COMMSCOPE®

White paper

Active equipment platform

Trends and the impact on cable management

As network equipment such as routers and switches, continues to evolve, changes in proper cable-management techniques and recommendations must also keep up with the times. Routers and switches are being marketed with higher densities and more capabilities. These higher-density platforms have more cables feeding them and require more power. More powerful equipment gives out more heat, so careful airflow and thermal management is more important than ever. Density within a single cabinet is increasing. Upgrades every few years (or less) are to be expected, therefore cables should be routed in a way that maximizes accessibility and intuitive maintenance. When as much as 70 percent of network down time can be attributed to physical layer problems associated with cabling faults, it is clear that infrastructure design and cable organization deserve priority consideration. Technicians must be able to access each of the crucial elements of a system without maneuvering through haphazardly strewn cabling.

This white paper addresses the four critical aspects of cable management, as they relate to the Original Equipment Manufacturer (Active Equipment) platform trends mentioned above:

- Routing paths
- Physical protection
- Installation
- Active equipment platform and maintenance issues

When executed and managed properly, these recommendations will help you gain significant benefits and savings throughout the life of your network.

Proper sizing of vertical and horizontal routing paths

Cable-routing paths should be clearly defined, intuitive, easy-to-follow and enable the use of standard cable lengths. The cable-management design should be clear to technicians so they can closely follow the routing paths intended. Leaving cable routing to a technician's imagination leads to an inconsistently routed, difficult-to-manage cable network. Furthermore, well-defined routing paths will reduce the training time required for technicians and increase the uniformity of the work being done during maintenance, rerouting and upgrades.

While available cabinet space will vary by model and equipment type within, it is a given that space is at a premium. Active equipment dominates the majority of horizontal space, so the design should make the most of other available real estate, especially cabinet depth. Carefully preplanned routing paths that maximize depth can have a direct effect on network operating costs and the time required to upgrade or restore service. As newer equipment generates more power, it also releases more heat. Proper cable-routing paths are vital so as not to impede airflow throughout the cabinet space.

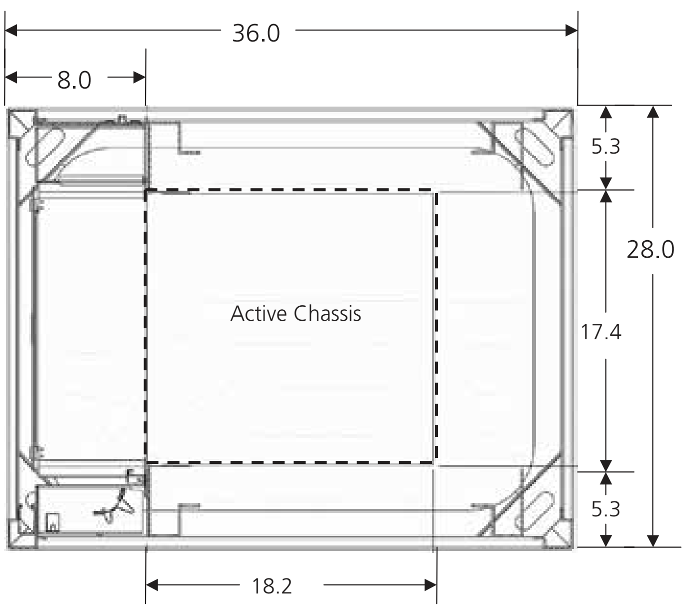
Although fiber cabling takes significantly less space than copper, it is also more susceptible to both microbends and macrobends. Poor routing causes bend-radius problems for both fiber and copper, so it is worth addressing in more detail.

There are two reasons for maintaining minimum bend-radius protection: enhancing the cable's long-term reliability and reducing signal attenuation. Bends with less than the specified minimum radius will exhibit a higher probability of long-term failure as the amount of stress put on the cable grows. As the bend radius becomes even smaller, the stress and probability of failure increase. The other effect of minimum bend-radius violations is more immediate; attenuation through a bend in a cable increases as the bend radius decreases.

