Server Technology

Quality Rack Power Solutions

Data Center Power: Managing for Energy Efficiency and Cost Savings

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HEADQUARTERS - NORTH AMERICA
Server Technology, Inc.
1040 Sandhill Drive
Reno, NV 89521
United States
1.775.284.2000 Tel
1.775.284.2065 Fax
sales@servertech.com
www.servertech.com
www.servertechblog.com

Western Europe, Middle East and Africa
Server Technology
Fountain Court
2 Victoria Square
Victoria Street
St. Albans
AL1 3TF
United Kingdom
+44 (0) 1727 884676 Tel
+44 (0) 1727 220815 Fax
salesint@servertech.com

Central Europe, Eastern Europe and Russia
Niederlassung Deutschland
Server Technology LLC
42119 Wuppertal
Germany
Tel: + 49 202 693917 x 0
Fax: + 49 202 693917-10
salesint@servertech.com

APAC
Server Technology
Room 2301, 23/F, Future Plaza
111-113 How Ming Street, Kwun Tong, Hong Kong
Direct line: +852 3916 2048
Fax Line: +852 3916 2002
salesint@servertech.com

Overview

Server Technology had the recent opportunity, along with other partner companies, to participate in discussions across the globe with data center IT and facility managers as part of a road show seminar: Data Center Energy and Operational Efficiency.

These events occurred with the 451 Research/Uptime Institute who provided insight into current industry trends and direction. Many of the major industry topics were the same as discussed in previous years, but this year new and innovative solutions were available to help data centers solve operational problems.

This white paper covers current data center trends and the biggest challenges data center organizations face today. Insight and solutions for these challenges are provided in this white paper.

Data Center Industry Trends

Several overall trends are on data center agendas today:

- Energy Efficiency
- Decrease in Power Usage Effectiveness (PUE) Values
- Increase in Virtualization Rates

Popular ways to increase energy efficiency include hot/cold aisle containment; raising inlet air temperatures to the devices; and air/water side economization.

None of these industry trends are surprising. Energy efficiency is important but not at the cost of uptime. In addition, while power costs are rising, and power availability in many markets is decreasing, energy-efficiency projects must have a defined and reasonable ROI. Organizations are not moving toward being green just for the sake of being green. For example, without a clear financial direction, a reasonably short ROI (18-months or less) almost guarantees these energy projects will not be undertaken.

It is interesting to note that stricter new EPA regulations governing power plant emissions of hazardous air pollutants – known as the Air Toxics Rule – will require installation of costly emissions controls for mercury and acid gases across the coal-fired generating fleet by 2015.

As shown in Figure 1 below, the estimated overall effect by 2015 is a net decline of U.S. coal-fired generation of 165 MWh, equivalent to 9% of the U.S. coal-fired generation in 2009.[1]

