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Server Technology® White Paper

Bottom-Up Data Center Power Management

White Paper STI-100-017
2016-April

Server Technology®
Quality Rack Power Solutions

Overview

Outlet switching and outlet-level power measurements are critical for the modern data center goals of complete management of devices, growth, and efficiency. It has been said for years that you can't improve what you don't measure. While there may be incidental improvements due to standard equipment upgrades or likely improvements due to initiatives that are based on past experience continual improvement will be impossible to prove without detailed measurements of IT equipment and control of the power at every level of the distribution system. Managing device deployment, usage over time, and disposition at the end of life is a daily activity in the data center. Understanding growth through density awareness, capacity planning, and uptime maintenance will continue to be a major challenge to the data center manager. Efficiency analysis will only become more critical as belts are tightened and competition increases over the coming decade. In this paper, we propose that rack PDUs with outlet switching and outlet-level power measurement capability are a must-have in the modern data center.

Managing IT Devices

The IT devices housed in the data center that the business depends upon are the networking, compute, and storage devices mounted into cabinets or racks. These devices have useful lifecycles defined by their purposes and must be managed, not just for what they are doing during operation, but for their lifecycle from deployment through retirement and all tracking in between. Additionally, managing a device includes understanding the cost of power consumption over time relative to the functional value of that device running during that time. In other words, it is important to know when a newer more efficient device should replace the older one on a performance per watt basis. With the cost of power visible to the responsible departments, or even explicitly charged to the budget of those departments, the timely retirement of that equipment can improve efficiency as well.

Lock-out & Deployment

One difficulty with regards to deploying new IT equipment in a medium to large data center environment is that of answering the threefold question "where?". The three big questions of "where" relate to the power, space and cooling required to support this new device. Quite often a piece of equipment will simply be installed where it fits and then recorded for traceability. This is a risky method of deployment when uptime and efficiency are considered highly important. Identifying not only where it fits, but also which rack has the right amount of available power on the right phase is critical for both uptime and efficiency. Trending tools that show cabinet power usage and temperature over time (e.g. the last year) help to determine if it is safe to install any more devices within a cabinet based on worst case conditions. One method to manage this is to "lock-out" the outlets that are not being used. In other words, turn off the outlets of Switched rack PDUs when no equipment is installed. Then schedule the application of power to the appropriate outlets when a job ticket is produced for installation of new equipment. Figure 1 shows a common GUI interface for outlet control actions. Many PDUs also have command-line interfaces and SNMP access for performing the same actions. Power management software such as Sentry Power Manager (SPM) by Server Technology can provide means to schedule the task of outlet control to coincide with ticketed deployments.

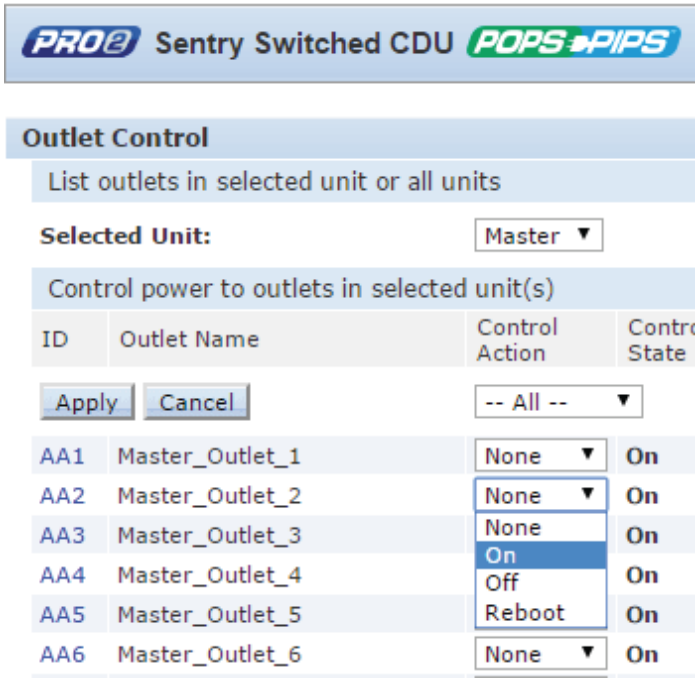

Figure 1: Outlet control from a network accessible PRO2 rack PDU by Server Technology.

