

OCTOBER 2010

Layer Zero™, the Infrastructure Layer, and High-Performance Data Centers



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The demands on data centers and networks today are growing dramatically, with no end in sight. Virtualization is increasing the load on servers. Connection speeds between servers, switches, and other active devices are increasing from 1 Gb/s to 10 Gb/s, and up 40 Gb/s to 100 Gb/s in the not too distant future. To support these speeds, copper and fiber structured cabling has also evolved to keep pace.

Higher interconnection speeds, virtualization, and other factors make the design of data centers and the cabling systems more complex—all in an environment where downtime and errors remain unacceptable.

Within today's data center, the role of structured cable management products—the passive infrastructure of racks, cabinets, enclosures, patch panels, cable trays, and cable routing components as shown in Figure 1—is receiving more attention for their role in creating a flexible, reliable data center. While the ubiquitous 7-layer OSI model begins at Layer 1 with the physical layer of cabling, Legrand|Ortronics has introduced the concept of Layer Zero™ to the OSI model to accommodate cable management and physical support infrastructure. Layer Zero encompasses the entire physical infrastructure that

supports your network: not only racks and cabinets with advanced cable management, but underfloor and overhead systems, pathways, and more.

The Layer Zero concept derives from the recognition that the physical infrastructure can play an important role in creating data centers that are more robust and manageable. Properly selected and deployed infrastructure products can

- Reduce power consumption and cooling costs
- Reduce the risk of equipment failure
- Improve overall system performance
- Provide an easier path for network equipment upgrades

Drivers of Network Evolution

- **Greater demand for data security.** Higher data security is mandated both by business needs and by regulation. In the healthcare industry, for example, both HIPAA and Joint Commission programs require tight security to protect patient records. As a consequence, storage networks and devices are more complex.
- **Greater demand on the data storage.** Not only does data need to be stored for longer periods,



Figure 1. The passive infrastructure – Layer Zero – is a critical layer in achieving a high-performance, reliable network.

Layer Zero™, the Infrastructure Layer, and High-Performance Data Centers

the need for real-time availability of enormous amounts of data is commonplace. Storage capacity grows rapidly, and tape drive farms are being replaced by storage area networks (SANs), which support high-speed access and data transfers.

- Media-rich and high-bandwidth applications.** Serving up videos, social networking, on-line collaboration, and similar media-rich applications requires high bandwidth and flexible access to storage. Applications like e-mail and social networking, while typically not large for individual transactions, are sent in extremely high volumes. These all require availability of the network servers and storage, along with more demand on the service providers in the residential space to provide faster connection speeds.
- Converged networks.** The days of deploying separate networks for data, voice, building automation, or building security are long past. A single IP-based network allows convergence of voice, video, data, and automation onto a single network. The vision of an IP-centric network allows a single network to handle a wide range of applications.
- Virtualization.** The consolidation of multiple operating systems and applications onto virtualized servers places great demand on the input/output I/O for faster speeds. Virtualized servers are migrating to 10 Gb/s I/O to ensure each virtual server has adequate bandwidth and access.
- Power Over Ethernet (PoE).** POE delivers power to devices over the copper network data cables. The obvious advantage is to eliminate a separate power feed, which is especially useful for remotely situated devices such as wireless access points, security cameras, access controls, building automation devices, and even VoIP phones. PoE can be deployed as an end-point device, where the power is sourced from the port of network equipment, and as a midspan device, where power is injected at some point in the cabling system.
- The changing roles of the IT and facility managers.** As the networks are converging, so are the roles. The IT manager's responsibilities extend

beyond just the network to concern over power and cooling management. The facility manager is now tasked with using existing systems to support the demand on the facility itself. For a new build, it is critical that facility design and network design are considered together.

The Role of Layer Zero in Supporting the Physical Layer

The remainder of this paper looks at the role of Layer Zero in supporting the structured cabling system. The costs of a structured cabling system—including Layer Zero and Layer 1—is a small part of the overall cost of the data center, typically 5% or less (Figure 2). Considering the modest costs of the cabling system versus the enormous costs of downtime because of cable failure or mismanagement, little is to be gained by shaving costs or not applying the system according to best practices.

