Data Center Infrastructure Monitoring

Data Center Infrastructure Monitoring (DCIM) play an important role in managing datacenter. Environmental parameters such as humidity, temperature, and etc. can affect data center efficiency. This white paper explains how and why DCIM is very important.

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Today, some data is worth more than tons of gold, even governments allocate big amounts of budget to keep them safe. Data centers are like a house for keeping bees! Protecting them is very hard indeed.

As for software security, hackers are a serious threat, but controlling the physical environment is even harder and more important than software security, for example if all the cooling systems stop just for 5 minutes, all the modules and chipsets will melt!

Global data is on the rise and never stops from its growth , in terms of scale, complexity, and functionality, paving a way for data centers to be more intuitive, coherent, holistic, and easily accessible. With disruptive technologies such as Big Data, Mobile Technologies, Social Network and Cloud Computing gaining incredible speed, there is an increasing need for data centers to proportionately bear the characteristics of these technologies too.

Years 2000-2011 were a period of rapid growth and change for data centers, Data center managers were forced to response to rapid, continuous changes dictated by the capacity and availability requirements of their organizations and the density of the equipment being deployed to meet those requirements.

For example, speed of switch-to-switch connection has increased from 10Gb to 100Gb in less 10 years!

Now, data centers must enter a new stage of majority marked by a more proactive approach to management to enable an increased efficiency, better planning and higher levels of service. Achieving actionable visibility into data center operations requires the ability to collect, consolidate and analyze data across the data center, using advanced devices, sensors, and management software to keep them in perfect functionality.

Data centers have traditionally been designed with the extra headroom to accommodate growth, but during the last decade, demands escalated so quickly that an added IT capacity consumed available headroom and outpaced supply in terms of floor space, power and cooling capacity.

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This created conflicts as facility personnel struggled to supply IT's demand for server capacity.

These problems were further exacerbated by two trends that emerged in the second half of the decade. The first is the increased focus on data center energy consumption. With both the density and quantity of servers rising, data center energy consumption became a significant factor in terms of IT cost management. In some cases energy costs were actually higher than the worth of data that was kept at the data center!

35 percent of data center energy consumption related to cooling systems, so early efforts to reduce data center energy consumption focused on reducing costs around data center cooling. Subsequent efforts took a more holistic approach that recognized the interdependence of data center systems, and shifted the focus to the IT systems that create the need for cooling.

Data Center Infrastructure Management (DCIM) is a superset of infrastructure monitoring and it encompasses the ability to manage data center physical infrastructure to optimize data center resource utilization, efficiency and availability.

DCIM includes management of the data center infrastructure layer (power, cooling, and the physical space), the IT infrastructure layer (compute, storage and communications equipment) and the gap between the two layers.

By enabling management across the gap, data center operators have visibility into the true capacity of their IT and infrastructure systems, allowing them to manage closer to actual capacity, rather than the conservative estimates that leave some percentage of capacity unused as a buffer.

Data Centers have historically used precision cooling to tightly control the environment inside the data center with strict limits. However, rising energy costs and impending carbon taxation are causing many organizations to re-examine data center energy efficiency and the assumptions driving their existing data center practices.

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1. Sensing Temperatures

One of the most significant consequences of the growth in data center density and complexity is the issue of heat density. As data center density has increased, cooling loads have grown and become more heterogeneous. It is no longer possible to manage temperatures on a facility level because rack densities may vary widely, creating hot spots in one zone while another zone is cooled below the desired temperature.

Installing a network of temperature sensors across the data center helps ensure that all equipment is operating within the ASHRAE recommended temperature range (64.4° F to 80.6° F). By sensing temperatures at multiple locations the airflow and cooling capacity of the precision cooling units can be more precisely controlled, resulting in a more efficient operation.

Additionally, the network of sensors can reduce cooling costs by allowing safe operation closer to the upper end of the temperature range, for example, at 75° F instead of 65° F. According to an ASHRAE paper developed by Emerson Network Power, a 10° F increase in server inlet temperatures results in a 30 percent reduction in compressor power draw.

The best practice is to attach at least one sensor on every rack, and it is also acceptable to place a sensor on every other rack when racks are arranged in the hot aisle/cold aisle configuration and there is a uniform loading across the row. Sensors should be located near the top of the rack where temperatures are generally highest.

2. Monitoring rack conditions

With increasing densities, a single rack can now support the same computing capacity that used to require an entire room. Visibility into conditions in the rack can help prevent many of the most common threats to rack-based equipment including accidental or malicious tampering, the presence of water, smoke and excess humidity or temperature.

A rack-monitoring unit can be configured to trigger alarms when water

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or smoke is detected, temperature or humidity thresholds are exceeded, or rack doors are opened (and can even capture video footage of the event). These "eyes inside the rack" can be connected to a central monitoring system where environmental data can be integrated with power data from the rack PDUs, while also providing local notification by activating a beacon light or other alarm if problems are detected. They should always be deployed in high-density racks and racks containing business-critical equipment

3. Detecting Fluid Leaks

A single water leak can cost thousands of dollars in equipment damage—and even worst, a huge loss in data, customer transactions or enterprise productivity. Leak detection systems use strategically located sensors to detect leaks across the data center and trigger alarms to prevent damage. Sensors should be positioned at every point which fluids are present in the data center, including around water and glycol piping, humidifier supply and drain lines, condensate drains and unit drip pans.