Tracking

The simple, or not so simple, task of identifying installed equipment typically comes down to naming each device within an asset management system and providing information regarding the rack name, the RU slot in the rack, and the rack PDU outlets used for the power supplies. A software package to identify the equipment in this manner and provide the "lock-out" switching control should be the go-to package for the data center manager. Figure 2 shows the Cabinet Devices page from a cabinet within SPM by Server Technology. By configuring the basic characteristics of each deployed piece of equipment such as name, RU position, size, and outlets used, you can manage deployments with ease.

Bill-back

It has been a slowly growing trend (many would say "too slow") to "bill-back", or at least "show-back", power usage of particular IT equipment to various departments within an organization. Not only does this result in better allocation of budget, but has been shown to improve efficiency by forcing business units to consider the value of each piece of equipment rather than hoarding servers or storage "just in case". The Uptime Institute has been a leader in promoting the "bill-back" model and provides an excellent primer in the article *IT Chargeback Drives Efficiency*. In order to perform "bill-back" or "show-back" in practice, one must first have an energy management system gathering data from the energy consuming devices. Figure 3 shows a standard Energy Cost by Location report pulled from SPM by Server Technology. A similar report by "Zone" can be run which allows business units to be monitored through groups of Cabinets that may be spread throughout multiple locations around the world. If necessary, this same software can monitor outlet-level energy consumption per piece of equipment as well.

