White Paper

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Next Generation Wire and Cable Management Systems: IT Demand Spurs New Solutions

The greatest trend affecting cable management systems is the far reaching demand of data communications and the increased reliance of both businesses and institutions on high-performance datacom cabling. Many leading communication manufacturers now report that more than half of their market for raceways and other systems is for data communication applications. As a result, manufacturers are developing new products and system enhancements that are taking these systems well beyond their humble origins.

Wire and cable management systems can be dated to the dawn of the electrical age, when someone needed to run wire where concealing it was impractical, such as a block wall. The solution was the raceway: a narrow channel that enabled wire to be run across, rather than behind a surface. While this development expanded wiring capability, it also contributed to the view that raceways were something of a last resort to be installed only when there was no other way to get wire where it was needed. This restrictive view has changed with the development of new wire and cable management solutions.

Design objectives

The continuing development of communications technology shows no sign of slowing down any time soon. What's more, people are working in ways -- and spaces -- that were unimaginable just a few years ago. Today's workspaces are designed for maximum communications capability and flexibility in the smallest space. They feature open and highly visible office landscapes with minimal restrictions on the placement of workstations and office furniture. Thus, the link between workstations and data/com networks is critical.

A wide variety of wire and cable management systems are available to manage, organize, protect, and connect the cabling infrastructure. However, an inherent problem is not recognizing the need for a design that incorporates both datacom (low voltage) and power (high voltage) to be shared within the same cabling architecture. Systems being developed need to enable communication and collaboration to take place anywhere, and provide the vital flexibility required, so that physical space can keep pace with changing business needs.

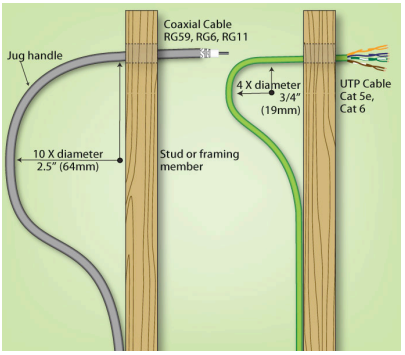
Next Generation Cabling

The continuing trend toward high-performance copper and fiber optic cabling, impacts the design of wire and cable management systems in many ways. Chief among these is the need to ensure the integrity of data transmission by maintaining the specified cable bend

radius. Specialized fittings are necessary for raceways and other wire and cable management systems in order to maintain a minimum cable bend radius and prevent damage and loss of cable effectiveness.

The TIA (Telecommunications Industry Association) has been developing standards for cabling buildings, and their intent is to develop a uniform wiring standard that will support multivendor products and environments. In several of their tests, they determined that tight bends in cables or those exceeding the minimum bend radius will distort the cable geometry and result in degrading transmission performance.

TIA standards are widely adopted and considered the global standard for data system design. Two such standards were specifically created in order to create guidelines for raceways and cables.



Example of minimum bend radius requirements for coaxial and data cabling.

These are:

- 568 Commercial Building Telecommunications Wiring Standards
- 569 Commercial Building Standard for Telecommunication pathways and spaces

The challenge is to create a raceway that will support:

- A wide bend radius with ample room to support a bend radius transition in any bend.
- Future proofed and fully compliant TIA 568B and 569B solution that exceeds current requirements and at minimum provide for a 10x bend radius throughout the system for routing high performance copper and fiber cable. For copper this translates to a minimum bend radius of 2".
- The system should also accept NEMA standard double gang faceplates.
- Provide for capacity and separation in applications requiring both data cabling and power.
- Provide for the easy ability to add and move faceplates at a later date without removing the pathway.
- Ease of installation.

With the continued demands of emerging technologies like Gigabit Ethernet, it is more critical than ever that every aspect of the structured cabling system, including pathways, be designed to ensure the highest channel performance. Raceway systems, for example, need to ensure that the minimum bend radius specific to Gigabit cable is maintained throughout.

Widespread adoption of 10-Gigabit Ethernet (10-GbE) is gaining momentum in data centers and as backbone applications, so it is critical that the design and installation of any structured cabling system takes into account the application's unique requirements. Every aspect of structured cabling system pathways must be designed to ensure the highest channel performance. Yet, today's familiar pathways and installation methods may not be adequate for new cable technologies that accommodate 10-GbE.

The TIA has yet to update the TIA 569-B standard to address the larger cable needed to support 10-GbE. Factors to consider include the larger diameter of the cable, additional bend radius required, and increased weight of cables, such as Augmented Category 6 UTP (Category 6A) and shielded cables (Category 6 FTP, Category 7 STP). These requirements differ significantly from those of older cable designs and have a direct bearing on the performance of a 10-GbE system.