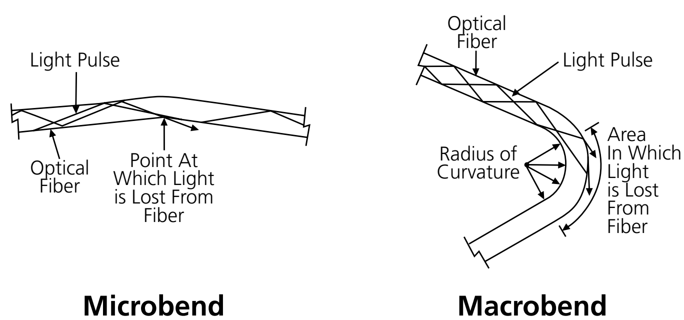
For fiber, the minimum bend radius will vary depending on the specific cable. However, in general, the minimum bend radius should be no less than 10 times the fiber cable's outer diameter (OD). Thus a 3mm cable should have no bends less than 30mm in radius. (Telcordia recommends a minimum 38mm bend radius for 3mm patch cords.) This radius is for a fiber cable that is under no tensile load or tension. If a tensile load is applied to the cable, as in the weight of a cable in a long vertical run or a cable that is pulled tightly between two points, the minimum bend radius should be increased due to the added stress.

Copper cables also require careful bend-radius protection. For example, the OD of cables such as CAT6$_A$ (augmented) has increased, adding extra weight and bulk to cable bundles. According to ANSI/TIA-568-C, a standard set forth by the Telecommunications Industry Association, the minimum bend radius under no load conditions for 4-pair unshielded twisted pair (UTP) cable should be four times the cable outside diameter.

The advent of reduced bend-radius fiber is an example of how technology has addressed, but not completely resolved, the bend-radius issue. While an improvement (allowing only 15mm bend radius), these new fibers do not diminish the need for effective cable management. They are still susceptible to the same problems that can plague regular fiber, such as attenuation from tensile load and problems from improper bend-radius protection.



CommScope recommends that the amount of available recess at the front of a cabinet for cabling be at least 6 inches for fiber-intensive active platforms and 8 inches for copper-intensive platforms. As density continues to increase and more cables must exit a cabinet, the need for additional cable routing space also must grow.



Care must be taken to avoid minimum bend radius rules when adding fibers

Another benefit of routing path uniformity is the reduced proficiency required to maintain and install new cables. With downtime translating directly to income loss, routing paths should be designed to be redundant and intuitive.

As the number of cables increase within a rack or cabinet, cable access becomes an increasingly important issue. In the past, an active equipment rack might have had only 50 cables installed in a cable pathway and managing those cables was much less of an issue. But as that same rack is fitted for next-generation broadband services, there may be upwards of 500 cables involved, making pathway loading routing even more vital to accessibility and maintenance.

CommScope recommends that no pathway be more than 50 percent to 60 percent full at any time, for more efficient initial installation and ongoing maintenance. It is important to plan for maximum future cable density. This will also help to prevent damage to the cables, allow cable mining, and provide better tracing of cables.

Cable accessibility becomes more important with equipment churn as often as every three years. Fill ratio is expressed in a range of lower fill ratio to upper fill ratio.

Full pathways contribute to microbends and macrobends and the added weight can crush or distort cables on the bottom of a bundled group. Gaining access to all existing cables is also a key aspect of system maintenance and upgrade processes. If a single cable is buried among hundreds, either fiber or copper, getting at the one cable you need to change or adjust can cause damage to the others in the pathway.

When cables are entering or exiting a cabinet, the transition points between bays should also not be ignored with respect to bend radius protection. Without proper protection or a cable-management product in place, cables too often are routed over sharp edges and become damaged.

To calculate fill ratio, CommScope uses the following method:

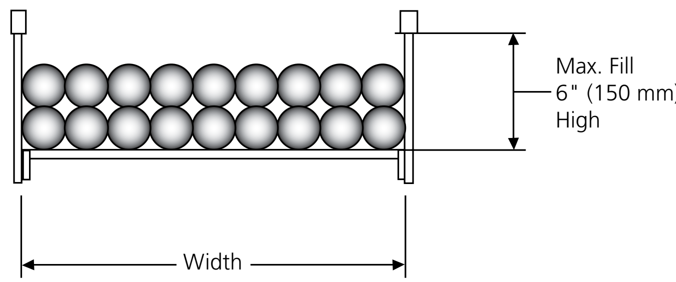
Find the cross-sectional area of the cable. Keep in mind maximum deployment density of the platform, not just what you are installing initially.

Find the lower fill area required for cables assuming tight or close packing of cables.

Find the upper area required for cables assuming loose packing of cables.