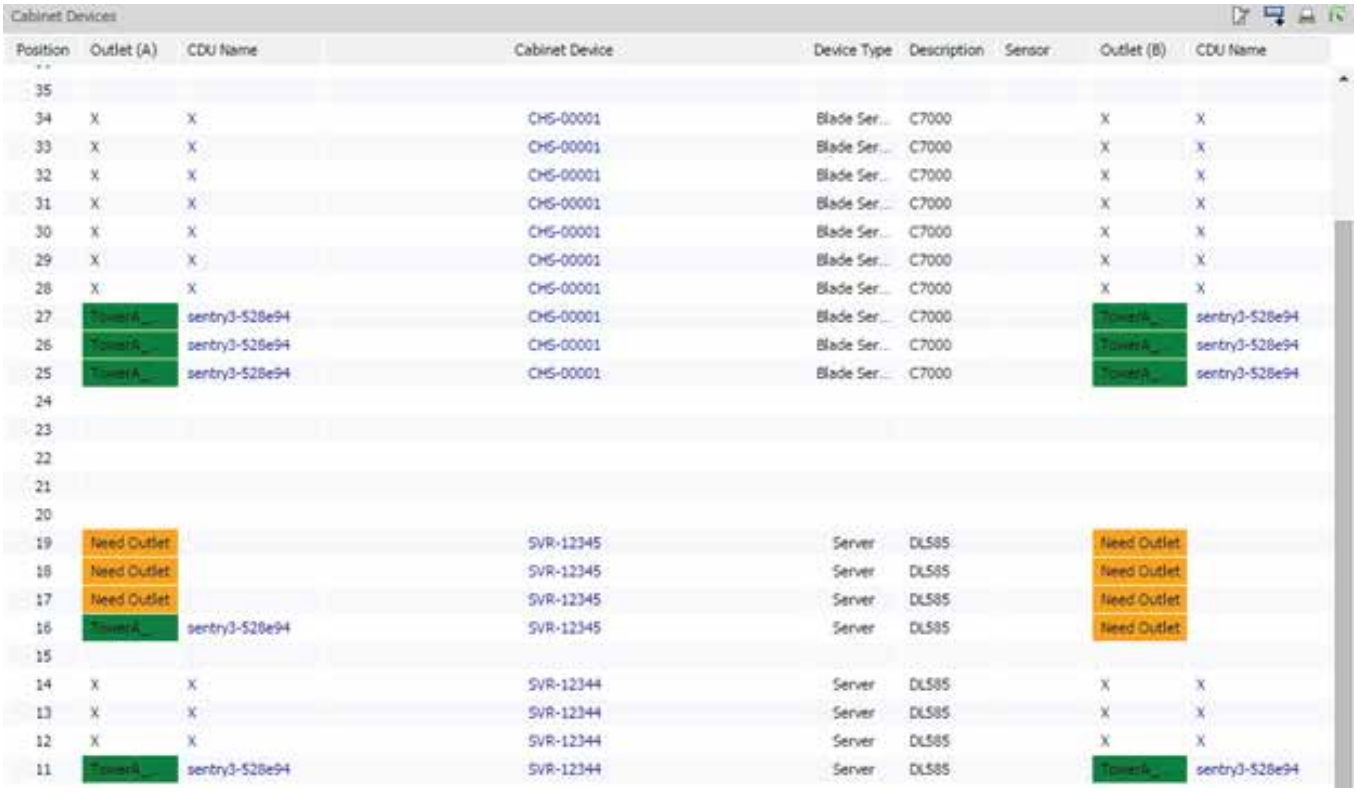

Figure 2: Cabinet Devices tab within SPM by Server Technology.

Energy Cost for Location @ Last Year

Run by sysadmin at Fri, 04 Mar 16 14:48:30 -0800

Location	Energy (kWh)	Energy Cost	Cost Unit
Ashburn	5694389.221	321732.99	USD
Mesa	6263828.143	353906.29	USD
Dublin	4555511.377	257386.39	USD
Singapore	3701352.994	209126.44	USD

Figure 3: Energy Cost report from SPM by Server Technology.

Managing Growth

It is easy to be lulled into thinking about growth simply in terms of the overall size of the data center or total number of data centers. It is not that there is no use in understanding that a particular data center is capable of 1.5 MW. In fact, it is critical to know where that data center is in terms of its utilization. The point is simply that one cannot forgo the task of understanding what is happening down at the IT device level when it comes to growth in the data center. Considering all factors of growth in the data center including density, capacity, and uptime is absolutely critical for data center management. This all starts with the equipment in the racks and the power usage thereof. With a full understanding of power usage

over time within the racks, stranded capacity will be uncovered allowing for optimizing growth within the resources already available.

Density

In the Server Technology white paper, *Managing Variable Data Center Rack Densities*, the case was made for planning the density of IT equipment within the racks over the life of the data center. We can take that a step further by recognizing the extent to which the particular equipment in each rack plays the predominant role in the overall density of power usage in the data center. Growth does not necessarily require deployment of new equipment. Figure 4 provides an example of how server utilization initiatives can affect the number of servers that can be deployed into a particular rack given a certain power circuit. In this case, 28 servers can be deployed at 30% utilization or 19 servers can be deployed at 80% utilization. In this example, growth involves adding applications to existing equipment in order to increase the utilization. This provides about an 80% performance per watt increase even though the number of servers deployed drops by about 30%.