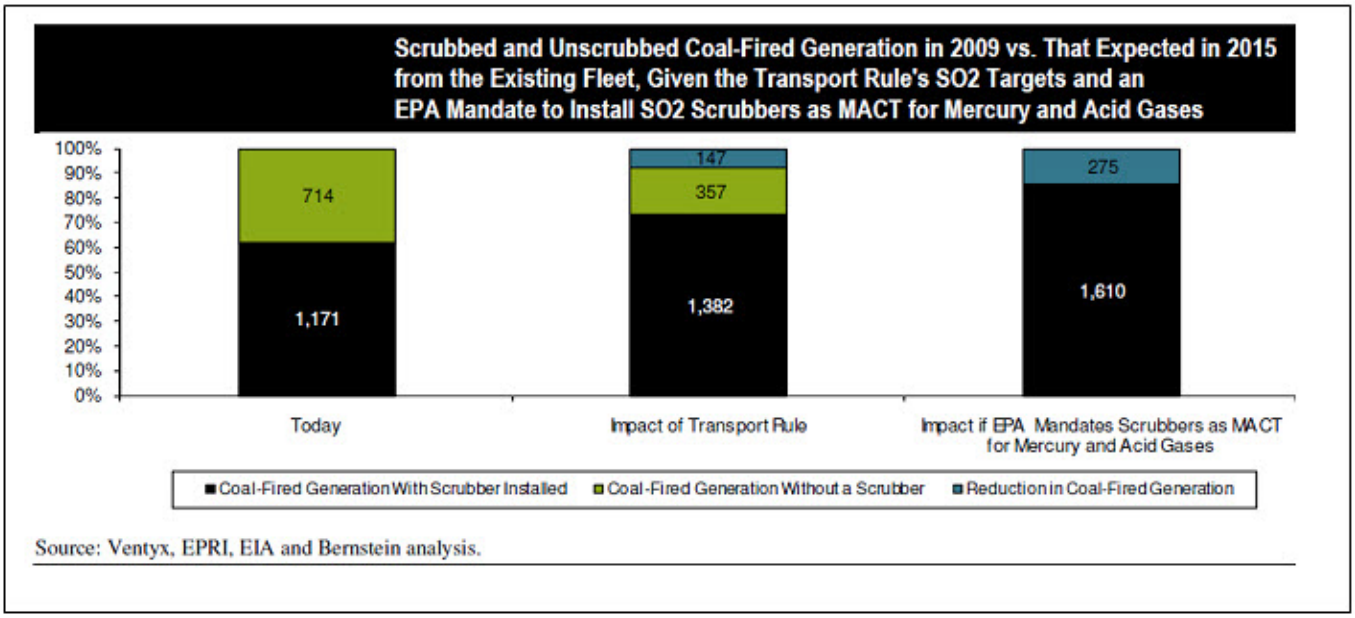

Figure 1. Comparison of Coal-Fired Generation

Clearly, raising the inlet air temperature is an effective way to increase efficiency. The standard "ASHRAE TC 9.9 Mission Critical Facilities, Technology Spaces and Electronic Equipment" has increased both the recommended and allowable temperature ranges with each update.

While ASHRAE studies show that increased temperatures do not result in radically increased fan operational costs[2], there are clearly some cost increases. In addition, studies by DELL[3] and other companies show that servers seem to live just as long under increased temperatures. Other studies by ASHRAE[4] and The Green Grid[5] show that there are only moderate increases in failure rates of servers operating at higher temperatures.

Years ago when higher operating temperatures were first discussed, there was a major concern: if a system cooling failure occurred in data centers with high temperatures and increased power densities, there would only be a 1-minute or less reaction time before equipment damage occurred. Although the reaction time may still be an issue, it is considered a minimal risk today.

Customer Challenges

With the understanding that organizations must be more efficient and reduce both operating costs and capital costs, the following major challenges facing data centers today were shared by customers during the seminar:

- Environmental Monitoring and Cost Savings
- Scheduling to Save Power
- Increasing Power Density/Demand
- Capacity Planning
- Greater Efficiency
- Business Performance Metrics
- Sustainability/Green Initiatives
- Locating Stranded Capacity
- Doing More with Less Resources

This white paper explores some of these top challenges and addresses them with the following solutions.

Environmental Monitoring and Cost Savings

A key method data centers use to save power on cooling is to operate devices at higher temperatures. Maintaining a safe environment at higher temperatures requires close monitoring and control.

ASHRAE offers updated guidelines about measuring temperatures at the data center cabinet: “ASHRAE TC 9.9 - 2011 Thermal Guidelines for Data Processing Environments – Expanded Data Center Classes and Usage Guidance.”

At the seminar it was stated that a number of data centers are older facilities, and in some cases, the data center was not even designed to support the devices it currently runs. For this reason, heat is a major issue in these facilities. In older data centers, the managers are required to measure power consumption numbers by cabinet, so the A/C engineers can determine where to increase cooling or add “spot” cooling” to avoid heating problems.

Many of these older facilities are in the process of upgrading their infrastructure; however, in the meantime they have to keep their existing systems in operation. Intelligent cabinet Power Distribution Units (PDUs) and software monitoring tools allow these facilities to easily report and trend on power usage by cabinet. Reports and trends by cabinet can alert the IT department about the location of potential hot spots, as well as provide a better understanding of the capability of the cabinet to support additional hardware.

The PDU products provided by Server Technology allow two temperature and two humidity probes to be connected to the master unit and two of the same probes to be attached to the link unit. These probes are on 10-foot cables that can be run to any location in the cabinet, allowing the data center to meet ASHRAE guidelines for environmental monitoring.

Scheduling to Save Power

Current software systems like Server Technology's Linux-based Sentry Power Manager (SPM) enterprise software product (available as an appliance or virtual solution), has numerous features to help organizations monitor, manage, and control power and environmental information in the data center.

SPM's scheduling feature allows the user to schedule many functions: system backups, data base maintenance, device discovery, email reports, email trends, outlet control actions, outlet cluster control, and outlet groups. Based on a pre-determined schedule, outlet control actions on that schedule allow the user to automatically shut down specific devices at designated times to save energy, as well as bring those same devices back online when needed.

Only a few years ago, shutting down devices to save energy would be unheard of for fear that the devices would not come back on. However, with government regulations today to reduce power consumption, as well as corporations looking for innovative ways to save costs and power, shutting down devices and other similar solutions are becoming popular practices, especially with the new legislation driving these efforts.

For government organizations, the following laws have made energy savings a requirement:

Executive Order 13514
Date Effective: 10/5/2009

Executive Order 13423
Date Effective: 01/24/2007

Energy Independence and Security Act 2007 (Sec. 431, 523)
Date Effective: 12/19/2007

Energy Policy Act 2005 (Sec. 102, 104, 109)
Date Effective: 8/8/2005

Early testing with one high level government security agency showed a 40% to 60% savings in energy when shutting down devices not in use in their data centers for defined time periods.

