Thermal Management Delivers Business Gains

TAKE YOUR THERMAL MANAGEMENT STRATEGY FROM TACTICAL TO STRATEGIC AND DRIVE RETURN ON INVESTMENT

Managing today's increasingly complex data centers means juggling a variety of priorities, including improving sustainability, boosting energy efficiency and reducing the total cost of ownership (TCO). These aims have to be balanced against the need to achieve uptime goals specified in service-level agreements while maintaining regulatory compliance.

New technological advances such as virtualization and cloud computing are increasing power rack density requirements, which are now reaching 10 to 20 kilowatts. High-density applications are reaching 20 to 30 kilowatts, effectively driving the utilization of any server from 10 percent to more than 70 percent. As a result, the requirements for power density and airflow are exceeding the available capacity at the rack level, resulting in power resilience and thermal challenges.

Legacy data centers and their cooling systems have traditionally been designed with an average power density per square foot in mind. In reality, data center loading can vary by rack and row depending on IT equipment and utilization, and this means varying levels of airflow and cooling can be required in different areas of a data center. An understanding of the airflow within a data center is vital to ensure cooling is being delivered where it is actually required, rather than blanket overcooling which is costly and inefficient. Unfortunately, it is all too common within legacy data
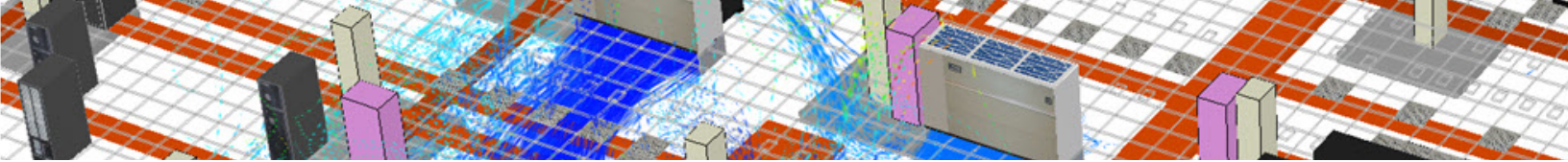
centers to have available space capacity, yet to not have enough power or cooling capacity. This often leads to the outdated and expensive practice of over-cooling the entire data center, which results in increased energy consumption and expense. The key is to understand the interdependencies between power, space and cooling to unlock capacity in order to extend the life of the data center and defer capital investments in a new facility.

The triad of utility costs, regulatory requirements and the need to reduce carbon emissions is forcing data center managers to take a more strategic approach to thermal management, which begins with understanding airflow.

In legacy environments, it is all too common for an aging infrastructure to limit the effective airflow that can reach servers and switches. Proper airflow management is one of the most critical aspects of designing and operating your data center. It ensures the efficient performance and uptime of IT equipment and applications, improving the bottom line.

Unfortunately, many data center managers are unaware of the real effects of the physical infrastructure on airflow, and also stymied by the lack of relevant and accurate operational information, which makes it difficult to make the best decisions for the facility. More often than not, departmental data

silos, which prevent the dissemination of information to relevant parties for review and planning, are to blame.

To break down silos containing cooling information, many companies are seeking the advice of a third party in implementing a long-term data center thermal management strategy. This can be particularly important for companies in Europe, where strict regulations make it difficult for data centers to be retrofitted to meet new requirements. US companies may soon have to contend with tightened regulatory requirements, as the administration recently signaled their intention to limit carbon emissions.

The key is to balance the deployment of IT equipment with the thermal management system's ability to cool the equipment, ensuring that you maximize your data center's capacity while preventing downtime due to thermal issues.

In an evaluation of a data center's use of cooling, it is important to assess three things:

》 Thermal capacity, to ensure that you have sufficient cooling for the IT equipment.

》 Capacity management, to understand if your IT equipment is optimally located within the data center. Where do hot-spots and cooling problems exist, and what can be done to overcome them? What can be done to unleash stranded cooling capacity, possibly avoiding the need to build a new data center? Is there enough capacity for the equipment, or is it time to build a new data center?

》 Energy efficiency, which should be assessed at the room, cabinet and device level to balance the cooling requirements with the IT equipment load.

SEAL, DIRECT, CONTAIN AND MONITOR
A best practice for optimizing cooling is "seal, direct, contain and monitor." The methodology behind this approach is to make incremental changes to resolve cooling challenges:

》 Seal every gap for complete separation of cooling and exhaust air.
Creating a complete air seal significantly reduces air leakage throughout the cabinet structure. It is important to use cabinets that have been designed to eliminate all possible air gaps other than those needed to mount equipment, minimizing bypass airflow (loss of air) and recirculation in the cabinet and providing lower inlet temperatures.

Install blanking panels.
The installation of blanking panels will help minimize recirculation of air by sealing open rack units, eliminating recirculation and preventing bypass airflow from going through the equipment. Recycling of hot exhaust air into the equipment air intake is caused mainly when hot exhaust air returns above or below the equipment and back into the inlets of the equipment, which can cause equipment to overheat in data centers.