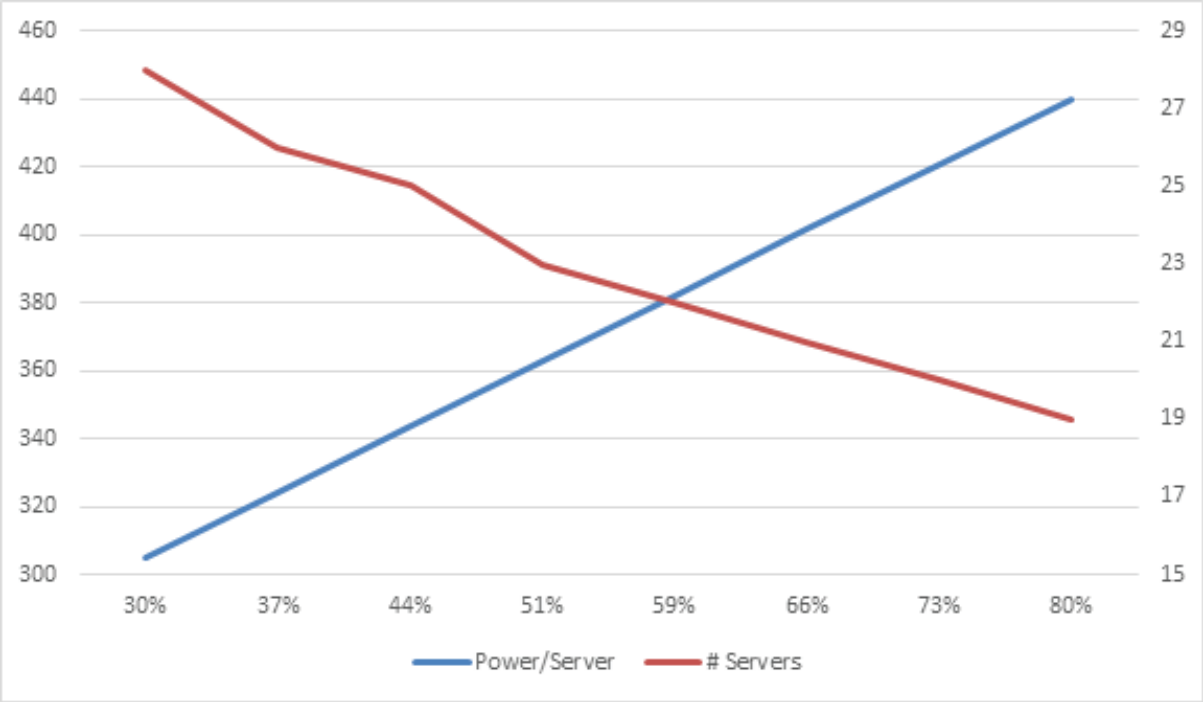

Figure 4: Power per server and Servers per rack vs. CPU usage – 30A 3-phase 208V circuit from *Managing Variable Data Center Rack Densities*, a white paper by Server Technology.

By measuring power per outlet at the rack PDU, the details of this effect can be seen. Effectively, we can say that this rack has higher power density, but lower physical equipment density. On the flip-side, newer deployments of equipment which increase physical density may or may not increase total power in the rack. These equipment trends have led to higher power rack PDUs with more outlets built for taller racks.

Capacity Planning

Planning for the growth of power usage in comparison to capacity is critical at all levels of the power chain; however, if the design is sufficiently implemented, capacity at the rack level can be predicted based on measurements of each piece of IT equipment. Figure 5 shows a Predictive Trend for Cabinet Total Power from SPM by Server Technology. In this case, simply increasing utilization of installed equipment leads to a trend of increasing power usage. More obvious stair-stepping may be seen in a growth trend that includes installation of additional equipment. Either way, a threshold limit for capacity can be set to allow for an alert based on a possible future condition. This results in an actual prediction for when a cabinet will run out of power or exceed a temperature threshold.

To add to this predictive trending based on actual utilization within a cabinet, one may use outlet power measurements for existing Cabinet Devices to help with "what-if" scenarios involving addition of similar equipment. POPS PDUs by Server Technology are one way to provide such valuable information.

