-942 compliant star topology cabling infrastructure, the MDA becomes the nexus of the data center, and installing a high-density, modular infrastructure enables easy MACs and troubleshooting.

This paper shows examples of how to cable a variety of Brocade products. Cabling from 16- to 48-port blades on different Brocade SAN Directors, Corning Cable Systems products are adaptable and can be optimized for a given implementation. With the use of Corning Cable Systems MTP Connector to LC duplex harnesses, cable volume in the vertical manager decreases by up to 77 percent. With this reduction in cable congestion and use of Corning Cable Systems port mapping architecture, ease of installation and administration of moves, adds and changes is provided.

With the additional connector insertion loss incurred with structured cabling, higher data rate links, such as 8GFC, need to be managed properly so that longer distances can be supported. With the use of high performance Plug & Play Universal Systems to minimize connector loss and maximize bandwidth performance, link distances can be extended. If support of extreme distances is required, single-mode fiber is an available option. The Corning Cable Systems and Brocade teams have been able to solve any cabling issue that has been seen in the field. In addition to offering of these pre-engineered, tailored solutions, Corning Cable Systems and Brocade offer design services to help customers develop custom cabling solutions for the data center.

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