

# Managing Density

## Managing Density in the Data Center: A Long-term Approach for the Future

Increasing capacity and network applications create new challenges for both the planners who design and the operations personnel who maintain the network. A managed density approach that takes a long-term view of data center design is key to ensuring maximum density and growth without disrupting operations that can cause a huge drain on productivity, profits, and service availability. Successful network managers should always take into account the importance of planning and maintaining data centers to maximize density and minimize maintenance hassles.

This paper discusses the five key elements of maintaining managed density in the data center:

- Planning
- Installation
- Cable Management
- Accessibility
- Reliability



## Planning

The planning process within your data center is crucial to achieving maximum density and ensuring that your network can grow today and still be managed tomorrow. Understanding how space and layout affect manageability makes the planning process more efficient. The following are important concepts that need to be considered during this all-important planning process.

### Physical Space

The cost to build a data center can be upwards of \$1,000 per square foot. Clearly, maximizing physical space is a critical aspect of data center design. Designers need to assess future growth potential and ensure there is a sufficient amount of space for the future. Data centers require ample areas of flexible “white” floor space that can be easily reallocated to a particular function, such as a new equipment area. Finally, room is needed to expand the data center if it outgrows its current confines. This can be accomplished by ensuring that the space surrounding the data center can be easily and inexpensively annexed.



**Ample Data Center White Space**

## Layout

Not only should there be enough space in the data center, but that space must be used wisely. The TIA-942 Telecommunications Infrastructure Standard for Data Centers recommends designing the data center with specific functional areas that define equipment placement based on a standard hierarchical star topology. Designing a data center with these functional areas makes the data center easily adaptable to changing requirements and growth and helps create an environment where applications and servers can be added and upgraded with minimal downtime and disruption. These functional areas also ensure that cabling can be easily managed, cable runs do not exceed recommended distances, and maintaining appropriate fill rates is not unnecessarily difficult.

### Cable Fill Rates

Too many cars on the road at one time can lead to major traffic congestion and accidents. The same basic rules apply to cable congestion. When many cables are routed into a single cable tray, tracing an individual cable from one point to another becomes difficult and the probability of problems or damage increases. This can eventually lead to decreased network reliability and an increase in the time it takes to reconfigure the network.

Cable fill rates specify the amount of cabling that can be installed in a pathway or space and still preserve the integrity of the cables and enable management and future growth. Cable fill rates are based on the cross-sectional area of the cables, determined by overall diameter, and the inside cross-sectional area of the conduit. A cable fill percentage of no greater than 50%-60% is recommended by industry standards. This rate allows cable ‘mining’ if the cable has to be accessed in the future and protects against overfilling which can damage the cable. Unfortunately, a lack of proper cable bundling or sloppy routing can often result in a fill rate above 60%. In areas where cables are entering or exiting a cable pathway, and in conduit bends, there is a reduction in available space due to maintaining maximum bend radius of the cable as it enters or exits the pathway. Fill rates are also constrained by a maximum height limitation due to the weight of cables causing possible damage or attenuation. Fiber optic cables have a maximum height limitation of two inches, and copper cables have a maximum height limitation of six inches.

Pathways space is another significant factor in overall data center deployment costs. Larger cabling diameters can decrease the number of cables permitted in a pathway or require larger, more expensive pathways. It’s therefore imperative to consider the overall diameter of the cable when choosing components. Smaller diameter solutions can go a long way in saving pathway space and money.

## Vertical/horizontal Cable ways

Ample vertical and horizontal cableways are essential in maximizing the density of your data center and supporting future growth and manageability. It's important estimate the amount of pathway space based on fill capacity and the number of additional cables that may need to be deployed in the future. Horizontal cable tray installed both above the racks and in a raised-floor system creates a protected pathway as cable traverses between functional areas and equipment racks in the data center. Good routing systems will provide adequate support, keep fiber separate from copper cable, protect from out-of-tolerance bends, and promote neat, easily accessible runs. Without proper routing systems, cables may hang unprotected. Exposed cables can accidentally snag, which can result in damage to the connector or cable itself. Over time, the weight of hanging fiber can also cause bends outside the acceptable limit, further damaging fiber and impacting reliability.



Vertical and Horizontal Cable Routing

Cableway space within cabinets varies based on model and equipment. Because equipment takes up the majority of horizontal space within the cabinet, it's important to ensure other available space when choosing cabinets, especially cabinet depth. ADC recommends at least 6 inches of available recess at the front of the cabinet for fiber and 8 inches for copper. As density increases, additional equipment generates more heat and more cables must exit a cabinet. Therefore cabinets must provide ample room for additional cable routing so as not to impede airflow throughout the cabinet.