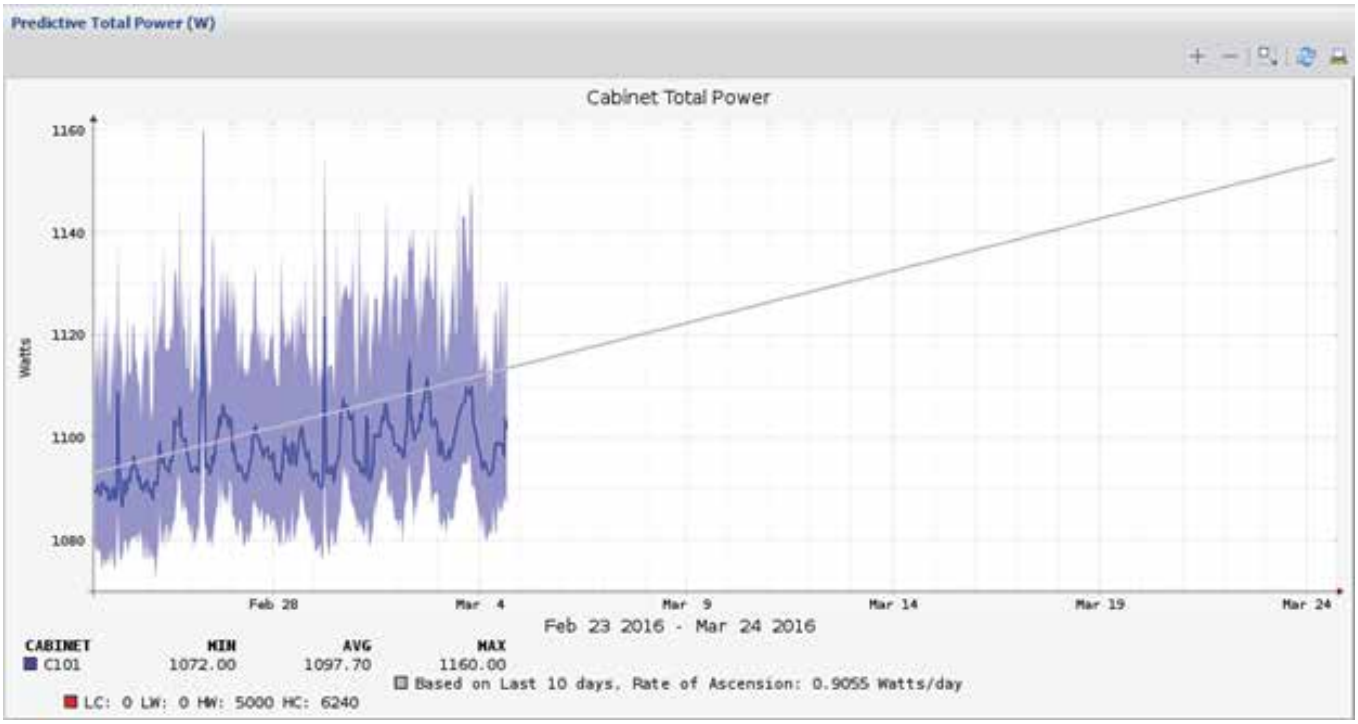

Figure 5: Predictive power trend from SPM by Server Technology.

Uptime

Regardless of the organization's data center uptime standard, few have allowances for reducing the uptime level simply because of a growth spurt. Network accessible outlet control reduces the response time to reboot locked-up equipment, especially for remote sites. Staged sequencing of outlet power after regaining lost power will help prevent surges from causing additional downtime. Of course, knowing the power consumption of individual power distribution devices over time helps gauge redundancy in order to maintain high levels of uptime. Figure 6 shows details of the power usage within a Cabinet using SPM by Server Technology. In this case, the power usage continually bounces above and below the threshold for the safety rating of the rack PDU circuits. No breakers will trip on the loss of one

Figure 6: Cabinet page with redundancy check from SPM by Server Technology.

power source, but safety compliance may be compromised. Take a look at the bar graphs in the lower left of the figure. Although the single PDUs on the “A” (left-most yellow bar) and “B” (center yellow bar) power feeds are in compliance with safety code, the “what-if” scenario where one power source is lost (right-most yellow bar) shows that it must be returned to normal function within the allowance of the electrical codes.

