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Considerations in the Selection of Enterprise & Data Center Fiber Patching & Splicing Cabinet Systems

An Integrated Approach to Managing Fiber & Copper Connectivity

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Introduction

Ratification of the TIA/EIA-568 Commercial Building Cabling Standard in 1991 was a major stimulus for the replacement of incompatible, disparate, and often difficult to manage computer and telecommunication equipment cabling with an orderly and well organized "structured" cabling system (SCS). This important standard introduced both manageability and flexibility into enterprise cabling systems. For the first time, building architects, consultants, designers and operators had a "blueprint" to facilitate easy installation and reconfiguration of their premises cabling systems to accommodate typically short installation time frames. The systematic organization of the SCS also provided major advantages to simplify the inevitable moves, adds and changes of users and equipment that routinely occur in all enterprises and data centers. The initial release of the 568 standard was based almost entirely on the performance characteristics and limitations of UTP copper cabling systems; hence the 100 meter limit for the horizontal subsystem. A key element providing the flexibility inherent in the SCS was the copper patch panel.

The historical dominance of UTP copper in enterprise SCS since TIA/EIA-568 has resulted in continuous product evolution in copper patch panel products. Fiber optic technology, with its greater supported distances, higher bandwidth and other advantages was essentially absent in the original TIA/EIA-568 standard but arrived in subsequent revisions of TIA/EIA-568 including TIA/EIA-568-A and 568-B. In the earlier versions of the 568 standard, fiber application in structured cabling systems was limited to the campus and building backbone subsystems. With the migration to ever faster and larger networks and the substantial recent increases in copper raw material prices, fiber is expected to have an increased presence in customer applications as well as in the upcoming TIA/EIA-568-C standard.

As fiber optic technology began to play a more significant role in the SCS, the importance of fiber connectivity products, including fiber patching and splicing products has increased. Traditionally, many fiber connectivity products were designed primarily for service providers such as the local and long distance telephone companies. While these products did provide cross connect, interconnect, splicing and terminating capabilities, many features required for today's high density enterprise and data center fiber applications were unavailable. For example, many early fiber patch and splice panels were designed to support a relatively low number of fibers and were often mounted on a wall rather than in today's high density equipment racks. An example of these early products was AT&T's Lightguide Interconnect Unit or "LIU." Now, as I.T. and data center managers are increasingly deploying fiber optics in their structured cabling systems, there is a need for innovative and feature-rich fiber connectivity solutions. This paper will discuss the important considerations for evaluating some of the most important elements of fiber structured cabling system cabinets, adapter panels and cable management accessories.

Characteristics of a well-engineered fiber cabinet

The ideal rack mountable fiber cabinet would offer many features of benefit to the enterprise or data center designer and operator. These would include consistent design across the full range of fiber counts required in the enterprise or data center. The cabinet should be designed in such a way as to provide a high level of stability and control of the backbone cables as they enter the rear of the fiber cabinet. The cabinets should be engineered to simplify installation and maintenance by providing expanded rear access. They should feature a large chassis with ample depth for easier and neater fiber management and support of today's larger active electronics. As copper is still a key media type in most enterprise and data center applications, the fiber cabinet should be designed for full compatibility with the 10.5" deep vertical channels in popular equipment racks. In addition, the front of the fiber cabinet should be designed to enhance the management and protection of the fiber patch cords as they exit the cabinet. Let's take a look at these fiber cabinet characteristics and related items.

Consistent design to support wide range of fibers and connection techniques

Large enterprises and data centers typically have many products and systems deployed to support their users and applications. Training, documentation and inventory costs may be reduced with a fiber cabinet design that may be applied in all areas of the enterprise or data center. One similar design should accommodate both low density areas such as the telecommunications enclosure (TE), mid density areas such as the telecommunications room (TR) and high density areas such as the main equipment room (ER). Similarly, in the data center, one fiber cabinet line should support the lower density Equipment and Zone Distribution Areas (EDA and ZDA), the mid density Horizontal Distribution Area (HDA) as well as the high density Main Distribution Area (MDA). The cabinet should also support the full range of applications required including patching only, whether the connectors are pre-terminated or field-terminated. It should also accommodate installations where splicing alone or interconnection only is required, for example in the reduced size Telecommunications Rooms possible in an economical centralized fiber optic cabling architecture.