The following SPM scheduling calendar shows the task overview page:

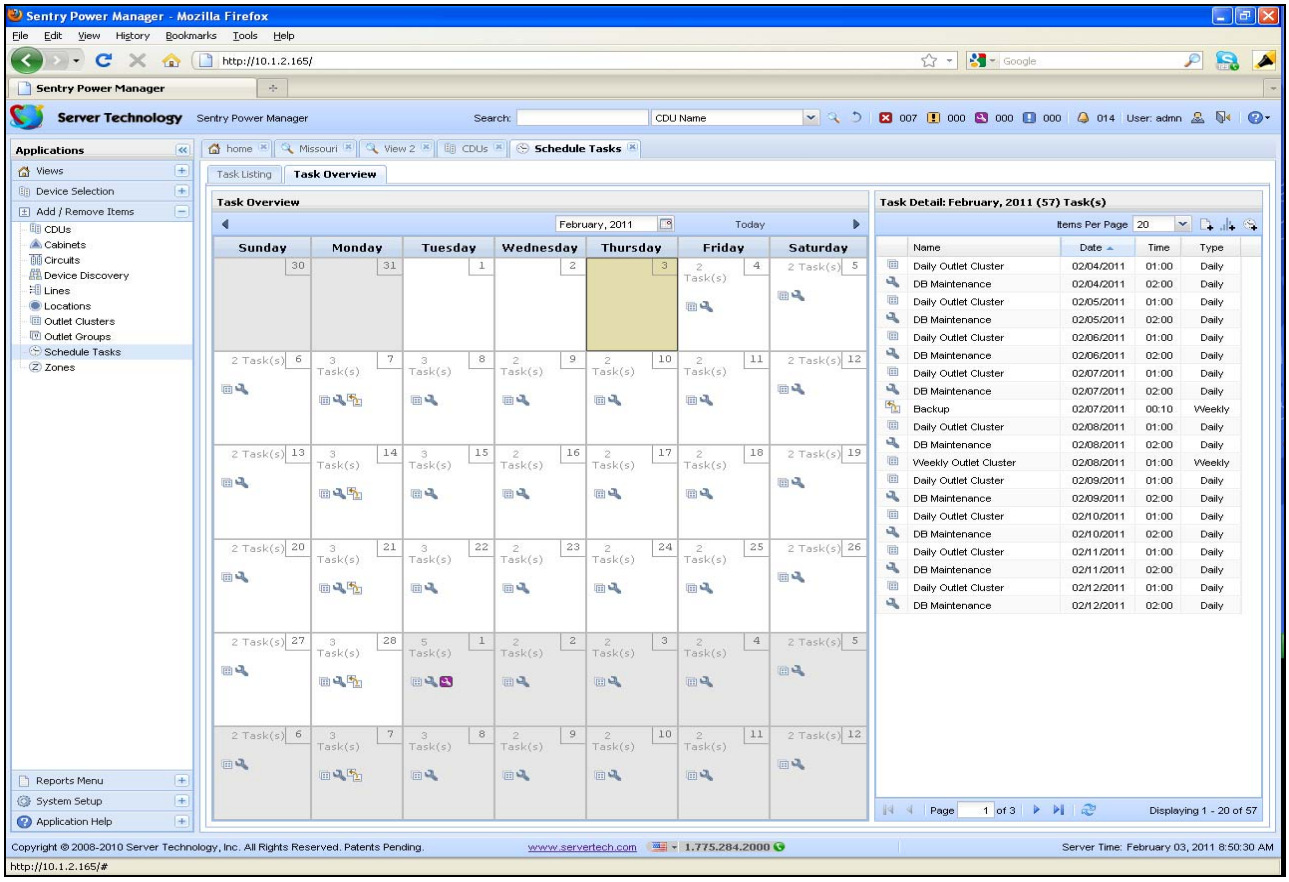

Figure 2. Example of SPM Scheduling Calendar

The scheduling concept can be applied at many global technology companies that run large lab facilities for integration and compliance testing. Some companies operate their equipment continually; local groups run during the day, and they allow groups in other countries to run the equipment during the night.

However, for most organizations, only a portion of their equipment is running at any one time in their labs, so why keep all these devices continually powered-up and running if they are not needed?

Capacity Planning

Predictive Trending

Sentry Power Manager (SPM) uses data to create trends that provide valuable information for both power and temperature readings. This functionality has been taken a step further by adding predictive analysis to the trending feature.

The patent pending functionality is a new type of trending that shows a line with the linear fit of the data over time along with the ascension/descension rate and the predicted date on which a threshold will be crossed. Examples of predictive trends follow in Figures 3 and 4:

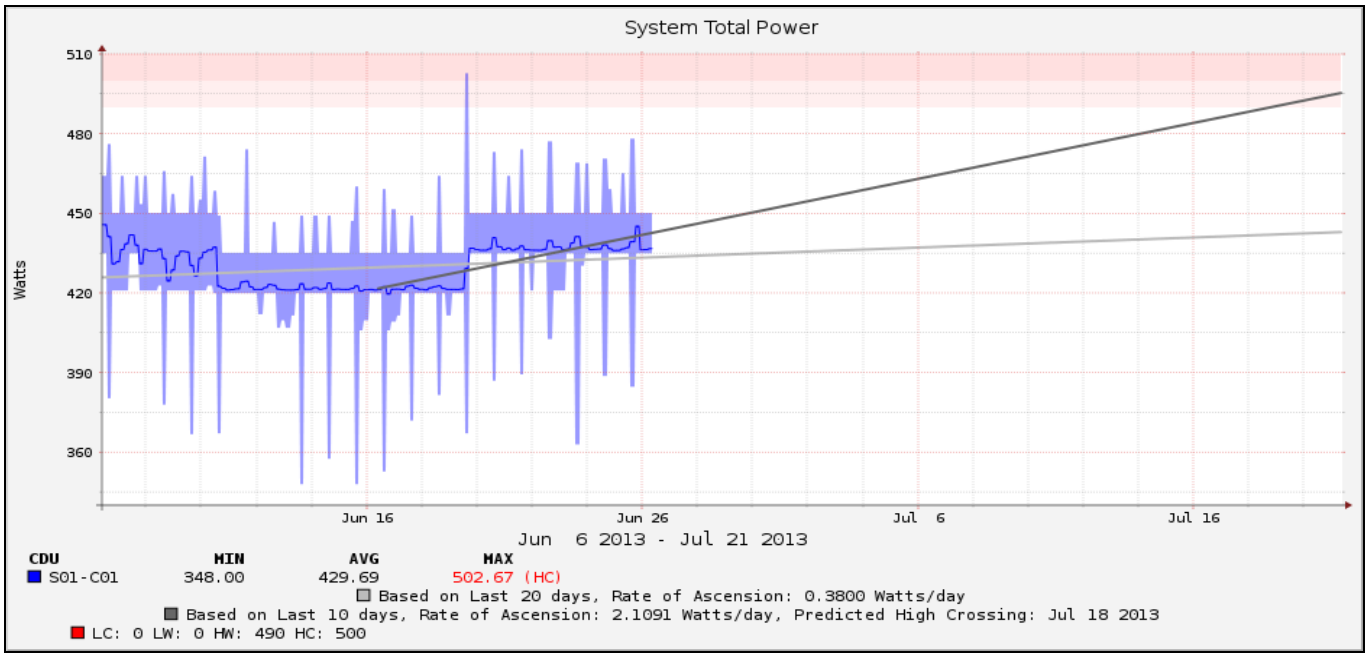

Figure 3. Predictive Trend – System Total Power

The progression line is graphed on top of the historical data. Alarms are issued if predicted that a threshold will be exceeded in the near future.

Threshold values are shown in the legend of the trend, and the minimum, maximum, and average values for any trended parameter for the time period (or over the time period) are displayed.