There is no guarantee that Category 6 UTP cable will support 10-GbE transmission for a defined minimum distance. Instead, TIA developed a Telecommunications Systems Bulletin, TSB-155, which defines additional testing guidelines to qualify installed Category 6 UTP and its ability to support 10-GbE. Testing within the Institute of Electrical and Electronics Engineers (IEEE; www.ieee.org) has shown that most Category 6 UTP cables will not support 10-GbE beyond 55 meters, and many do not come close to 55 meters. Category 6A UTP cable is designed to support 10-GbE on a four-connector, 100-meter channel. To provide this higher level of performance-without adding shielding-the cable was redesigned to reduce the effects of alien crosstalk.

Alien crosstalk (electrical noise from other cables) has become the dominant noise source for 10-Gbe because external noise cannot be controlled through digital signal processing (DSP) techniques. DSP techniques are only able to eliminate internal cable noise like near-end and far-end crosstalk; and echo cancellation techniques minimize the effect of return loss. The way to minimize alien crosstalk is to provide greater separation between cable pairs or by shielding pairs from neighboring cables.

Category 6A UTP cables have larger overall diameter that provides additional separation between twisted pairs within adjacent cables to reduce alien crosstalk. There are two shielded options that support 10-GbE: Category 6 FTP cables employ foil around all four pairs while Category 7 STP cables have a shield around each pair and an overall shield around all four pairs. The larger diameter and bend radius of these cabling options have a significant impact on the cabling pathway design.

The difference in diameter between Category 6 and Category 6A may seem trivial, but it can have a significant impact on the number of cables that can be accommodated in a particular pathway. For example, TIA recommends that a 0.75-inch (21-mm) conduit will hold two Category 6 cables, but only one Category 6A cable, at 40% fill. Similar capacity reductions are noted for other cabling pathways. System designers should plan for perimeter raceway systems, cable trays, furniture systems, and other pathways to handle the largest cable outside diameter (OD) to be installed for the life of those systems. TIA recommends a minimum of two cables per work area; however, BICSI-suggested best practice is to design pathways for three cables.

Diameter, bend radius for 10-GbE cabling

Cable	Diameter	Bend Radius
Category 6	0.22” (5.72 mm)	1.00” (4 x OD)
Category 6A	0.35” (9 mm)	1.42” (4 x OD)
Category 6 FTP	0.28” (7.24 mm)	2.28” (8 x OD)
Category 6 STP	0.33” (8.38 mm)	2.64” (8 x OD)

Diameters listed in this table are nominal values of cables currently being sold. Not all cables of a particular category have the outside diameter listed here.

The larger bend radius of Category 6 FTP and Category 6A UTP cables also requires more space-in telecommunications rooms, horizontal pathways, and at the workstation-so as to avoid creating tight bends that degrade performance. Additionally, Category 6 FTP and Category 6A UTP cable is heavier than the cable that is currently in use. Caution must be taken so that even if the current TIA guidelines for fill-rate are followed, the additional weight of the cable does not cause problems for the cable at the bottom of the conduit.

Any distortion of the cable jacket could result in performance problems during the life of the system. And because its greater weight makes cable more difficult to pull, pathways that offer in-lay installation may be preferable for both initial installation and to accommodate moves, adds, and changes.

The impact of 10-GbE cabling will be felt throughout the building from the main equipment room to the workstation. Not only is the twisted-pair copper cabling becoming larger and heavier, but there is an additional need to better manage cable bundle size and provide adequate separation between cables:

• **Entrance facility/equipment room.** Cable-management requirements will be impacted by cable diameter, weight, and bend radius. The cable management used must be able to accommodate the additional size and weight of the cable. This will require additional space in the racks, including vertical and horizontal management that will allow random cable placement to minimize alien crosstalk issues. Insufficient cable management may result in cables becoming compressed or kinked, which will result in decreased performance. When selecting a rack solution, make sure it will accommodate the larger bend radius of the backbone cabling; also keep in mind the additional requirements for equipment or patch cords on the front of the rack.

• **Telecommunications room.** As in the entrance facility, adequate cable support is needed in the telecommunications room. Typically, there are three different cable systems that need to be managed-backbone, horizontal, and cross-connect-introducing a range of cable types from fiber to high-pair-count and the new Category 6A UTP cables. Additionally, telecommunications room space is at a premium, contributing to the need for higher cable density. Racks and cable management must accommodate the routing demands of cables that may be larger, heavier, and require a greater bend radius, often in limited available space.

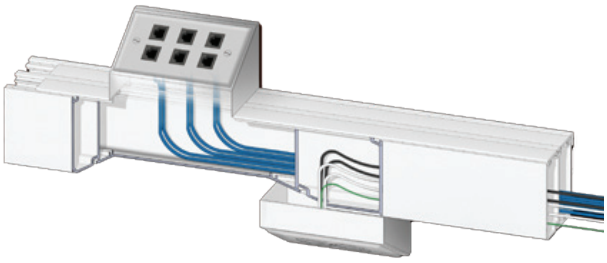
• **Horizontal and backbone pathways.** A wide variety of wire and cable management systems are available to support Category 6 FTP and Category 6A UTP cable. The selection of a particular system depends on many factors. Of particular concern is maintaining the proper cable bend radius, supporting extra weight, and providing additional space to manage large, loose cable bundles.