## Complete Utilization of Equipment

When designing a data center, you need to plan for the maximum cable densities of a fully deployed system. Planning for maximum cable densities now will help make adding capacity easier in the future. If a cabinet or rack does not have sufficient space to handle additional equipment, connectivity, and cables for future deployment, a new rack may need to be purchased, and physical floor space must be available. Having a properly designed and planned data center that takes future growth into consideration allows you to utilize existing space and racks for maximum capacity deployment. This will ensure a more efficient utilization of your investment.

## Installation

There are several measures that can be taken during cable installation to ensure maximum density and minimize maintenance in the data center. One of the best ways to accomplish this is to install cabling using a centralized distribution system in a cross-connect scenario where all cables are brought to one area for maintenance, patching, and servicing. This provides maximum flexibility when it's time to add, change, or reconfigure network elements.

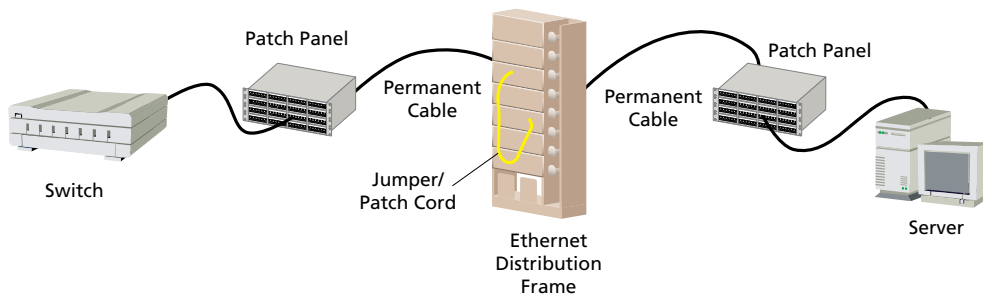
A centralized distribution system offers several advantages over direct cabling methods. With direct cabling, reconfiguring network elements requires pulling up raised floor tiles, finding riser space, and abandoning existing cables. On the other hand, a centralized distribution method provides the ability to connect equipment by using patch cords or jumpers at the cross-connect while all network elements have permanent equipment cables that remain terminated on the rear of panels in the distribution field and are never handled again.

Another benefit of centralized distribution is better utilization of floor space and facilities. The better the space utilization, the less likely you will have to expand the size of your data center or erect a new facility. Even with smaller and more compact equipment designs that

make better use of rack and floor space, direct cabling methods require more cables over time, which in turn uses more pathway space. Technicians may actually find it impossible to fill empty rack space with new equipment due to cable congestion, working or abandoned, at the rack or cabinet. With a centralized cross-connect, achieving the requirements of lower costs, highly reliable service, and maximum density is possible.

Here are a few key advantages provided by a well-designed centralized distribution system using a cross-connect scenario:

- Lower operating costs: Compared to the other approaches, cross-connect greatly reduces the time it takes for adds, moves or changes.
- Improved reliability and availability: Moves, adds, and changes are effected on the patching field allowing changes in the network without disrupting service and without having to move sensitive equipment connections.
- Competitive advantage: A cross-connect system enables rapid changes to the network and reduces the risk of downtime with the ability to isolate network segments for troubleshooting and quickly reroute cables in a disaster recovery situation. Capacity is added to the network in minutes instead of hours, decreasing time to revenue and providing faster service availability for a competitive edge.



**Cross-Connect System**

## Cable Management

Your network equipment can only perform as well as your cables. A gigabit port is of no value if the cable connecting that port is damaged. All cabling and connectivity within the data center need to be deployed with proper bend radius protection, well-defined cable routing paths, room to work on connectors and cables without affecting adjacent circuits or ports, and physical protection for equipment cables, intrafacility cable, patch cords, and jumpers. Without end-to-end cable management, some of the problems encountered include cables stepped on and piled-up in raceways, maximum bend radius exceeded, difficult connector access, and hours to trace cables, all of which increases the time required to decommission hardware and bring new hardware online.



