Server Technology White Paper

WP

Advances in Power and Environmental Monitoring for Increasing Efficiency in the Data Center

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Overview

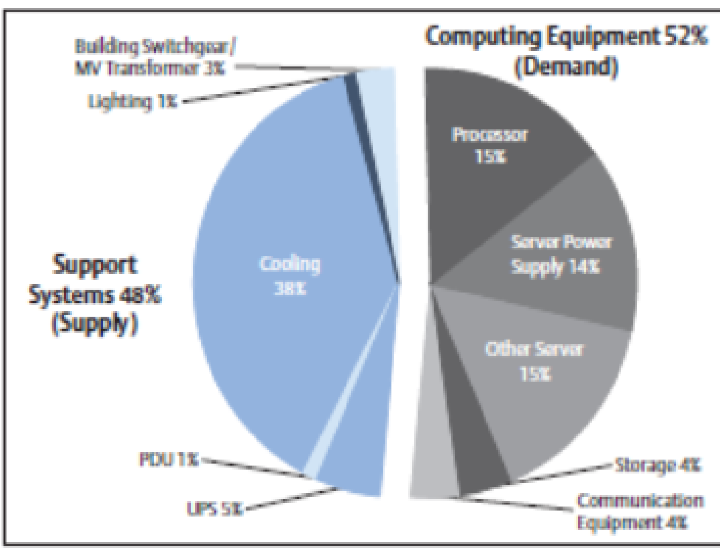
To maximize efficiency in the data center, you first have to "follow the money" which means understanding where the bulk of your costs are and determining how to best maximize those resources by increasing efficiency and therefore reducing costs.

When operating a data center, it is clear that the high cost items are the power and cooling. You hear a great deal of industry talk about increasing data center efficiency with conclusions typically being drawn like "just operate your facility at higher temperatures", use "free cooling" to reduce cooling costs, implement "virtualization and consolidation projects" to reduce power consumption, determine which servers are zombies and turn them off, or use capacity planning to decide where to install new devices.

These are all valid and useful points, but without proper monitoring tools in place to understand where your power is consumed or where there are hot spots, these goals can be difficult or even impossible to accomplish. Also, without the ability to fully understand the value, or possible harm caused when changes like these are made within the data center's ECO system, you could run into real problems when making these changes without fully understanding the consequences.

This white paper will "follow the money" and show where the power is being used within your data center facility, along with the effects of changes like increasing the overall temperature within your data center. The challenge is to balance the desire to be more efficient against increased power densities, uptime, and redundancy goals within the "physical infrastructure" of the data center.

The following graphic from Emerson Network Power[1] shows that demand-side computing equipment accounts for 52% of the energy usage in a data center.



Category	Power Draw*
Computing	588 kW
Lighting	10 kW
UPS and distribution losses	72 kW
Cooling power draw for computing and UPS losses	429 kW
Building switchgear/MV transformer/other losses	28 kW
TOTAL	1,127 kW

Figure 1. Demand-side computing equipment accounts for 52% of energy usage

This illustration from Lawrence Berkeley National Laboratory also notes that power used at the compute load is 51% of the total amount of power used in the data center.

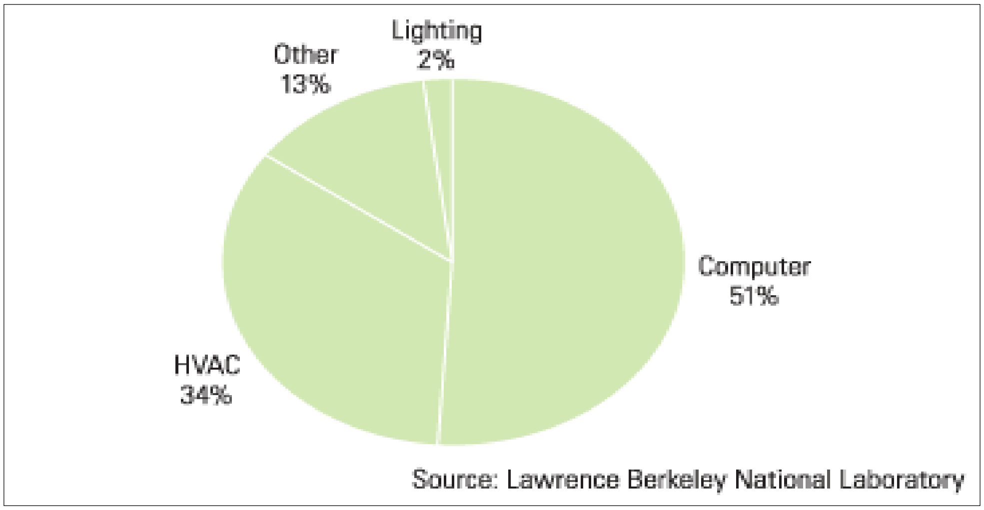


Figure 2. Power used at the compute load is 52%

Figures 1 and 2 confirm that more than half of the power in the data center is used at the IT load or within the data center equipment cabinet or rack (typically anywhere from 40% to 55% of power usage within a data center). In addition, the IT load is by far the largest source of heat, making these two areas the obvious targets for increasing efficiency and lowering costs. In fact, the equipment cabinet can be thought of as its own unique ECO system in the data center.

This white paper explores power and environmental monitoring in the data center, describes new cabinet power distribution technology and control, shows how these technologies are being used, and presents industry standards and recommendations for how all this fits into your physical infrastructure. Most of all, this paper shows you how to increase your efficiency using these solutions.