Managing Efficiency

Efficiency is about being “green” and keeping the “green” in your wallet. The most important reason to improve efficiency is to save money. Reduced power consumption at the IT equipment power supply level cascades all the way up the power chain and the cooling requirements. This is not just from the standpoint of basic kW-h costs, but also from the standpoint of reduced capital expenditures at deployment and as growth continues. One of many articles expressing the importance of managing efficiency is *The truth is: data center power is out of control* published by DatacenterDynamics. It highlights the Jevons Paradox which states that increases in efficiency will increase demand such that overall consumption actually increases. In the data center, that means that the power usage will increase regardless of efficiency advances. One might take that as an argument for neglecting efficiency initiatives, but that would be a grave mistake. Efficiency only becomes ever more important over time as other competitive organizations become more efficient. With that in mind, managing efficiency will take several forms depending upon the place of focus in the data center. At the racked IT equipment, that includes the choice of power supplies and the proper utilization of the IT resources. It also leaves some low hanging fruit. That of equipment being powered during off hours or when no longer being used at all.

Power Supplies

Managing efficiency at the IT equipment power supply level really takes two forms. First, power out over power in, which is the technical definition of efficiency. This is reaching a trivial point of discussion as power supply efficiencies near 95%. The second aspect is that which we might call effectiveness. This has to do with the amount of useful work returned by the equipment compared to the power usage. The Green Grid's DCeP (Data Center Energy Productivity) has been useful for understanding this effectiveness within data centers. In their March 13, 2014 memo on *Harmonizing Global Metrics for Data Center Energy Efficiency*, they reiterate their recommendation for using IT energy consumption directly at the IT load in order to calculate PUE. Though many servers have means to gather power supply performance data, most other types of equipment do not. This leaves the data center manager only one choice – get power draw and energy consumption over time from the rack PDU using outlet-level monitoring. Figure 7 shows an Energy Consumed report from SPM based on the outlet energy metrics available using POPS PDUs by Server Technology.

Energy Consumed For Locations On Outlet Readings By Day

Run by sysadmin at Wed, 16 Mar 16 14:25:18 -0700 for the time period of 2016-02-01 to 2016-02-29

Time	Location	Energy (kWh)
2/2/2016		
	DC1	10636.07
2/3/2016		
	DC1	11203.11
2/4/2016		
	DC1	10989.39
2/5/2016		
	DC1	10774.34
2/6/2016		
	DC1	11348.75
2/7/2016		
	DC1	11132.25
2/8/2016		
	DC1	10914.41
2/9/2016		
	DC1	11496.28
2/10/2016		

Figure 7: Energy Consumed report from SPM by Server Technology.

Load Shedding/Scheduling

In many organizations, fully powered data center racked IT equipment is not required 24/7. The ability to power down some or all of the equipment during un-manned hours is the most significant way to reduce power consumption and thus costs. Figure 8 shows the results of one governmental organization which determined that equipment need not run during off hours. They saw resulting power usage of their POC data center dropping by more than 50% on average over any given week.

Outlet-level control allows scheduling of such down-time through automated processes. Many rack PDUs allow access to control outlet state automatically through scripting or SNMP commands. Software packages like SPM by Server Technology can provide simple tools to group outlet control commands into a single scheduling task that can be replicated as needed based on demand hours.

