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Key Considerations for Remote Management and Operational Efficiency in Data Center Cabinets

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In an interconnected world, where organizations use a mix of enterprise-owned and cloud-based services, managing assets and white space remotely has become increasingly important. That process begins with a focus on the data center cabinet (rack) and gaining an understanding of how the subsystems in the cabinet form an ecosystem to support Information and Communications Technology (ICT) equipment.

By integrating the data center cabinet with hardware and software into a single platform, data center managers can truly gain visibility and understanding of the different dynamics within the data center to make informed decisions. Furthermore, the integration of IT infrastructure, hardware and software from the same manufacturer eliminates the challenges and confusion that result from pairing different products from different providers.

This white paper defines key considerations for remote management and operational efficiency in data center cabinets and shows how selecting an integrated solution will help simplify white space management.

Manage Power With Intelligence.

Power Distribution, Monitoring & Control

Power management within the white space—particularly inside the cabinet—is critical to ensure availability of all IT applications, as well as to minimize the overall energy footprint of the data center. Additionally, with efficient power management, it's possible to boost operational efficiency by managing and monitoring power at the rack- and device-level.

To optimize power distribution, monitoring and control in your cabinet ecosystem, consider the following when selecting an intelligent power distribution unit (PDU).

- **Branch circuit monitoring:** To assure power availability, it is important to monitor all circuit breakers in the power chain. Within the data center white space, overcurrent protection is utilized on rack PDUs, as well as remote power panels or busway systems. Since there are several branch circuits on a PDU, it is critical that all branch circuits be monitored on the rack PDU. In general, monitoring as close to the device as possible provides better reporting to inform optimization.
- **Remote management (threshold alarms and data logging):** Select a PDU with intelligent remote management capability for continual automated monitoring. Features such as the ability to set thresholds and get notifications or alerts when warning or critical thresholds are exceeded are crucial. Plus, data logging to keep records for analysis is important. Generally, there is a one-to-one association between a branch circuit on a floor PDU and the input of a rack PDU. Hence, monitoring of the rack PDU provides an additional benefit of monitoring branch circuit currents on those upstream power chain devices.
- **Outlet-level monitoring:** Reducing energy footprint of the IT equipment is best served with monitoring of power consumption at the outlet level of the rack PDU. Information obtained can be used to identify servers that are over or underutilized. Outlet-level readings also provide information to determine what servers and applications would be best suited for virtualization, and where there is available space and capacity in racks.



- **Outlet-level switching:** Another important aspect of power management is the ability to cycle power to hung IT equipment. This is served by PDUs that have the ability to cycle power to each individual outlet. These PDUs also allow the ability for use of outlets to be controlled by the rack PDU administrator. Outlets can be turned off unless specifically assigned to power equipment to carefully manage power and utilization.
- **IP consolidation:** The cost of networking equipment in the data center can be significant. Dedicating a single network connection to each monitoring device reduces the perceived advantage of automatically collecting data, as the cost of deploying IP networks is high. IP consolidation addresses this concern by providing the ability to link many PDUs under a single IP address. The market offers PDUs with IP consolidation capabilities that range as low as eight and as high as 48 PDUs.
- **High ambient temperature rating:** With high-density cabinets holding densities above 10 kW, it is important to select a rack PDU that features the highest possible ambient temperatures. Good PDUs in the market today feature temperature ratings of up to 149°F (65°C).
- **High outlet density:** As the demand for IT resources continues to rise, more data centers are deploying 48U and taller server cabinets to support more equipment within defined square footage. High outlet density PDUs with (54) C13 outlets allow data center operators to optimize their investment in the taller cabinets, while still benefiting from all the features of an intelligent PDU.
- **Simplified load balancing:** With higher rack power densities, three-phase power distribution to the rack is increasing. Phase-balance outlets divide the load evenly across phases and allow shorter cords and successive power connections.
- **Prevent accidental disconnections:** Select a locking outlet that does not require special power cords, an added expense, to secure power connections at the PDU.
- **Easy identification of the failover unit:** Use a match pair of color-coded PDUs to provide a visual indicator of the primary and redundant power feed to help keep connections organized.
- **Integration with Data Center Infrastructure Management (DCIM) software:** The ability to trend and plot energy use can help visualize patterns, and identify root cause of out of bounds conditions. This illuminates the need to move a workload or a piece of equipment to another rack or to retire underutilized equipment.