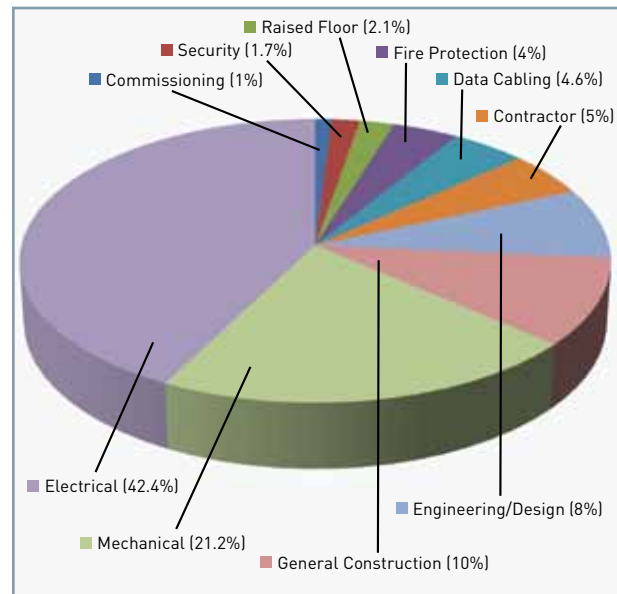


Figure 2. Typical data center cost breakdown

Another consideration in planning IT infrastructure support is the life of the network and its components. The design needs to address the short- and long-term goals of the network and the owner. A good rule of thumb when considering the life of the components is as follows:

WHITE PAPER

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Servers	3 to 5 years
Network Equipment	5 to 7 years
Physical Infrastructure	10+

The structured cabling could see up to three upgrades in equipment before being considered for replacement. It is critical to specify structured cabling to support not only today's applications but tomorrow's as well. It becomes a wiser investment to deploy Category 6a for copper cable and OM3 or OM4 multimode fiber with an eye toward tomorrow's needs. The additional cost will always be less than the cost of replacing and removing 'old' cable because you specified only for today's needs.

7 Key Elements for an Effective Network

Legrand|Ortronics has identified seven key elements that are critical to the effectiveness of the network. Without the proper management and optimization of these elements networks lose effectiveness, bandwidth, speed and quality. Managing these elements with Layer Zero infrastructure solutions will help maximize your network's potential and performance.

The seven key elements are:

- Airflow management
- Energy efficiency
- Network performance
- Flexibility
- Density
- Protection
- Scalability

We'll look at each one individually.

Airflow Management

As shown in Figure 3, cooling the data center accounts for 25% of the total costs. The costs related to power consumption are a large part of the overall costs for the operation of a data center. The Layer Zero infrastructure can enhance airflow and cooling efficiency to help control power and cooling costs.

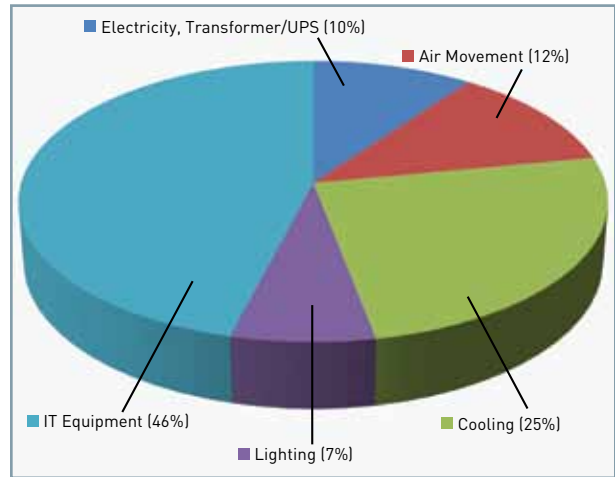


Figure 3. Data center operating costs

ANSI/TIA-942 recommends a hot aisle/cold aisle configuration for air flow management as shown in Figure 4. The key aspect of any air flow management design is to get the conditioned air to the switch intakes and manage the exhaust air so it does not re-circulate back into the switch intake.

In a typical configuration, cooling air comes from the underfloor plenum up into the room through perforated floor tiles. This cool air is drawn through the equipment, where it picks up the heat generated by equipment, and exits the rear of the rack into the hot aisle. This warm air is then directed openly or through ducts for recirculation through the CRAC units. Racks are positioned to face each other, intakes on the cold and exhausts on the hot aisle. It is important that the cold aisles remain cold and hot aisles hot: mixing air from the two should be avoided.

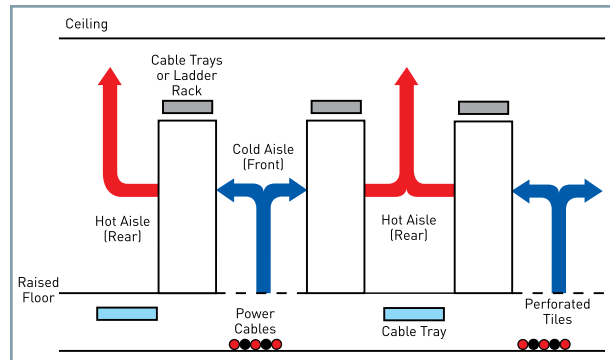


Figure 4. Hot aisle/cold aisle cooling efficiency depends on managing the airflow

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Cisco and other switch/server manufactures have developed side-to-side airflow within the chassis of some larger units. This arrangement is growing in popularity because it allows easier access to the switch components and aids in the changing out of equipment as needed.