**Proper Cable Management**

The key to cable management is understanding that the cabling system is permanent and generic. It's like the electrical system – a highly reliable and flexible utility that you can plug any new applications into. When it's designed with this vision in mind, additions and changes aren't difficult or disruptive. Highly reliable and resilient cabling systems adhere to the following principles:

- **Bend Radius Protection:** At turns in fiber runs, a minimum 1.5-inch bend radius is needed, or the bend radius should be no less than 10 times the fiber cables outer diameter. Bends with less than the specified minimum bend radius are more likely to fail over time. Minimum bend radius violations also cause micro bending of individual fibers that allow light to escape the signal path, resulting in signal attenuation. More severe bends can break fiber strands completely, resulting in signal loss. New reduced bend radius fiber can be bent to 15mm (0.590 inch) bend radius, but that does not eliminate the need for proper cable management. Copper cables too can be affected by minimum bend radius violation, and the standards specify a minimum bend radius of four times the cable diameter.
- **Separated Cable Types:** Horizontal pathways should be designed such that UTP and coaxial cable are separated from fiber to protect fiber from damage and ease tracing. Heavier copper cables can crush or cause microbends in the fiber. Routing fiber in its own trough pathway system will best protect it from damage. Power cables must also be separated from copper data cables by a minimum of 12 inches to help reduce noise induction on the copper cables.
- **Ample and Intuitive Cable Routing System:** Ample and intuitive overhead and under-floor cable pathways reduce jumper pile-up and congestion, minimize risk of microbends or damage to fiber, and lower maintenance time due to easy removal and tracing of jumpers.
- **Rack Management and Slack Storage:** Common and ample vertical and horizontal cable management installed both within and between rack frames ensures effective cable management and provides for orderly growth. Built-in jumper storage panels within the rack minimize the number of required jumper lengths and maintain the proper fiber bend radius. Jumper Storage Panels simplify frame installation, in turn saving money by reducing the inventory of different jumper lengths. The enclosed system ensures easy cable access without fiber cross-over points.
- **Common Rack Frames:** Using common rack frames throughout the main distribution and horizontal distribution areas simplifies rack assembly and provides unified cable management.

Using first class products and proper cable management provides a very clear path to route a particular cable, leaving fewer options and virtually eliminating the chance for human error. Well-defined routing paths also reduce the training time required for technicians and make patch cord routing and rerouting a simpler operation. ADC believes that proper cable management techniques are key to managing density in the data center and eliminating the potential problems that non-managed systems will likely face in their future.

## Accessibility

Another key element in managing the density in the data center is accessibility. Whether it is accessing cable in the pathway or ports in the rack or cabinet, it is critical that each component within your data center can be easily accessed. In addition to having defined routing paths that makes accessing individual cables much easier, quicker, and safer, there are several accessibility philosophies to keep in mind when selecting products.

- Look for fiber optic components that promote access to individual adapters and connectors without affecting adjacent components. This can greatly reduce time required for operations and maintenance.
- Selecting angled patch panels and cable managers enables easy connector access while reducing cable strain and offering bend radius protection.
- Components that offer rear access make field termination or splicing fast and efficient while also providing a high-density termination/splice solution for maximizing rack space.



**Easily Accessible Adapters and Connectors**



**Angled Patch Panels and Cable Managers**

## Reliability

Finally, in a today's highly competitive environment, reliability is mandatory. Companies depend heavily on their data centers to perform and cannot tolerate service disruptions that affect revenue. The cabling must consistently support the flow of data without errors that cause retransmission and delays. One way to ensure reliability is to select cabling and connectivity backed by a reputable vendor with guaranteed error-free performance. This will help avoid poor transmission within the data center. As networks expand and bandwidth demands increase, the data center cabling must also be able to maintain constant reliability and performance. The cabling itself should therefore support current bandwidth needs while enabling anticipated migration to higher network speeds without sacrificing performance.

Reliability of the data center also comes back to proper cabling management and accessibility. Proper cable management solutions not only make it easy to manage density, they also physically protect cables from accidental damage, which can significantly affect network reliability. Every area in the data center from pathways to racks should ensure maximum protection for every cable and connector. In addition to physical protection, increases in transmission speed require strict controls on a fiber's bend radius. Pathways must maintain proper bend radius at all points where the cable makes a bend — both at initial installation and when cables are accessed or added. Avoiding service outages means managing and protecting the cable in your data center.

Accessibility helps maintain data center reliability, especially during network reconfiguration. Being able to quickly and easily access cables and connectors saves a significant amount of time, which directly impacts operation costs. While accessibility is key to completing reconfigurations quickly, it's also imperative that any cable or connector can be accessed without damaging adjacent cables or connectors. Searching for a fiber in a packed raceway increases the likelihood that service on an adjacent fiber is disturbed.

## Conclusion

Maximizing density is more than just the equipment you install. It includes a comprehensive strategy in design, layout, and execution that starts with proper planning and addressing future concerns. Understanding and following proper installation, cable management, accessibility, and reliability philosophies will ultimately help in maintenance and performance of your high-density network.

### **For More Information**

Three Principles of Data Center Design: ADC Literature Number 102261AE

TIA-942 Data Center Standards Overview: ADC Literature Number 102264AE

WHITE PAPER



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