Seal raised-floor cable cutouts with air sealing grommets.
Air sealing grommets create an effective, airtight seal to eliminate cool air bypass and hot air recirculation. Several open raised-floor cable cutouts can leak as much air as an entire perforated tile. An unwelcome side effect of unsealed cable cutouts is hot air recirculation over the top of the cabinet, causing hot-spots at the front of the IT equipment. Another effect is bypass airflow, which contributes to lower energy efficiency, since the air is not being used to cool the IT equipment.

》 Direct cold air to where it needs to go.
Utilize inlet and exhaust ducts with IT equipment that breathes side-to-side to direct cold air directly to the IT equipment and to prevent hot exhaust from being recirculated inside the cabinet and causing hot-spots and reliability issues.
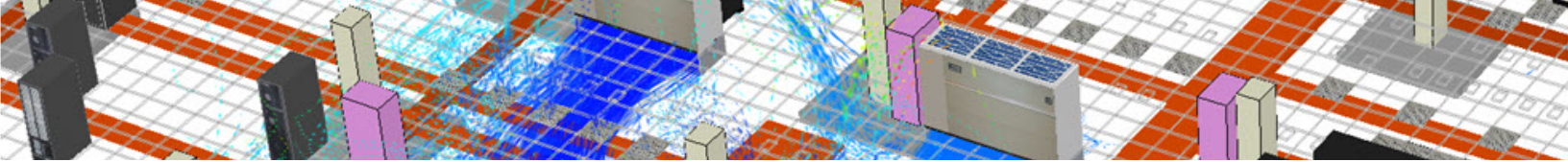
》 Contain cooling and exhaust air for maximum cooling capacity efficiency and space utilization.
Cold aisle containment systems eliminate hot air recirculation and mixing of hot air into the cold aisle, which can lower cooling performance by 30 percent.

The principle behind air containment is to prevent the mixing of hot and cold air, for two primary business

Computational fluid dynamics, or CFD, is a branch of fluid mechanics that uses numerical methods and algorithms to analyze and solve problems that involve fluid flows, including airflows. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. In the case of thermal management of data centers, CFD can be used to simulate airflows for a better understanding of existing cooling efficiency and to optimize thermal and airflow behavior by modeling what-if scenarios to optimize data center layouts and remediate hot spots in data centers. It can also help organizations determine ideal cooling for new data centers.

benefits: First, containing air can increase cooling efficiency up to 30 percent, which means that it directly reduces your monthly power bill for cooling. Second, this increase in cooling efficiency enables the deployment of higher-density equipment, which makes it possible to defer the capital expense of building a new data center or adding more cooling capacity to an existing data center to support higher densities.

Containment options, such as cold or hot aisle containment and vertical exhaust ducts (VEDs), are choices to consider for new as well as existing data centers. For existing data centers, finding the option with the highest ROI and the ability to realize the highest efficiency with the shortest payback period often depends on the current data center configuration and constraints.

For example, pathways, ceiling heights, plenum locations and other obstructions must be taken into consideration when determining the best containment solution. In the end, containment is a viable option that can significantly increase cooling capacity and reduce cooling operating expenses, which is why many companies turn to thermal simulations using computational fluid dynamics (CFD) to model multiple scenarios to determine the option with the highest ROI.

» Monitor to maintain operational and energy efficiency.

Data center managers face the challenge of maintaining and managing energy efficiency gains in a highly dynamic environment in which power consumption and environmental variables are constantly changing.

A complete data center infrastructure management (DCIM) solution provides visibility into environmental factors affecting the data center, enabling data center managers to make informed thermal management and energy efficiency decisions. Without visibility into real-time and historical temperature, humidity and energy usage measurements, an erosion of efficiency gains, power usage reductions and capacity utilization can occur over time, leading to higher TCO.

VISUALIZING AIRFLOW: A CRITICAL COMPONENT OF COOLING OPTIMIZATION

To maximize the efficiency of your cooling system, you must uncover the root causes of any cooling problems plaguing your data center. If you don't do so, it can be impossible to choose the appropriate course of action to resolve cooling problems—let alone improve your cooling efficiency.
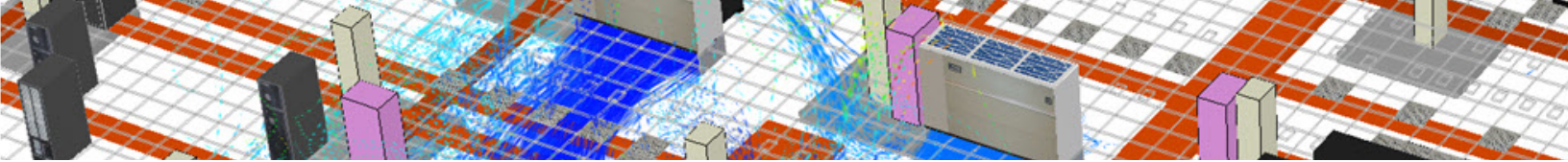
Balancing the deployment of IT equipment with the cooling capacity that should be available for it is difficult, because the optimization of your data center's cooling systems requires an intimate understanding of something you cannot see: airflow. The right amount of cold air needs to be delivered to the air intakes of each and every piece of IT equipment, and the hot exhaust from the IT equipment needs to be removed without interfering with cooling.