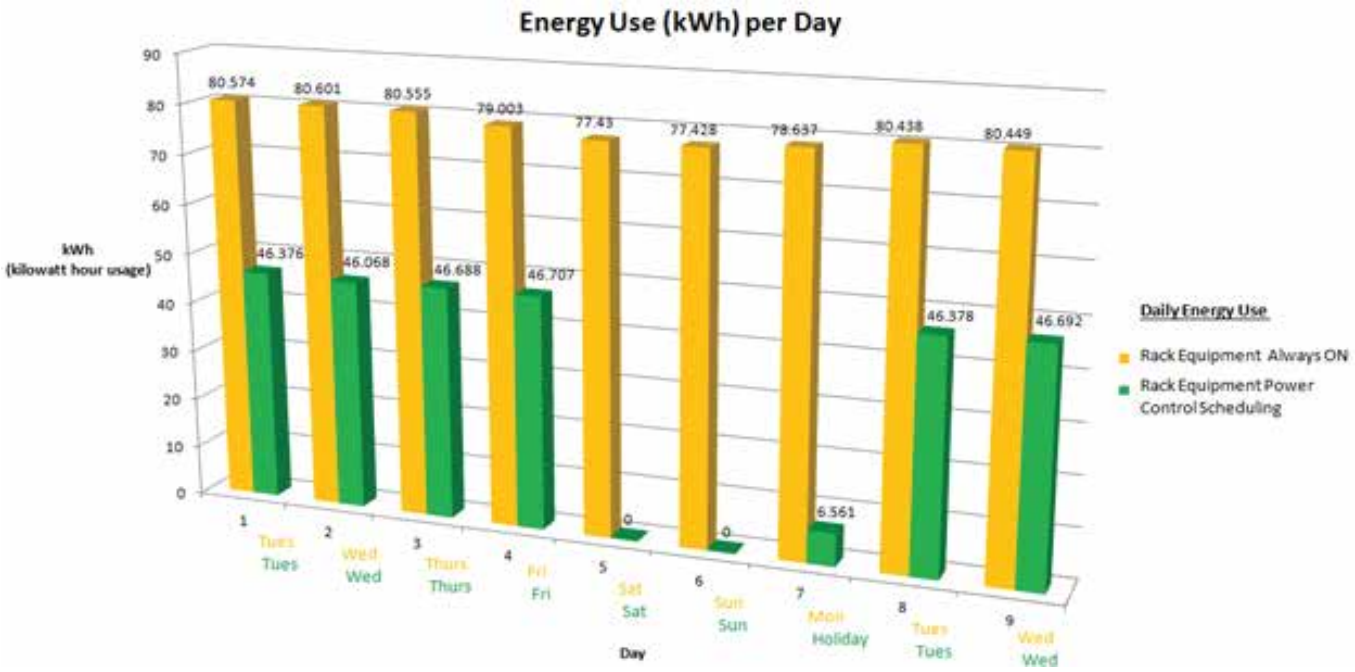

Figure 8: Real savings from scheduled outlet control.

Zombies

Even though the industry literature has long been lobbying against the waste of "zombie" servers – devices that are on but not being used – there has been little movement to reduce their impact on data center efficiency. The Natural Resources Defense Council (NRDC) provided a compelling assessment of "zombies" or "comatose" servers in its *Data Center Efficiency Assessment* of August 2014. One simple statement out of that Issue Paper stood out – "to our knowledge no IT manager has been fired for keeping comatose servers online." The authors also state that "Removing comatose equipment is proving to be more of a management and behavior challenge than a purely technical one." We agree: outlet-level measurement over time allows for an analysis of which devices remain only in an idle state and can be turned off or recommissioned. Figure 9 shows a simple trend based on Cabinet Device from SPM by Server Technology. The continuous low power usage is the tell-tale sign that this device is a "zombie".