Monitor Equipment Proactively.

Environmental Monitoring

One of the most common causes of downtime is hardware failure resulting from exceeded temperature or humidity levels within the cabinet. In contrast—as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommends as industry-best practice—it is important to maintain the appropriate temperature levels within the white space, as they have a strong correlation to the overall energy consumption within the data center.

According to ASHRAE 2015 Thermal Guidelines, IT equipment of all classes should be maintained within a temperature range of 64.4–80.6°F (18 – 27°C) and relative humidity within the range of 40 – 60%. Also, the difference between inlet and outlet temperature should be within 35°F (20°C) and should not change more than 9°F (5°C) in any 15-minute period¹.

It is important to measure, and track inlet and outlet temperature and inlet humidity at each rack/cabinet in order to assure conditions are within ASHRAE recommended limits. A good strategy is to place a temperature and humidity probe near the top front and rear of each cabinet.

To optimize environmental monitoring in your cabinet ecosystem, consider the following when selecting an environmental monitoring solution.

- Remote temperature and humidity monitoring: Both inlet and outlet temperature and inlet humidity need to be monitored to ensure conditions are within ASHRAE recommended ranges, equipment specifications or your site requirements.
- Integration with the PDU: So temperature and humidity data can be collected through the PDU network connection and interface.
- Upper and lower thresholds and data logging: The ability to set an upper and lower threshold for temperature and humidity that prompts an automated alarm to technicians if conditions approach a limit is essential. This also allows you to define parameters for your site based on your operating conditions, and will log any out of bounds conditions for record keeping and analysis.
- Integration with DCIM software: The ability to trend and plot temperature and humidity conditions can help visualize patterns, and identify root cause of out of bounds conditions. This helps operators recognize the need to move a workload or a piece of equipment to another rack, or indicates that airflow management is deficient in a particular rack.



Protect Equipment Electronically.

Access Control

As more equipment is collocated or placed in remote sites, the need for physical security becomes extremely critical. In a networked world, securing personal and business data from theft has become an issue of paramount importance.

Industries that exchange highly secure information, such as financials and health care sectors, have to abide by strict regulatory and compliance regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) for health care, the Payment Card Industry Data Security Standard (PCI DSS) for the payment card industry and the Federal Information Security Management Act (FISMA) for federal agencies. These regulations mandate that organizations must limit physical access to information equipment to authorized individuals.

Hence, it is critical that access to IT equipment within cabinets is properly controlled and managed. A networked electronic access control solution at the cabinet level will prevent unauthorized physical access, and it will provide administrators with an audit trail of all authorized and unauthorized access attempts.

To optimize access control in your cabinet ecosystem, consider the following when selecting an access control solution.

- **Seamless integration with the cabinet and PDU interface:** Ideally, the electronic access control solution should be fully integrated with the intelligent PDU so that there is no need to power and network the electronic locks separately. A single web interface that displays information on cabinet access and power distribution greatly simplifies white space management.
- **Smart card authentication:** Select a solution that recognizes most existing employee cards to avoid time-consuming programming.
- **Audit trail for regulatory compliance:** Most importantly, select an electronic access control solution that provides you with a record of every access attempt and easily integrates the information in the PDU interface or DCIM software for easy reporting.
- **Integration with DCIM software:** The ability to document, track and report access at each cabinet, as well as control access to cabinets and administer users quickly from the DCIM software is important.

Optimize Your System Remotely.

System Integration with DCIM software

A simple, yet robust, DCIM software that helps you visualize trends of all activities in the room and cabinet in a single screen brings the concept of simplified white space management home. When procuring DCIM software, focus on simplicity, usefulness and easy deployment.

To optimize system integration in your cabinet ecosystem, consider the following when selecting a DCIM software solution.

- **Data charting of trends:** By easily visualizing trends and occurrences, you can quickly identify problem areas, and optimize site capacity, utilization and security.