To develop a cooling strategy that makes your data center more efficient and effective, you need detailed knowledge of your data center's thermal dynamics. Every data center is unique, so analyzing and arriving at a strategic cooling plan and the best thermal configuration requires assessment, analysis and insight. One approach to thermal management is to engage a professional firm to perform thermal modeling to optimize cooling with CFD. The output of CFD analysis is a color-coded map that resembles a meteorologist's weather map (see Figure 1) that simulates all the equipment in the data center along with the airflow and the temperature.

A CFD analysis includes what-if scenarios to test the effect of different choices, such as increasing capacity, deciding on positions of IT equipment, using containment technology on the overall thermal picture. All CFD analyses are not alike; detail is vital. For example, modeling a cabinet as a black box based on kilowatts yields high-level results based on imprecise

Figure 1
CFD Analysis simulates Data Center equipment with airflow and temperature

generalizations and assumptions whereas a model based on actual IT equipment in a cabinet takes into account the temperatures and airflow through each piece of equipment, pinpointing problems that would be invisible to a model based on kilowatts alone. The key is to feed enough detail into the tool to enable it to pinpoint the problem, not the symptom.

THERMAL ASSESSMENT DESIGN SERVICES FOR NEW DATA CENTERS

When deployed during the initial planning and design phases, a CFD analysis can help maximize efficiency at the beginning of a data center lifecycle, helping prevent problems from occurring in the first place.

» **For example,** the existing data center capacity of an Internet service provider (ISP) in the United Kingdom was being depleted at an unacceptable rate. To handle its additional load, it often had to deploy extra physical servers. As the server footprint increased, the cost of powering and cooling the server estate increased. Capturing accurate energy and power usage information was difficult.

The increasing demand for more capacity and high-density IT loads to support technologies such as cloud and hosting services led to the demand for more power, cooling and capacity. This resulted in dramatic increases in operational costs and put a substantial strain on the ISP's IT and facilities budgets.

Since 2009 Panduit, a global provider of intelligent infrastructure solutions, has worked with the ISP to overcome these challenges. Panduit implemented a power and environmental management infrastructure with a holistic view of energy and environmental parameters in the ISP's existing data centers as well as in the design of a new energy-efficient data center capable of supporting higher densities.

The solution includes the application of Panduit Intelligent Data Center and SmartZone™ solutions, including the SmartZone™ Software Suite (which provides infrastructure visibility and management), SmartZone™ gateways and appliances (which monitor and capture real-time data in each zone of the data center) and SmartZone™ services (which help analyze the physical infrastructure's condition and requirements at the outset of the planning process).

» **The result:** improved operational and energy efficiencies with significant cost reductions and improved facility performance.

AVOIDING THE OVERPROVISIONING TRAP

A key part of data center design is a predictive thermal analysis carried out before the facility is filled with IT equipment, to avoid overprovisioning the cooling systems to maintain uptime. "The old rule of thumb was to overprovision the data center cooling plant and keep the data center cold like a meat locker," says Robert Chernesky, Solutions Development Manager, Panduit Advisory Services. "Today, companies are applying ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) guidelines through CFD modeling to prevent overprovisioning and achieve an energy-efficient data center with the lowest operating expense."

Decisions on where to put equipment need to be based on available power, cooling and space to prevent data center fragmentation - the loss of capacity that results when the lack of one or more resource prevents the use of otherwise available capacity.

ENABLING DATA-BASED THERMAL MANAGEMENT DECISIONS

As an infrastructure solutions provider with a proven track record of helping clients make better choices for thermal usage, Panduit has experience in challenging traditional assumptions (such as the belief that overcooling is necessary to avoid IT equipment failure) and driving decision-making based on facts that are supported by ROI data rather than opinions.

Data centers are beginning to push traditional limits, with higher-density racks being deployed in facilities that weren't initially designed for them. However, there are a myriad of choices to accommodate higher-density loads, and companies are turning to CFD modeling to simulate the optimum solution with the highest ROI to reduce the risk of making an incorrect choice. It is equally important to get down to the root causes of existing thermal issues that might be small today but will only be magnified into larger problems in the future. Fixing the root causes opens the door to maximizing energy efficiency, not just by preventing hot-spots but also by enabling you to raise set points to reduce the operating expense of your cooling systems.

Once you've gathered data from a simulation or a modeling exercise, you can consider facts rather than opinions and guesswork. Thermal assessments provide the visibility required for you to take a strategic approach to thermal management - and Panduit is the infrastructure partner to help you achieve results.

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