Lower fill ratio = $\dfrac{\text{the lower area required for cables}}{\text{actual area of cable manager}}$

Upper fill ratio = $\dfrac{\text{the upper area required for cables}}{\text{actual area of cable manager}}$



Vertical routing at 50% to 60% of capacity

Horizontal to vertical transition at 50% to 60% of capacity

Importance of physical protection

Every element of a cable-management system should address the physical protection of the installed cables. Every cable throughout the network must be protected against accidental damage by technicians or equipment. Cables routed between or traversing equipment must be routed with physical protection in mind. Allowing cables to drape openly across active equipment, around hard edges, or even to rest on the floor, can result in data failures and ultimately lost revenues.

This also points to the issue of mixing fiber and copper cables in a pathway. CommScope recommends that the different cable types be segregated, as the heavier copper cables can force microbends in fiber. Besides aiding in the ability of technicians to track and replace faulty cables, cable separation also protects fiber cables from being crushed or bent by heavier copper cables.

In order to provide proper protection and ensure future growth and reconfiguration capabilities, all cables routed outside of the rack should be run through a dedicated cable raceway system. Ladder racks are still appropriate for copper cabling, but fiber cable should be supported along the entire length of the run to prevent microbends as well as to protect it from overloading and crushing. An outside-the-rack fiber management system should physically separate, protect, and route the fiber while ensuring that a two-inch minimum bend radius is maintained throughout, even as more cables are added in the future. The system should be is extremely flexible, making cable routing simple and reducing installation time without sacrificing durability. As the system is in an area in which technician activities are common, the cable raceway system also needs to be durable and robust enough to handle day-to-day activities. A durable, properly configured raceway system with suitable cable management, especially bend-radius protection, helps improve network reliability and makes network installation and reconfiguration faster and more uniform.

Due to possible crosstalk issues, as well as general maintenance and accessibility, CommScope recommends separating power cables from data cables as much as possible. Proper spacing between cables further helps reduce crosstalk, and makes ongoing maintenance much easier. TIA-570 recommends a 12-inch minimum separation between data cabling and AC power cables and sources.

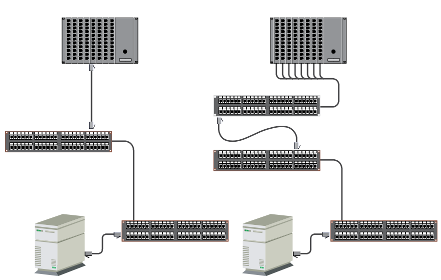


Figure 1.
Interconnection vs. Cross-Connection

Installation and maintenance requirements

A distribution frame (MDF) system can be designed and installed in two different configurations: interconnect or cross-connect. Each has its advantages, but the latter is rapidly replacing the former in new installations.

The use of a central patching location in a cross-connect scenario provides a logical and easy-to-manage infrastructure whereby all network elements have permanent equipment cable connections that once terminated, are never handled again. The advantages to deploying centralized patching include:

- Reduced risk of down time with the ability to isolate network segments for troubleshooting and quickly reroute circuits in a disaster recovery situation.
- Enhanced reliability by making changes on the patching field rather than moving sensitive equipment connections.

Lower operating costs by greatly reducing the time it takes for modifications, upgrades and maintenance.

Deploying common rack frames with ample vertical and horizontal cable management simplifies rack assembly, organizes cable, facilitates cable routing and keeps equipment cool by removing obstacles to air movement.

One of the most important considerations to ensure that the distribution frame will work to your expectation is in the management of the cross-connect cords. Because patch cords are almost always purchased at predetermined lengths, they are seldom the precise length needed. Purchasing multiple cable lengths and then having the technicians select proper lengths is rarely an effective practice. Fewer, longer lengths of factory-produced cable are almost always the preferred way of supplying patch cords to the field staff. The resulting “slack management” issues, if not properly managed, can negate much of the design work we have previously discussed. Excess length, left to drape across panels or floors, or simply looped somewhere outside the cabinet is both unsightly and presents a strong likelihood of damage. Thus it becomes essential to operate with a slack storage-management system, either through an interbay-management panel or a slack-management panel within the cabinet.