As more fiber is deployed in larger installations, alternative connection techniques such as optical cassettes and pre-terminated fiber trunk cables are growing in popularity. The optical cassette solution provides an integrated fiber connectivity system using a multi-fiber ribbon backbone or reduced diameter loose tube cable terminated with an MTP®/MPO connector. These small diameter cables are designed to interface with an optical cassette supporting one or two MTP/MPO 12- fiber connectors on the rear and up to 24 LC or SC fiber connectors on the front of the cassette (Figure 1). Familiar LC or SC connectors on the front of the cassette provide connection capability to a wide range of current and legacy optoelectronics. Connecting 12 backbone fibers simultaneously using cassette-based technology is a significant time and money saver in both enterprise and data center applications. Ever higher speed networks and their resultant decreased cable plant loss budgets are readily supported with state-of-the-art high bandwidth 50/125 µm laser optimized multimode fiber (LOMF). Networks built with these advanced fibers provide increased cable plant loss budgets to readily support cassette-based solutions.

Figure 1 – 12 fiber ribbon backbone cable used to connect optical cassettes

The pre-terminated trunk cable is a backbone cable with factory installed connectors extending from the rear of the fiber cabinet adapter panel to the mating end of another adapter panel in another rack. A well-designed fiber cabinet supports any combination of cassette-based, pre-terminated and field-terminated connections (Figure 2).

Figure 2 – Optical cassette and fiber adapter panels ready to be installed in fiber cabinet

Finally, since many installations involve both patching and splicing at the same location, the cabinet should easily accommodate one or the other or both. Fiber cabinets are available today with consistent designs including 1 rack unit through 4 rack unit (1U, 2U, 3U and 4U) configurations.

External fiber management

The traditional cable arrangement for structured cabling system fiber cabinets routes the backbone cables to the rear of the cabinet. Patching is performed at the front. With fiber density increasing in enterprises and data centers, it is typically more efficient to install the fiber cabinets in a physical support system (rack) than on the wall. These racks are sometimes referred to as cable management systems. Fiber cables are brought into the rack from above or below, but in either case, good vertical cable management is essential. Cable management cages mounted on the rear of the rack simplify vertical cable management and entry into the fiber cabinets while providing an additional level of physical protection for mission critical fiber optic backbone cables. Better cages feature additional "fingers" providing virtually unlimited locations at which to tie-off the fiber cable. Some cages also provide additional vertical members to provide more locations for attachment of hook and loop cable fastener strips. To ensure that the cables remain contained within the cable management cages, some manufacturers include latches at regular intervals, approximately every 4", along the height of the cage. Finally, it is important to verify that the fiber cable manager is designed to mount on the specific rack required for the project. Some cable managers are designed specifically for fiber racks. However, most enterprise IT and data center managers prefer to deploy racks that are equally capable of supporting fiber and copper connectivity.

Backbone cable access

The fiber cabinet should have provisions to facilitate easy and rapid backbone cable entry. One of the most effective ways of doing this is with modular cable fastening brackets (Figure 3). Fiber cabinets that are consistent in design across models (1U to 4U) should all use the same cable brackets, simplifying training and installation while minimizing inventory. Brackets are generally available for either top or bottom mounting to the fiber cabinet based on the cable entry path. Due to the limited height of 1U fiber cabinets, there is usually sufficient room to accommodate only top mounted brackets. To simply and securely attach the backbone cables, some manufacturers offer brackets that are designed for attachment of hook and loop straps. Notably, zip-tie fasteners should not be used with fiber optic cable due to over-cinching complications as a result of their tight compression capability and narrow width. Inside the fiber cabinet, integral lances may be provided on the sliding tray to which the backbone cables can be fastened, also with hook and loop straps. Additional functionality is provided with fiber cabinet trays that slide both forward and backward within the cabinet. Backbone cable access for fiber management and splicing is facilitated by sliding the tray rearward. Forward movement of the tray provides excellent access for fiber patching in the front of the fiber cabinet. Another desirable fiber cabinet feature provides the capability to pass backbone cables vertically from cabinet to cabinet, further protecting these critical cables and providing a cleaner installation.