Legrand|Ortronics has developed accessories for the Mighty Mo® 10 racks and Mighty Mo cabinets to facilitate the setup of hot/cold aisle air handling. This is accomplished with a baffle that directs the cold conditioned air into the switch intake and directs the switch exhaust into the hot aisle for dissipation as shown conceptually in Figure 5. This design allows for proper air flow management for environments with side breathing equipment.

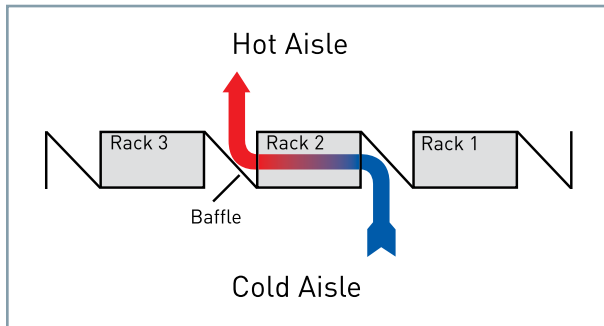


Figure 5. Baffles help maintain proper airflow from cold aisle to hot aisle in side vented equipment

The importance of the baffles in enhancing cooling is demonstrated in Figures 10 and 11, which show thermal imaging data for setups with and without the baffles.

Figure 6 illustrates the air flow management with no baffles installed. Here, exhaust from the switch on the right is directed into the intake of switch to its left and so on down the line. In other words, hot exhaust air is mixed with the cold air, raising the temperature of the intake of switches down the line. By the time the air reaches the last switch on the left, the intake air temperature can be as high as 100°F, which not only stresses the switch but also means the air conditioning system will work harder and consume more power.

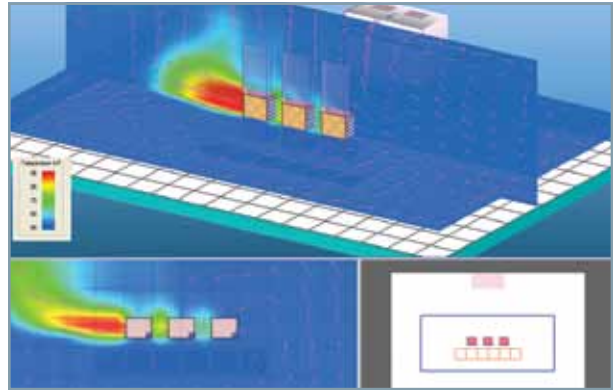


Figure 6. Airflow management in a standard EIA rack without airflow baffles

Figure 7 shows the same simulation, but this time an Ortronics Mighty Mo 10 rack with the air management baffles installed. Temperature gradients are more even since the baffles facilitate hot aisle/cold aisle airflow management. Cool, conditioned air enters the switches and is exhausted into the hot aisle. The mixing of hot and cold air seen in the baffleless example is avoided.

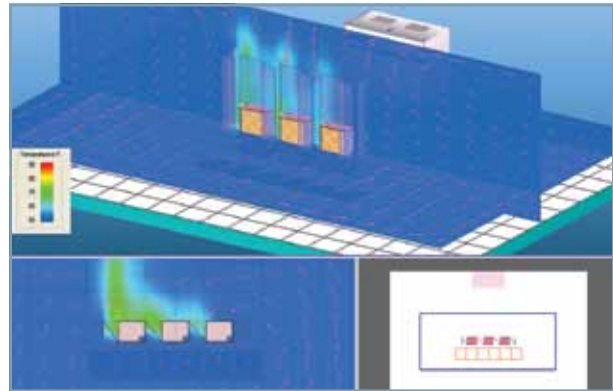


Figure 7. Airflow management in a rack with baffles

The use of baffles allows the air conditioning's setpoint to be raised 15° from 50°F to 65°F while maintaining proper temperature levels in the active equipment. Sun Microsystems has calculated that every 1°F the cold-aisle temperature can be raised translates into a 4% reduction in energy costs. Thus, airflow management in this case study allowed a 60% reduction in costs related to the cooling of the switches.

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Energy Efficiency

As you have seen, passive airflow management can effectively lower the costs of cooling without requiring fans or other additional power-consuming sources. Additional airflow management is achievable with accessories to separate hot and cold aisle spaces, particularly in the space between racks and ceiling. For example, an air containment system (Figure 8) effectively partitions hot and cold aisles.