In-cabinet slack storage

Active equipment platform and maintenance issues

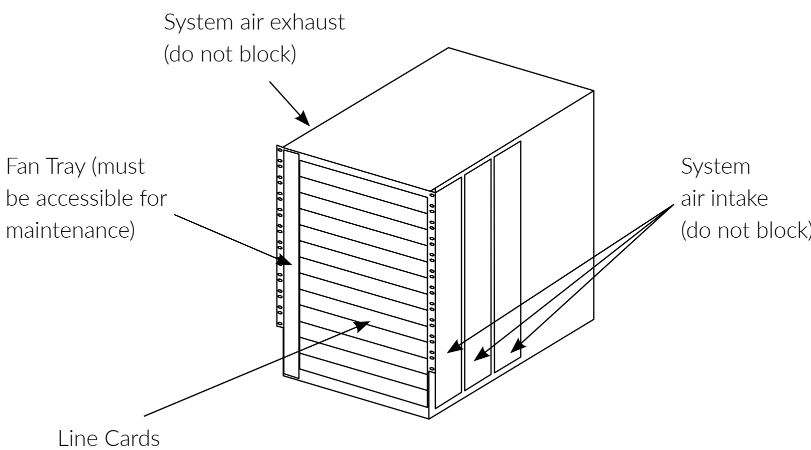
Proper cable management always begins with the initial equipment installation. Keeping cables in an orderly and easily maintained fashion is relatively simple at this point, but initial installations are rarely left untouched, unmodified or unexpanded. If the cable-management system ignores the future impact of these issues, system effectiveness, profitability and flexibility are all drastically affected.

Some of the considerations that should be part of your plan include making it easy to avoid routing cable over Active Equipment platform areas that may require maintenance. This could be as simple as designing the system so that free running cables never cross fan trays or power supplies, which may need to be removed for maintenance or replaced in the event of failure.

You should also provide access space for future deployment of new cards or equipment. Initially, perhaps only a few active cards will be populated in an Active Equipment platform chassis. Cable management and routing paths should allow for easy deployment of additional cards in the future, without having to disrupt or disconnect existing terminations or service.

Thermal issues must also be addressed in the design stage. Powerful next-gen equipment generates a lot of heat, which must be properly ventilated outside of the cabinet. There is no standard formula for thermal management space, but it is always a good practice to make sure that cabling does not route over intake or exhaust areas on the Active Equipment platform chassis. Cables also should not impede intake and exhaust areas within the cabinet.

Today's network is a living and growing entity – and what is enough today will almost certainly be too little for tomorrow. With that in mind, future-proofing the network wherever possible should be a major consideration. Ignoring future growth will result in higher long-term operational costs resulting from poor network performance or a requirement to retrofit products that can no longer accommodate network demand. In the past, active equipment had far less cable to be managed. Now, with the increase in density and number of ports, utilizing a flexible, robust cable-management system that can grow with your network demands is becoming a make-or-break issue. You should be able to add or install various components on demand, without retooling an entire infrastructure.



Active Equipment platform with horizontal cards (side-to-side airflow)

Summary

As competition intensifies, low cost, high bandwidth, flexibility and reliability will be the hallmarks of successful service providers. As Active Equipment platforms continue to evolve, strong cable-management systems with proper bend-radius protection, well-defined cable routing paths, easy cable access, physical protection and a flexible, robust cable routing system will enable you to operate a highly profitable network.

Good cable-management practices, from initial design and installation to ongoing maintenance and upgrades, allow you to keep your network up and running. This is important to your network operations, but is extremely important to the efficient management of information exchange across your entire organization.

Top 10 best practices for cable management

10. Incorporate slack management to utilize single-length cable assemblies (or accommodate multiple lengths)

9. Maintain bend-radius protection at all times

8. Accessibility - Routing paths should not block fan trays, airflow or patch panels, and allow individual cable and connector access.

7. Chassis recess space in cabinet ideally should be at least 6" for fiber, and 8" for copper

6. Protect cables during entrance and exit from cabinet

5. Separate fiber and copper cables as much as possible

4. Keep maximum cable fill volumes between 50-60 percent

3. Utilize a cross-connect distribution frame

2. Always ensure proper physical protection

1. Plan for the future!

Everyone communicates. It's the essence of the human experience. *How* we communicate is evolving. Technology is reshaping the way we live, learn and thrive. The epicenter of this transformation is the network—our passion. Our experts are rethinking the purpose, role and usage of networks to help our customers increase bandwidth, expand capacity, enhance efficiency, speed deployment and simplify migration. From remote cell sites to massive sports arenas, from busy airports to state-of-the-art data centers—we provide the essential expertise and vital infrastructure your business needs to succeed. The world's most advanced networks rely on CommScope connectivity.

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