Figure 3 --
Top & bottom cable fastening brackets

Backbone cable stability and control

It is important to ensure that the backbone fiber cables are secured in such a way as to prevent movement between the fiber sheath and sub-units as well as between the sub-units and the managed 900 µm buffered fibers in those sub-units as shown in Figure 4a. Integrity of the buffered fibers and the connectors to which they are attached should be maintained by the backbone cable fastening system. It is recommended that the backbone cable be installed in a helical configuration as shown in Figure 4b in order to allow sufficient slack to accommodate forward and rearward movement of the sliding fiber cabinet tray. Hook and loop cable straps provide an excellent way to secure the backbone cables to the fiber cabinet. Look for cabinets with built-in and appropriately located lances to facilitate installation of the cable straps.

Figures 4a and 4b – Backbone cable subunit movement isolated from internal fiber management using helical arrangement and built-in lances

Internal fiber management considerations

As with the newer, higher speed copper media such as Category 6 and Augmented Category 6, bend radius control is important for fiber optic media. The fiber cabinets should provide bend radius management at every transitional point. State-of-the-art fiber cabinets are designed to provide this control at the rear where the cable enters the cabinets, internal to the fiber cabinet itself, as well as at the front of the cabinet where the patch cords exit.

Comprehensive and flexible fiber management inside the fiber cabinet may be accomplished with additional strategically positioned lances for grouping, organizing and securing cable subunits. Fiber organizers may be used to create fiber rings of sufficient diameter to facilitate maintaining the appropriate bend radius. The most flexible bend limiters and fiber organizers are installed simply by twisting them 90 degrees to lock into position. Higher density within the cabinet is enabled through the use of stackable bend limiters and fiber organizers.

Figure 5 – Fiber cabinet with low profile stackable splice trays and stackable cable managers

Splicing is commonly used in many enterprise and data center fiber networks and the ease at which the fiber cabinet supports this connection method is important. As with connectors, fiber splicing density is steadily increasing in both of these applications. To minimize inventory stocking levels, it is advantageous to have the splice tray holder built into the fiber cabinet's sliding tray thus eliminating unnecessary splice tray height and creating room for additional splice trays within the fiber cabinet. The functional lances that are a built-in feature of the tray used to position fiber cables also facilitate management of fiber splice trays. Fusion splicing, once primarily used in outside plant service provider applications, is increasingly being used in data centers and enterprises. The fiber cabinet, therefore, should readily accommodate fusion splice trays in capacities up to the commonly used 12-fiber counts. The most efficient fiber splice trays are stackable, for installation in an appropriately designed 1U to 4U fiber cabinet. Installation of fiber splice trays on the fiber cabinet's sliding tray may be facilitated through the use of hook and loop "D ring" straps that secure as many as 10 high density splice trays. Fiber management at the splice trays is improved through the use of stackable bend limiting clips that are installed and locked into position with a 90 degree twist as described earlier.

Patch cord protection

The increasing popularity of small-form-factor (SFF) fiber optic connectors such as the LC is resulting in many more fiber patch cords being connected to the front of the fiber cabinet than may be installed with the larger SC connector. SFF connector patch cords may be built with smaller diameter cordage than is typically used with larger connectors. Without proper protection, these patch cords may be pinched or otherwise damaged when the door of the equipment rack is closed.

Proper design of the fiber cabinet can greatly minimize this possibility of damage by featuring enlarged cable exit ports that permit routing of the patch cords away from contact with the rack door. Snap-on bend limiters offer the dual advantages of not only maintaining the proper installed fiber patch cord bend radius but also keeping them positioned away from the door. The aforementioned lances built into the sliding fiber cabinet tray also serve to bundle the patch cords and locate them out of harms way. Small details such as perforations stamped into the fiber cabinet chassis enable the use of third-party cable managers for protection of the patch cords. Due to the small vertical dimension of 1U fiber patch panels, an articulating front door that slides forward and pivots downward provides similar patch cord protection while improving accessibility for patch cord management and organization.

Integration with popular fiber and copper cable management systems

As more data centers and enterprises continue their migration to fiber, it is common that both media types will be installed in the same cable management systems or racks for many years to come. It is important, therefore, that the fiber cabinets used in these applications are seamlessly integrated with the cable management systems in which they are installed. This implies that dimensional details, such as fiber cabinet depth facilitate backbone cable connection and routing in the rear of the rack. The most popular cable management systems typically have a vertical channel depth of 10.5". The fiber cabinets should be designed with an appropriate depth that eliminates the need to add additional bends to these fiber cables simply to contain them within the rear dimensions of the rack. The cabinet dimensions should not limit the installation and access of electronics such as Ethernet switches. A fiber cabinet depth of 19" is ideal for installation in the most popular cable management systems. Further benefits are available with fiber cabinets providing multiple mounting bracket attachment points so that the cabinets may be mounted at various depths for optimal front and rear access.