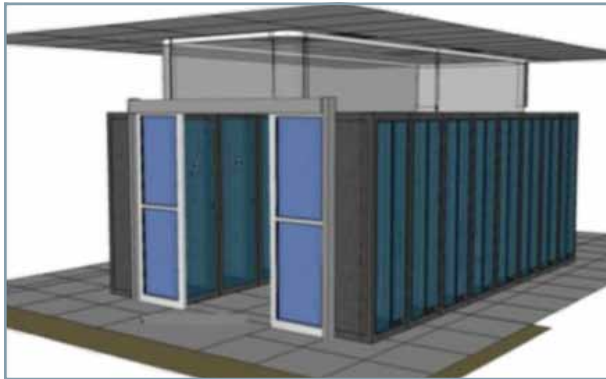


Figure 8. Partitioning hot aisles and cold aisles from rack to ceiling increases cooling efficiency

Careful cable routing in pathways can also improve cooling efficiency and lower costs. Using cable management systems is another way to improve airflow. The important thing is to avoid blocking airflow paths.

Design the route based on other obstacles within that space and environment. Network cables must be a minimum of 2 inches from power cables. Route cables away from electrically noisy environments. Reducing the number of 90 degree bends within the same pathway will limit the stress on the cable during installation or changes.

Network Performance

The performance of the structured cabling has a direct effect on the network performance. Poor cabling performance—either through underspecifying or through poor installation and management—degrades network performance. Network errors, fragmented frames, and excessive retransmissions can degrade performance and, at worst, cause expensive downtime.

The performance of the cabling is expected to perform to its TIA category rating for up to 25 years after installation.

The support of the structured cabling is critical to maintain the performance levels and needs to be properly addressed in the design. Tight bends, kinking, and unsupported weight must be avoided to ensure that cable performance remains with specification. Even worse is the possibility of inadequately managed patch cords causing lateral stress on ports and damaging them over time. Replacing a damaged switch port is a costly and preventable event.

To maintain network performance, pay attention to the details in routing and supporting the cabling system. For example, channel bend limiters protect the integrity of the cable by providing the proper bend radius as cables enter or exit the channel and prevent damage to the cable from sharp cabinet edges. Similarly, cable management spools effectively manage excess copper or fiber cable slack. They mount at rack unit intervals, providing flexibility and ensuring proper bend radius for cables.

Flexibility

Moves, adds, and changes (MACs) are a constant part of a network's administration. The cabling system should have the ability to support MACs at the rack and cabinet levels. Vertical and horizontal cable management must properly support both the horizontal cables into the patch panels and also the patchcord routing at the front of the panels.

Modular cable management systems increase flexibility. The easier it is to adjust or add individual components, such as patch panels or server/switch mounting rails, the more flexible and scalable is the network.

Scalability

Related to flexibility is scalability—the ability to accommodate growth and changes to equipment. The faster new equipment can be deployed and brought online, the greater the cost savings to the network manager. Sometimes the growth is simply a matter of duplicating existing setups; other times it involves

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new configurations as the data center moves to higher density servers and other significant changes in topology and architecture. In either case, scalability can bring great benefits in easy deployment and minimal disruption to network operations.

Modularity aids scalability. By ensuring different components can work together and often are interchangeable, modularity not only offers a mix-and-match approach to providing the building blocks to support scalability.

Density

The triple combination of convergence, virtualization, and high-density servers means that racks need to accommodate both more equipment and more interconnections. A Mighty Mo® rack, for example, can support up to 1340 Cat 6 network ports. It also allows up to 48 patchcords per vertical rack unit on each side to ensure availability of cabling without clutter or mess. Figure 9 shows a typical high-density installation.

In designing for high-density configurations, look for racks and cabinets with generous cable-routing capabilities on each side. Deep management channels not only accommodate a larger number of cables, they make them easier to manage—such as tracing an individual cable or adding new cables.

Choosing the right rack and cable pathway components can save money in the long run. Design cable pathways to handle not only today's weight & density requirements, but also tomorrow's. A fully loaded enterprise-level switch can weigh 900+ pounds. While a two-post rack might be fine for patch panels, a four-post rack is the better choice for equipment.



Figure 9. Effective cable management in high-density configuration must prevent stresses on equipment ports while still accommodating MACs

Protection

From physical security, such as preventing unauthorized access to servers, to protecting network performance by safeguarding the integrity of the cables, to monitoring current and temperature for power surges and heat spikes, Layer Zero solutions offer a comprehensive way to protect your network equipment. Each product complements each other, creating a unified system that provides complete protection from threats to your network.

Conclusion

The proper design of facilities is critical to support the life of the network, protect the investment, and to provide best in class service to the users. Legrand|Ortronics offers facilities infrastructure support with well-designed Layer Zero solutions. Through the combined use of industry standards, best practices, and innovative products a Layer Zero solution will fully support the network demands not only today, but also tomorrow.

REV 12/10



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