A leak detection system can be operated as a standalone system or be connected into the central monitoring system to simplify alarm management. Either way, it is an important part of the sensor network that gives data center managers visibility into operating conditions. Controls of current generation infrastructure systems are equipped with sophisticated controls that enhance reliability and enable multiple units to work together to improve performance and increase efficiency.

Water sensors can be used under racks to detect leaks. There are individual sensors and "rope" or "cable" sensors. A rope sensor can be laid under a row of racks and detect water anywhere along its length. A rope sensor can also be wrapped around pipes to detect leaks.

4. Intelligent Control of Precision Cooling

Intelligent controls integrated into room and row air conditioners allow these systems to maintain precise temperature and humidity control as efficiently as

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efficiently as possible. They coordinate the operation of multiple cooling units to allow the units to complement rather than compete with each other, as sometimes might occurs when intelligent controls are not present.

For example, one unit may get a low humidity reading that could trigger the precision cooling system's internal humidifier. But before turning on the humidifier, the unit checks the humidity readings of other units and discovers that humidity across the room is at the high end of the acceptable range. Instead of turning on the humidifier, the system continues to monitor humidity to see if levels balance out across the room.

Integrated control systems on room-based and rack-based cooling systems can also be used to enable preventive maintenance programs and speedy responses to system problems. Data collected by these systems enables predictive analysis of components and proactive management of system maintenance. Event logs, service history logs and spare parts lists all support a more efficient service.

In fluid dynamics, Bernoulli's principle states that for a fluid flow, an increase in the speed of the fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy. If you think about a shower curtain, before the shower is turned on the shower curtain hangs straight down. But when you turn on the shower the fluid inside the shower (air, steam and water) is moving faster than the fluid outside the shower (air) so the shower curtain is drawn into the shower because the pressure inside the shower has decreased. For hot/cold aisle deployments using variable speed fans to conserve energy, the difference in the flow of air between the two aisles can potentially cause less rigid partitions such as plastic curtains to

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be drawn into one of the aisles creating air leaks. A differential air pressure sensor — set up to alert when thresholds are crossed —can help identify any pressure differences that might lead to partition leaks and inefficiencies.

5. Intelligent Control of Critical Power

UPS systems now include digital controls with the intelligence to alter and optimize the performance of the UPS. They automatically calibrate the system and ensure the UPS is working properly. In addition, they ensure that the UPS switches between traditional operations and bypasses during overloads, protecting the UPS system and the overall power infrastructure. This minimizes the need to make manual adjustments based on site conditions. Instead of requiring a service technician to manually adjust the analog controls, the UPS system itself monitors the conditions at the site (power factor, load and ambient temperature) and makes adjustments to maintain optimum performance.

These controls also enable more efficient operation through energy optimization and intelligent paralleling features. Energy optimization mode increases UPS efficiency by powering the IT load from the bypass path while providing some power conditioning. An organization may choose to activate energy optimization during periods when utility power quality is thought to be particularly good or when availability requirements are not as high, such as nights or weekends. Energy optimization mode can improve UPS efficiency by as much as five percentage points, but also introduces the possibility of compromising total power protection. This risk can be mitigated when the controls are designed to keep the UPS inverter “hot” while the system is in energy optimization mode, allowing faster response to utility power disturbances.

Intelligent paralleling provides another option for improving UPS efficiency in multimodal systems. Intelligent paralleling manages the load across multiple UPS modules and can automatically deactivate modules that

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are not required to support the load, while still ensuring that the system is providing adequate redundancy. For example, a four-module N+1 system sized to support 700 kVA using four 250 kVA UPS modules can support loads below 400 kVA with only three modules. This capability can improve system efficiency by up to six percent without sacrificing protection.

6. Managing Alerts And Alarms

Minimizing system downtime has been the traditional justification for data center infrastructure monitoring and it continues to be a powerful benefit. The ability to view immediate notification of a failure—or an event that could ultimately lead to a failure— through a centralized system allows for a faster more effective response to system problems.

Equally important, a centralized alarm management system provides a single window into data center operations and can prioritize alarms by criticality, to ensure the most serious incidents receive priority attention. Every alarm needs to be gauged for its impact on operations. For example, it may be acceptable to defer a repair of one precision cooling unit if 30 are working normally, but not if it is one of only two units.

Taking a step further, data from the monitoring system can be used to analyze equipment-operating trends and develop more effective preventive maintenance programs.

Finally, the visibility into data center infrastructure provided by a centralized system can help prevent problems created by changing operating conditions. For example, the ability to turn off receptacles in a rack that is maxed out on power, but may still have physical space, can prevent a circuit overload. Alternately, alarms that indicate a rise in server inlet temperatures could dictate the need for an additional row cooling unit before overheating brings down the servers the business depends on.

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7. Monitoring Energy Efficiency

Energy costs comprise a large proportion of data center operating costs but many facilities lack energy monitoring capabilities.

8. Monitoring Batteries

To prevent data loss and increase server uptime, most data centers require a dedicated battery monitoring system. The best practice is to implement a monitoring system that connects to and tracks the health of each battery within a string. The most effective battery monitoring systems continuously track all battery parameters, including internal resistance, using a DC test current to ensure measurement accuracy and repeatability. Supported by a well-defined process for preventive maintenance and replacement, monitoring batteries can significantly reduce the risk of dropped loads due to battery failure and additionally, optimize battery life and improve safety.