- Perimeter raceway systems are available in many sizes to accommodate larger cables. New internal configurations have been developed to provide more space for required larger cable bend radius. And removable covers facilitate lay-in installation.
- Cable tray is a popular pathway solution, but larger trays may be needed when installing Category 6A cable. Trays must have drop-out fittings that meet or exceed bend-radius specifications. Trays and supports must meet higher weight requirements; hooks will not

give the support required for large bundles of larger, heavier cabling.

- Underfloor and cellular duct systems offer ample capacity and may be more cost-effective than using conduit to feed floor boxes.
- Conduit must be sized appropriately-a minimum of 1.0 inches for two cables and 1.25 inches for four cables.

• **Work areas.** Larger diameters and greater bend-radius requirements dictate more spacious housing for cable slack that will be hard to manage in standard wall boxes. Even if the slack is pulled back into the wall, a larger box still must be used to maintain the larger bend radius required. This additional slack-space requirement must be designed into the pathway. Double-gang boxes should be used for two cables, per BICSI recommendations, and it is suggested that triple-gang or larger boxes be used for four cables.



Mono Systems AdvanceWay Accommodates all high performance connectors (i.e. 10-gig, AV, HDMI, etc.), specified bend radius of all high performance cables (i.e. Cat 6a, Cat. 6, etc.), most power devices and provides Universal acceptance of devices from all manufacturers,

Designers and installers must also be aware of continuously evolving standards, codes, and regulations. Although 10-GbE over twisted pair presents some new challenges, quality product, quality design, and quality installation remain the basis for the highest channel performance.

Providing enough room to accommodate bend radius must be balanced with the desire to make the cabling infrastructure as visually unobtrusive as possible. This balance is impacted by a requirement that power and low-voltage channels be physically separated to eliminate the effects of electrical fast transient (EFT) disturbances. The required separation in raceway systems imposed certain design restrictions that limited the placement of receptacles and data jacks, and reduced a raceway's capability to meet bend radius requirements. A new raceway design maintains complete separation of services while offering improved function and flexibility. It features crossover fittings that maintain required separation while providing greater space within the raceway to accommodate the bend radius of larger diameter Gigabit cable.

Aesthetics and flexibility

Wire and cable management systems must be designed to be aesthetically pleasing as well as functional and flexible. New generation nonmetallic raceways need to feature eye-pleasing profiles and be available in a wide range of colors. Specialized materials and device plates that hide cover seams will offer improved aesthetics over metal raceways. System components that are commonly used together, such as raceways and information outlets, should be color matched and manufactured for a seamless look. Flexibility is also needed to allow for addition of faceplates anywhere in the system without altering the aesthetics of the raceway. Ideally a faceplate should be movable along the entire raceway and allow faceplates to be easily attached both above and below.

The push for improved aesthetics is also seen in systems that offer flush and recessed activations that are very nearly invisible. Poke-thru devices, for example, offer receptacles and datacom ports in unobtrusive flush profiles. High-capacity service activations accommodate more outlets, making them less obtrusive than older, low-capacity fittings.

Conclusions

Much of the impetus for new wire and cable management products and systems continues to be driven by the need to effectively manage increasingly complex datacom requirements in business and institutional environments where flexibility is a paramount concern. One manufacturer who has responded to the growing importance of information technology with wire and cable management solutions is MonoSystems, and their AdvanceWay™ products.

This next generation surface mount cable management system accommodates all datacom and power cabling requirements, including new Gigabit cabling, as well as ensuring maximum operational and systems flexibility, while enhancing workplace aesthetics. The AdvanceWay™ product line is a flexible modular system that cost effectively incorporates the needs for both power and datacom distribution and incorporates the added feature of universally accepting of devices from other manufacturers.

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*** Mark Katko is a well-known network Engineer in the U.S. He has designed and implemented highly sophisticated communication networks for all of the Regional Bell Operating Companies, Fortune 500 Companies such as Dana Corporation, Trinova and is well renowned for his cutting edge work with the Sisters of Mercy Health Care System.,*

Mr. Katko was a Founder and Chief Technology Officer of LightSource Telecom, LLC, a start-up Competitive Local Exchange Carrier which exclusively served the new residential development sector. Besides his recognized accomplishments as an telecommunications engineer, (he holds, or has made application for, five U.S. Patents in telecommunications technologies) Mark has demonstrated leadership and management skills in addition to an aptitude for finance. He has founded and grown several businesses while "wearing multiple hats"----not just his technology one.

Mr. Katko currently serves a President and CEO as well as Senior Engineer of Maxcom Enterprises LTD, LLC