- Power capacity trend and analysis: Trending power capacity over time can help you forecast power consumption more accurately.
- Power charge back reporting: Closely control power consumption expenses with DCIM software that unifies data from various equipment into a simple report.
- Failover testing: Test the failover capability of the data center without having to shut down the power chain. Select a solution that proactively provides information to confirm whether or not failover capability within any cabinet is being compromised.
- Active power by month and device: This feature helps data center managers quickly identify spikes, prevent potential power issues and maximize uptime. Leverage this feature with power monitoring at the outlet level to identify power consumption by server, which helps in the identification of under and over utilized servers for potential replacement with more efficient devices or virtual servers.
- Searchable database and easy integration: DCIM software provides excellent preconfigured dashboard and reporting tools, but access to the data that DCIM collects and stores is also important to create more advanced reporting for other system integration. Additional insights are possible when combining data from the facility (DCIM) with data from the network and servers or from other asset management tools.
- Expandable with advanced features: Your basic DCIM software should provide power monitoring and management, environmental monitoring and access control by capturing data at the cabinet level. It should automate measurement, capture and store data, monitor and alarm thresholds, trend power and environmental conditions, simplify administration of user access rights, and log each access attempt. It should also be able to expand to provide more robust asset management, power chain and connectivity mapping and change and workflow management.



Support Equipment with Strength.

Equipment Cabinets

The fundamental purpose of an equipment cabinet is to stack equipment vertically. When you select the size of your cabinets, you are designating a specific amount of floor space that will store a specific amount of equipment. You also need to be able to transport that equipment safely across your site. There are two main considerations: cabinet footprint and cabinet load bearing capacity.

To optimize support in your cabinet ecosystem, consider the following when selecting a cabinet.

- Deeper cabinets support proper power, cable and airflow management: The cabinet footprint is the amount of floor space the cabinet will use. The cabinet needs to be deeper than equipment, and include additional space for airflow management, cable management and power distributions accessories. Cabinets that are 600 mm W x 1200 mm D for servers and 800 mm W x 1200 mm D for networking/switches are recommended. The deeper footprint accommodates deeper equipment and leaves space at the front of the cabinet for airflow management and along the side and rear of the cabinet for power distribution and cable management.



- Robust design with high static load rating: Ideally, your cabinet should be rated for 4000 lb (1814 kg) to 5000 lb (2268 kg) of equipment when attached to building structure. Reputable vendors will load-test their cabinets with a third-party laboratory using a common industry standard such as UL® 2416, the UL Standard for Safety for Audio/Video, ICT Equipment Cabinet, Enclosure and Rack Systems, which includes a test recommendation of up to four times their weight capacity.
- For sites that practice cabinet-level deployment: If you use a systems integrator to load equipment into a cabinet and then deploy the integrated cabinet onto your site, the cabinet needs a stated rolling load and shipping load of 4000 lb (1814 kg), and the casters need to be rated to support those loads. UL 2416 includes a test to qualify the rolling load, and there are also transportation tests to qualify shipping performance.
- For sites that are in seismic zones: If you deploy the cabinets into an area with high potential of seismic activity, the cabinet requires special anchorage, and may require additional bracing. Consider a seismic-rated cabinet that is specifically designed for seismic zones. In addition to standard load testing, these cabinets are shaker-table tested to assure a high equipment load.

Control Airflow with Efficiency.

Cooling and Airflow Management

Reducing data center cooling costs is still a high priority among most data center operators, so addressing airflow management is key. An effective airflow management (containment) strategy allows the data center cabinet to support high-density equipment, while bringing in energy efficiency and lowering cooling costs.

To optimize cooling and airflow management in your cabinet ecosystem, consider the following when selecting airflow management accessories.