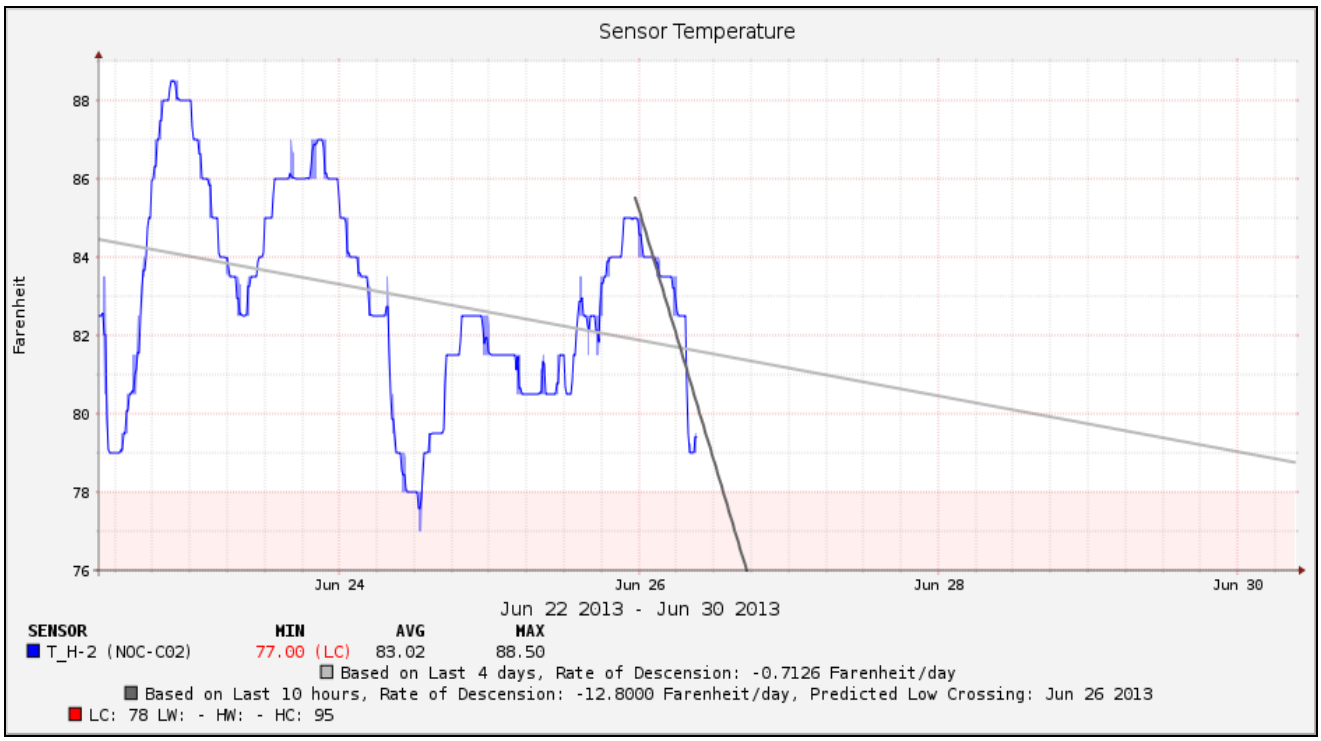

Figure 4. Predictive Trend – Temperature

Monitoring Power Usage

By understanding the amount of power used within a cabinet and rolling this information up into groups of cabinets (that SPM refers to as zones), a great deal of important information is made available to assist with operational decisions in the data center.

Consider the following power and capacity information:

- Monitoring at the Cabinet Level. When power usage is known, potential hot spots in the data center can be identified.
- Knowing Cabinet Power Usage. The amount of cabinet power usage can be reported to help identify cabinets with power and space availability for the installation of new devices.
- Cabinet Capacity. It can be determined which cabinets have exceeded their capacity (or will exceed their capacity in the future) based on the current growth rate.
- Zone Level Monitoring. Knowing power usage at the zone level allows power monitoring information obtained from the UPS or RPP to be compared against the actual usage at the devices. This information determines how many additional cabinets can be installed in a zone.
- Location Level Monitoring. Knowing power usage by location helps with planning and allocation of new cabinets. This information indicates how many more new cabinets can be supported based on the current infrastructure, or on planned additions for the infrastructure.

Increasing Data Center Efficiency

Focusing on Green Initiatives

Today it is clear that increasing efficiency while still operating green initiatives within ROI is important for many reasons: saving costs (including power costs), meeting business requirements, reducing the carbon footprint, and being known as an environmentally-responsible corporation.

Green initiatives are gaining exposure in many large organizations with the addition of new "C" level positions with titles such as Energy and Sustainability Program Manger, Safety and Sustainability Manager, and Environmental and Sustainability Engineer.

The chances have increased dramatically that a company will have to explain its green initiatives currently in place, or show what steps the company is taking to address increased efficiency. Lord Kelvin's famous quotation for reaching excellence has never been truer than it is today: "If you cannot measure it, you cannot improve it."

Some organizations have been ahead of the efficiency curve and have not only been measuring and monitoring but also using software tools to make large amounts of efficiency-related data valuable to other areas of the corporation.

Accurate and complete data is critical for effectively running a data center and making critical decisions. Reports, trending, and predictive trending – all of which are based on accurate power and environmental information – are key to increased efficiency. Additionally, this information helps to solve capacity planning problems and identifies zombie servers in the data center.

Using Circuits for 3-Phase Load Balancing

Many companies are challenged with higher cabinet power densities and the need to increase efficiency, resulting in an increase in the number of cabinets running 3-phase power, as well as 400V 3-phase power (like the rest of the world).

There are numerous white papers that discuss the advantages of 3-phase solutions. Server Technology offers several documents, including:

- Three Phase Power in the Data Center, STI-100-005.
- Power Efficiency Gains by Deploying 415 VAC Power Distribution in North American Data Centers, STI-100-008.
- Efficiency Gains with 480V/277V Power at the Cabinet Level, STI-100-012
- Phase Balancing: The Last Few Inches of a High Efficiency Power System, STI-100-009.

The Sentry Power Manager (SPM) software product allows management of the circuits of infeeds from our Power Distribution Units (PDUs), which are the branch circuits coming from the Remote Power Panel (RPP). This feature allows the combination of these PDU infeeds by zone, and in the data center that combination translates to a specific PDU or RPP.

Once a circuit is created, the user can easily see if the three loads are in or out-of-balance. When there is a number of different power types and levels coming from the RPP, and there is phase-balancing at the cabinet, this situation does not imply load-balanced at the RPP.

The SPM Circuits feature allows the user to plan, track, and manage the physical infrastructure of power systems feeding one, or multiple, PDUs. The Circuits feature provides a summarized view of the defined circuit layout in the data center, as shown in Figure 5 below. SPM considers a circuit to be a full power line to the data center, either single phase or 3-phase, as the user defines the circuit.