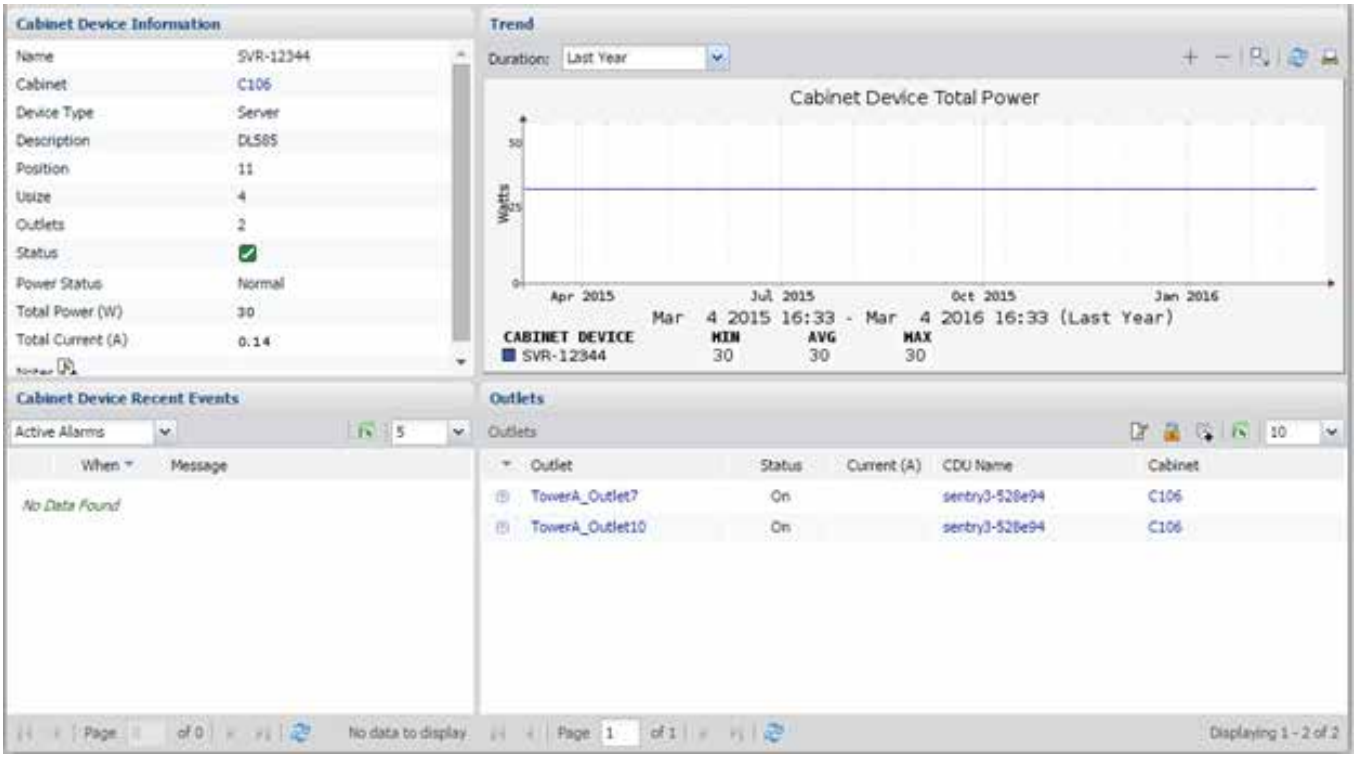

Figure 9: Cabinet Device trend from SPM by Server Technology.

Summary

A system where intelligent rack PDUs with outlet switching and outlet-level power measurement capability are coupled with a power and energy management software is a must-have in the modern data center. Switched POPS PRO2 series PDUs with SPM by Server Technology meet this need. These features help data center personnel manage the three key aspects: the IT equipment throughout their lifecycle, the growth within the data center rack, and the organizational efficiency requirements for a competitive edge through cost savings.

Stay Powered. Be Supported. Get Ahead.

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Why Server Technology

Server Technology's power strategy experts have provided power solutions for labs, data centers, branch offices and telecommunications operations for 30 years. Over 60,000 customers around the world rely on our cabinet power distribution units and award winning power management solutions to reduce downtime, facilitate capacity planning, improve energy utilization, and drive efficiency. With the best quality, best technical support and most patents, Server Technology products provide uncompromising reliability, innovation, and value for the datacenter. Only with Server Technology will customers Stay Powered, Be Supported and Get Ahead. www.servertech.com

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