- Door perforation and internal airflow management: Select a cabinet with a high percentage of door perforation for maximum front-to-rear airflow. Additionally, specify airflow management accessories for the cabinet that optimize front-to-rear airflow. These include grommets to seal any cable openings in the equipment mounting rails, baffles that seal the space between the equipment mounting rails and the top, bottom and sides of equipment to block airflow around equipment and blanking panels to seal any open (unused) rack-mount spaces in between equipment.
- Compatibility with Vertical Exhaust Duct, Hot Aisle Containment (HAC) or Cold Aisle Containment (CAC): A Vertical Exhaust Duct directs hot exhaust air from the servers to a plenum above the drop ceiling and back to the cooling units or to outside vents, thus isolating the hot from cold air within the cabinet and room. A Vertical Exhaust Duct is a highly efficient cabinet-based alternative to HAC and CAC. Optimal airflow management practices also recommend airflow management accessories that block airflow under and around contained cabinets, so the cabinets or aisles are completely sealed.



Fast Fact

For more details on the three basic types of containment systems and the economic benefits of airflow management, please read the companion papers, [Data Center Airflow Management Basics: Comparing Containment Systems](#) and [Data Center Airflow Management Basics: Economics of Containment Systems](#)

Organize Cables with Flexibility.

Cable Management/Pathway

The cabinet should include specific and physically separate pathways for power and network cables and mounting locations for power distribution units (PDUs) that minimize interference with airflow through the cabinet. Additionally, cable openings in cabinet panels should have a seal to minimize air loss around cables.

To optimize structure in your cabinet ecosystem, consider the following when selecting a cabinet.

- Separate power and network cable pathways: Power and network cable pathways are accessories added to the cabinet. Use separate accessories to support power and cable pathways. Place these in the cabinet so that they are physically separate.
- For server cabinets: Use a PDU mounting bracket and vertical cable managers with finger guides in server cabinets to support PDUs on one side and network patch cords on the other.
- For network/switch cabinets: Use vertical cable managers with finger guides and lashing panels in network cabinets to support patch cords at the front of the cabinet and premise cables at the rear.



Simplify Operations with a Single-Vendor Solution.

A Single Source

In addition to satisfying all of the technical product requirements and recommended key features addressed above, your solutions provider adds value when it offers the following services.

- Provides a fully integrated solution – A fully integrated solution that includes instrumentation and software to combine all the key elements of white space management discussed above makes overall deployment and ongoing management much simpler and economical.
- Enables easy sourcing and fast delivery – As more colocation and remote compute sites emerge in the future, the overall time to get these sites up and running will become more critical. Preinstalled infrastructure equipment within the cabinets, such as PDUs, electronic access locks and environmental sensors, significantly saves overall deployment time.
- Allows for modification of standard product, if required – Each data center is unique. If you require a feature that is not part of the standard offer, your vendor should be able to work with you to customize the system. For example, you may require a special mounting bracket, modified panel work on the cabinet or require specialized kitting.
- Offers pre- and post-sale services – Understanding the exact requirements for your site may require onsite consultation, comparison of various scenarios and demonstration and testing of monitoring. During your installation, you may need some assistance. After commissioning, you may need access to technical support or firmware updates. Finally, you should know what the warranty period is and if it includes advanced replacement for power and electronic products.



Conclusion

Current computing and networking trends should result in more equipment being collocated or placed in remote sites. Optimizing higher density and remote sites requires a new approach to fitting and monitoring in the white space.

Airflow management in each cabinet and the separation of hot and cold air within the white space is the critical first step to realizing significant energy savings from cooling systems. Monitoring at the cabinet/rack and device level are critical for ensuring uptime and optimizing higher density sites. Taking measurements that are more granular results in better insights on under and over utilized equipment and informs decisions that maximize utilization of available capacity.

An effective cabinet ecosystem will provide you with a simplified path to white space management, allowing you to consistently manage, monitor, protect, optimize, support, control, organize and simplify your operations.

References

¹ASHRAE. 2015. *ASHRAE Datacom Series 1: Thermal Guidelines for Data Processing Environments, Fourth Edition*. Technical Committee 9.9.

Contributors



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Ashish Moondra has over 20 years of experience developing, managing and selling rack power distribution, uninterruptible power supply (UPS), energy storage and Data Center Infrastructure Management (DCIM) solutions. Ashish has previously worked with American Power Conversion, Emerson Network Power and Active Power, and has been an expert speaker at various data center forums.