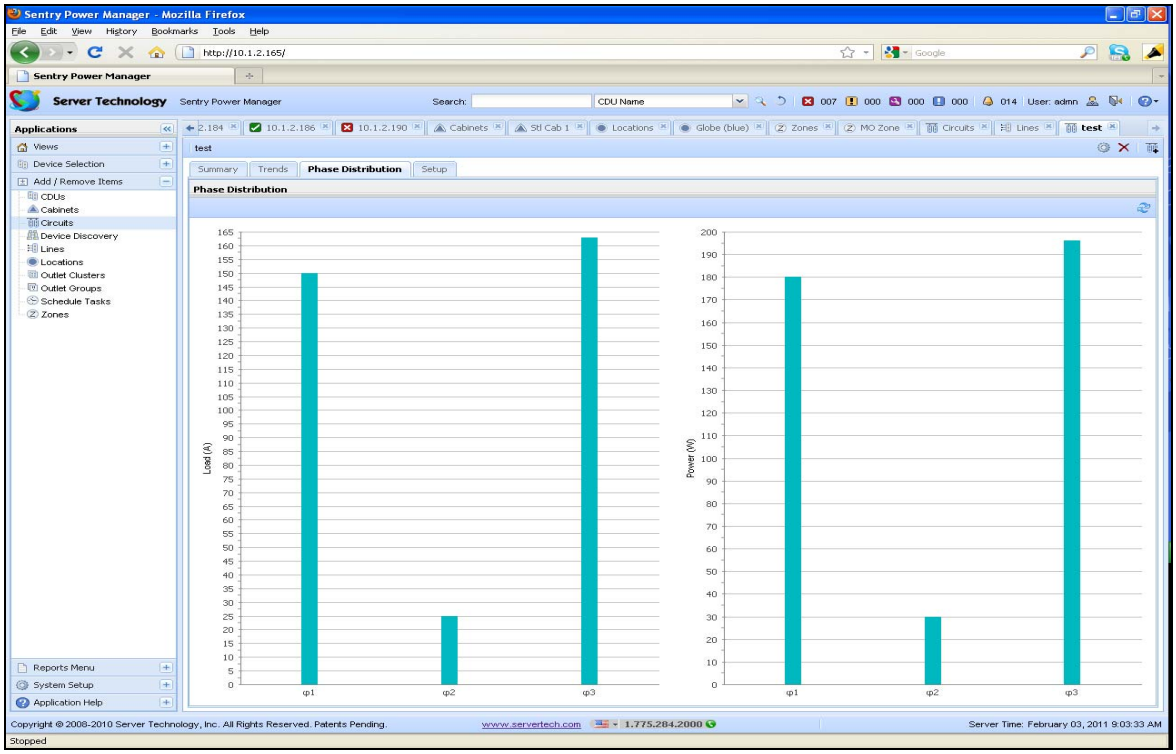

Figure 5. Circuits – Example of 3-Phase Load

Since a circuit tracks lines of power across multiple devices, the Circuits feature reports aggregate total power and load values across multiple power sources. All load and power readings for the devices on lines and circuits are totaled, and the balance of power in a 3-phase system is analyzed.

This effect is reported in trending over time in the Trend graphs which assist in assigning thresholds for real-time warnings. Circuit trending can be used for aggregated power by analyzing the power usage of lines of power over time to monitor the results of devices turning on and off at specific times of the day.

Locating Stranded Capacity

Finding Zombie Servers

It has been known that the typical level of server utilization in a data center is somewhere in the 15% range, depending on the source. In addition, it is a well-known fact that most servers will use anywhere from 40% to 60% of their power usage while sitting idle and not doing any useful work. This is why so many virtualization and consolidation projects are seen today. Locating stranded capacity is a key issue in the industry trends and this work is expected to continue. Besides saving power, there are also a number of utilities like Pacific Gas and Electric (PG&E) that provide cash incentives for documented virtualization projects.

Power Distribution Units (PDUs) using Server Technology's Per Outlet Power Sensing (POPS) in combination with Sentry Power Manger (SPM) allow our users to identify similar devices and what their power loads are. This type of monitoring quickly and easily determines which servers are sitting idle and which ones are doing useful work.

Setting a low power alert threshold allows data center and IT personnel to be notified when devices are sitting idle for a period of time. SPM's Outlet Low Usage report provides the total energy usage in kilowatt-hours over a user-specified period of time for outlets that continuously remains below that threshold. Such outlets might indicate zombie devices that waste power.

Power Monitoring/Custom Device Templates

Not only is cabinet-level power monitoring important but rolling up multiple cabinets into a zone lets the user look at power usage for all the cabinets in the data center connected to a particular UPS or PDU.

Working with tools that allow the user to look at zone-level power data, and also compare this data from the software with the actual UPS or PDU power load data, adds a great deal of value to the reports and the information derived from them. These tools help with facilities planning and where to locate new devices or cabinets. In addition, the tools help with capacity planning to determine whether there are enough power and cooling resources available to support these new devices.

Monitoring Solutions and Software Tools

Data centers frequently believe they are out of power or think they might be approaching a threshold; however, without monitoring they do not know for sure. Power is often allocated but not used at many data center facilities. Monitoring power usage and understanding whether there is additional capacity in the current facility versus the costs of building a new facility or adding capacity at a Co-Location facility can have huge ramifications within the organization.

The user has to look at the standard cabinets equipped with intelligent PDUs, and it must be taken into account that cabinets like Storage Area Networks (SANs) may or may not be monitored. In these cases, the user can either: (1) input a fixed load for one of these devices to ensure that its power usage is included in the overall totals, or (2) install a monitoring device in between the SAN and the power infeeds to the device that allows power usage monitoring.