Labeling features consistent with TIA-606-A

One of the most important, but often overlooked details in structured cabling systems is the record-keeping element of managing these systems. The TIA-606-A "Administration Standard for Commercial Telecommunications Infrastructure" is intended to provide the guidelines and choices of classes of administration for maintaining the telecommunications infrastructure in a data center or commercial enterprise. As the density and required reliability of these installations continues to increase, it is even more important to fully document these systems not only at initial installation, but over the entire life-cycle of the system. The fiber cabinets selected should make it easy to label each cabinet and connection within the cabinet. The labeling surface should be large enough to be readily identified, even in dim light; a white background is best. Moves, adds and changes are inevitable in any of these systems, and when they are required, the available time for completion is typically short. Under these constraints, the technician is far less likely to re-label the connection if he or she has to search for a new label. Reusable label cards on the fiber cabinet make it easy for the technician to implement and/or continue good labeling practices consistent with TIA-606-A. Fiber cabinets with Plexiglas doors and silk screened target markets may be used to secure these reusable, drop down label cards. These doors also may be equipped with locks for additional security.

Selecting the fiber adapter panels

These relatively small components can support a tremendous amount of data throughput so their design is important. With densities increasing in many enterprises and data centers, small-form-factor fiber connectors are being utilized more often and thus fiber adapter panels supporting more connectors are required. Fiber cabinets with larger chassis provide more efficient space utilization, which is important when fiber adapter panels with as many as 24 fibers are used.

The panels should be available in configurations to support all popular fiber connector types including the LC and SC. They should also be easy to select and order. Look for one comprehensive fiber panel product line that can also be ordered in configurations to support the ST and MT-RJ for distribution of optical signals to legacy equipment interfaces.

Fiber adapters (couplings) should be designed to transfer the maximum amount of optical energy across the connection or mated pair so as to minimize attenuation at the connection point. For multimode systems, phosphor bronze sleeves are the most cost-effective choice. Multimode fiber adapters are currently beige in color. Singlemode system adapters require higher alignment precision and are thus often constructed with ceramic sleeves and currently colored blue. Additional color coding may be standardized in the future based on work in progress in the TIA TR-42.8 committee.

Figure 6 – LC quad adapter panel supporting 24 fibers

The fiber adapter panels provide a secure and stable mounting surface for the adapters. The adapter panels in which they are installed should contain readily identifiable fiber position markings. They should support today's high density applications through the use of LC quad interfaces with up to 24 fibers. Legacy equipment with SC interfaces is typically supported in fiber counts up to 12. Data center and IT managers planning for expected future growth will likely order larger fiber cabinets than required as well as some percentage of blank adapter panels in which they will install additional fiber adapters and panels as that growth materializes.

Summary

Today's rapidly growing, high density enterprise and data center fiber structured cabling systems require a new level of performance and flexibility in patching and splicing fiber cabinet subsystems. Selecting the optimal family of fiber cabinets and accessories can significantly reduce design and installation time. After the installation is complete, full-featured fiber cabinet products expedite the ongoing moves, additions and changes that occur on a regular basis. There is no longer a need to compromise important fiber patching and splicing system by installing it in anything less than a state of the art integrated cable management system that supports fiber as readily and efficiently as copper.

Key features to look for in a fiber cabinet line include a large chassis that facilitates access and internal fiber management. The cabinets should readily support all three of today's termination methods equally well using optical cassette ribbon cable technology, pre-terminated trunk cables or field-terminated connectors. The cabinets should be installer-friendly providing a high degree of access, stability and control for rear access backbone cables. The installation practices should be simple and intuitive. They should provide safe and reliable patch cord management and easy access. They should be designed to facilitate initial and ongoing standards-based labeling recommendations. They should also be engineered to provide flexibility to meet special future requirements. At a minimum, they should meet and ideally exceed all relevant industry standards. Selecting a fiber cabinet product line with these considerations in mind will help ensure the most effective fiber management over the entire life-cycle of the structured cabling system.