The following items (in order of customer popularity), show how monitoring solutions and software tools, including Data Center Infrastructure Management (DCIM), are currently used:

- Real time power and environmental monitoring
- IT asset inventory tracking and configuration change
- Trending and analysis of historical operational data
- Capacity planning for power, cooling, and space
- Identification of zombie servers and devices
- Cooling optimization
- Airflow and CFD modeling
- Cost modeling, forecasting, and allocation

Numerous DCIM software solutions are found on the market today, and each solution has its own strengths and weaknesses. In addition, there are many Building Management System (BMS) solutions and other software applications that are currently installed in data centers around the world. None of these products in the market today are known to perform well in all areas.

SPM is capable of providing large savings in costs and time for IT and facilities while also exporting power and environmental information through an open Application Programming Interface (API) to other systems in the data center infrastructure. For example, if the user has a DCIM or BMS and wants to import information to these systems to use a single monitoring view, the process is easy.

Doing More with Less Resources

Today companies are tasked with doing more with less. Unfortunately, fewer resources mean that less gets done, regardless of the upper management edict to “just figure it out.” Tools that can provide time saving solutions are invaluable in today’s work environment. There are software tools now that assist the user in device configuration as well as maintenance support for items like firmware upgrades to PDUs.

The following tools are integrated into Sentry Power Manager (SPM) software and designed to help with product installation and support:

SNAP

SNAP is an SPM feature that allows users to take the PDU out of the box, connect it to the network, and direct the unit to push down a number of key configuration settings (as a template). SNAP provides communication, security, and an information exchange between the PDU and SPM. An example of the SNAP template follows in Figure 6:

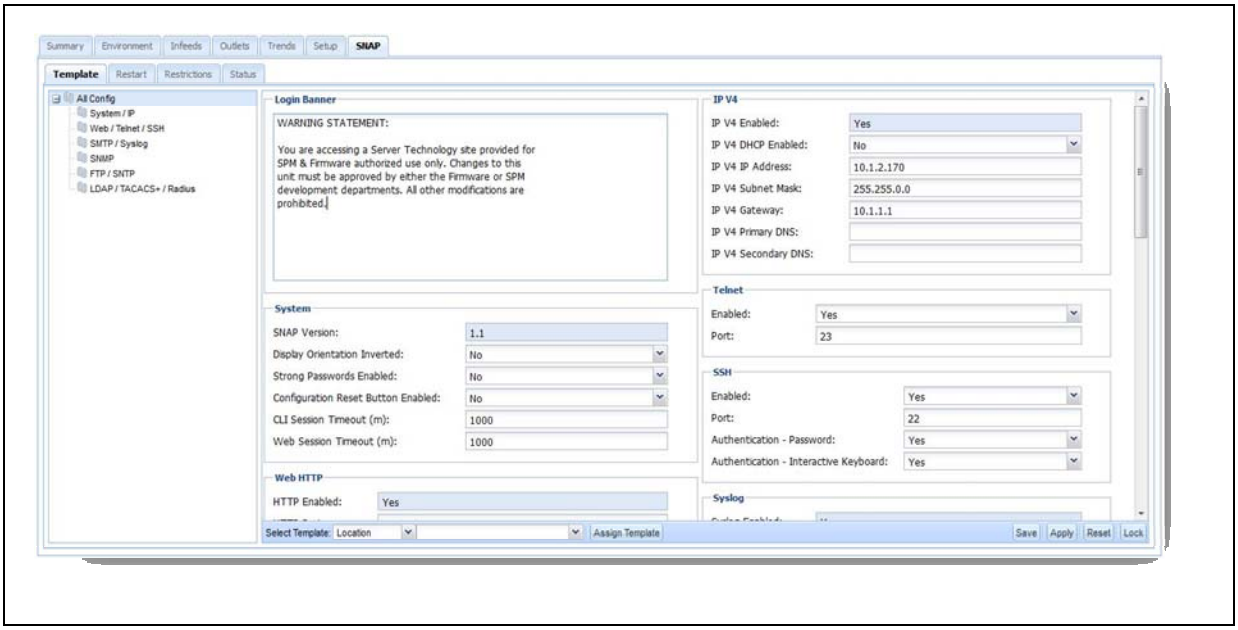

Figure 6. Example of a SNAP Template

This type of speed and device communication is critical today from a time-savings perspective, and also with consideration for how PDUs are provisioned within the data center.

In many cases, the PDUs are installed and providing power to the cabinet (especially in a new facility), before the network is up and running. Once the network is operational, the data center often does not have time to go back and configure all the PDUs to get them on the network.

SNAP is the first “plug and play” environment for intelligent PDUs with SPM because SNAP pushes down configuration information to the PDU through a manual discovery or automatically through a pre-determined discovery schedule.

Firmware Updates

SPM can perform as the FTP server to allow the user to post firmware upgrades to the SPM system and schedule when the upgrades are made to the PDU. During firmware upgrades, power to the outlets is not interrupted or compromised in any way.

Redundancy Check

Just because a data center cabinet has two power infeeds (from different sources), depending on the tier rating of the facility, this situation does not in any way imply that the cabinet is properly cabled and redundant. More often than not, work tickets are submitted because someone has installed a new device in the cabinet and not powered it correctly.

Common tests for cabinet redundancy include failing one of the power infeeds and determining if the other source is capable of supporting the whole IT load.

Other tests measure the loads with a clamp meter or compare current load readings from a metered PDU. Unfortunately, these tests are labor-intensive processes and they might cause issues if the devices are incorrectly cabled.

One way to avoid problems is to use SPM's Cabinet Redundancy feature, shown below in Figure 7, which ensures that if the cabinet is not redundant the user is warned in advance so the appropriate action can be taken.

Such a warning avoids downtime and eliminates the need for other time and labor intensive ways to determine which data center cabinets are redundant.

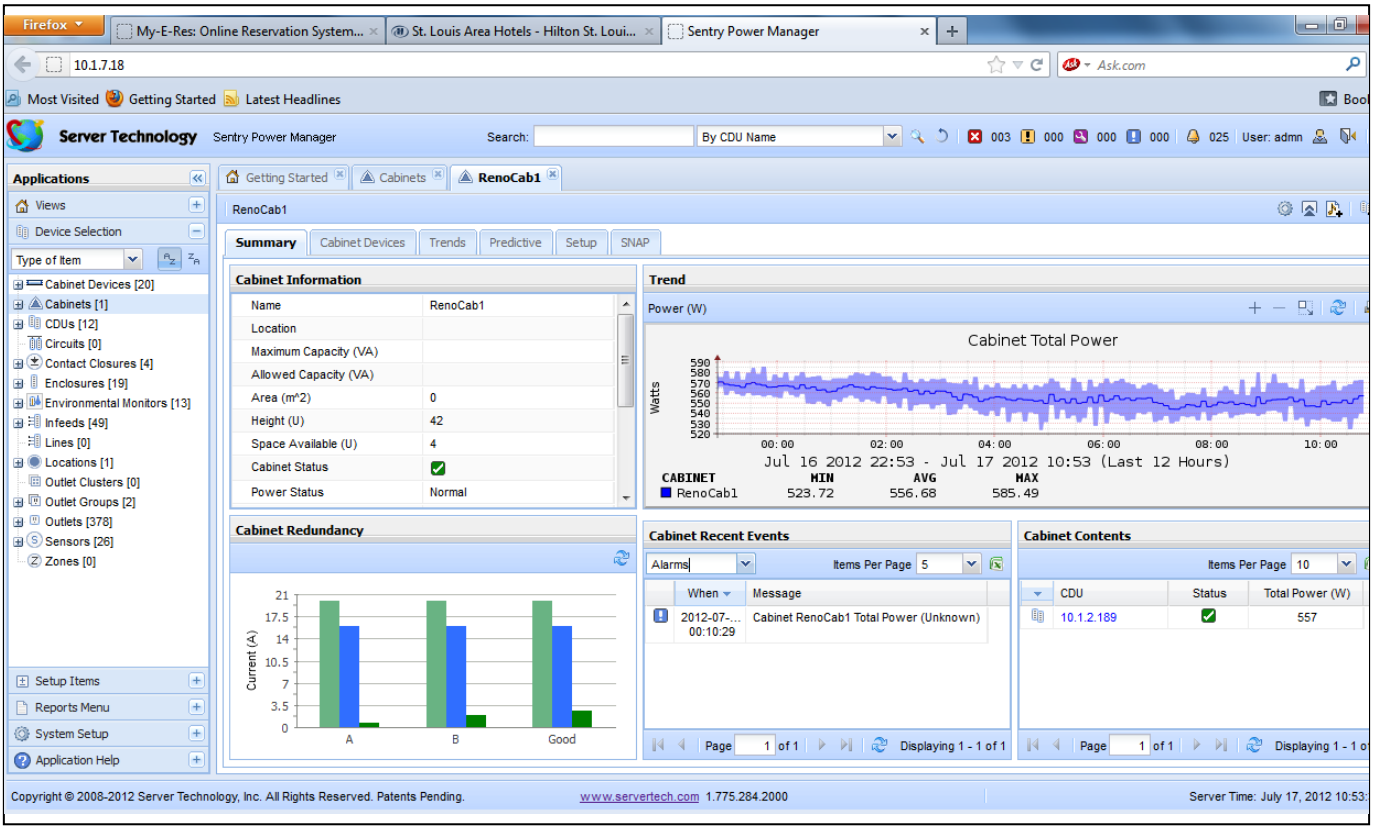

Figure 7. SPM Cabinet Redundancy (panel displayed in lower left corner)

Summary

When most IT organizations list their top three areas of operational concern, power is often the first item.

This might translate to keeping up with increased densities as organizations try to meet the ever greater demand for computing and storage. Or, the concern might be associated with the cooling challenges that result from these increased densities. Either way, power cost and availability will continue to drive efficiency within each data center organization for the foreseeable future.

Proper monitoring tools ensure the user begins to measure data center operations for a better understanding of past, present, and future performance.

Solutions that incorporate both hardware and software tools that have evolved together and are tightly integrated through years of experience and hundreds of installations typically provide the best results and information.

Innovations that continue for monitoring and information usage are critical for the future of the data center. This white paper discussed several innovative solutions and tools that are delivered every day with effective results to data centers worldwide.

References

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