Power Monitoring: Do you really understand your power usage?

It is interesting that the power chain is measured and monitored in multiple locations throughout most data centers, but is often forgotten once the power enters the data center cabinet. This is especially notable considering that roughly half of the power used can be traced directly to the cabinet, as illustrated in Figures 1 and 2. Further, power is typically one of the greatest single costs associated with operating a data center.

Often monitoring at the cabinet is the invisible line between the IT and Facilities groups. Even though monitoring at the infeed of the Cabinet Power Distribution Unit (CDU) is really the same as monitoring at the Remote Power Panel (RPP), as the branch circuits coming out of the RPP are the infeeds to the CDU. Of course you do not account for losses in the lines if you measure at the RPP instead of measuring directly at the equipment cabinet.

Intelligent PRO2 CDUs provide power monitoring at several different levels that reach well beyond the cabinet itself. Not only can you better understand your power infrastructure, there are multiple opportunities to increase efficiency and ensure uptime as well.

Power monitoring discussions often center on the servers themselves, as there are several ways to get power usage information from these devices. Typically, this involves using multiple communication platforms or tools, depending on the server's manufacturer. Of course the data center manager has to treat each cabinet as its own independent infrastructure/ECO system, and there are several things to consider:

- Many devices are installed in the cabinet along with the servers.
- Environmental information like temperature and humidity is most valuable when measured external to the devices in the cabinet.
- Overall power usage of the cabinet determines the amount of cooling required.
- Overall power usage of the cabinet is the key information needed to understand redundancy and capacity planning, and to locate stranded capacity.
- The overall IT load is one of the two measurements needed to compute Power Usage Effectiveness (PUE).
- Device-level measurements at the power supply of the server allow you to determine utilization, know the power usage of the entire device, determine if a power supply is failing, and locate zombie servers (servers doing no useful work).

Power Monitoring Solutions Using PRO2 CDUs and Why

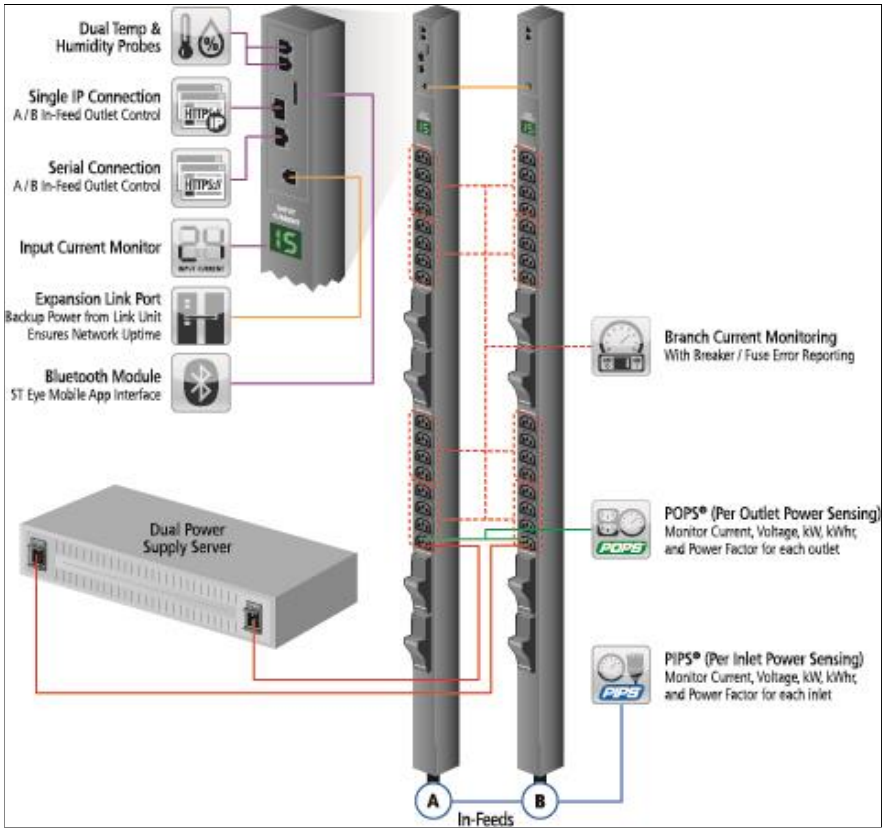


Figure 3. Power Monitoring Using PRO2 CDUs – PIPS, POPS, and Branch Current Monitoring

Infeed Monitoring of the PRO2 CDU with Per Inlet Power Sensing (PIPS)

The power cable whips coming out of the Remote Power Panel (RPP) are typically called branch circuits and are the power infeeds into the CDUs. At this point in the power chain, you can determine the amount of power used within each cabinet, the amount of available power for new devices, and you can begin to understand key items like capacity planning and identifying stranded capacity. With software tools like Sentry Power Manager (SPM), the cabinet-level information can be used at the cabinet, zone (a group of cabinets), or location level.

Sometimes this information is monitored by Facilities at the RPP, but this information usually ends up in a Building Management System (BMS) for which the IT group often does not have access. Therefore, PIPS measurements are popular when purchasing CDUs, and are used by both Facilities and IT. In fact, the IT group often has an interest in these measurements because the Facilities group typically does not share monitoring information from the RPP – if power measurements are even taken at that point in the power chain. (See Figure 3.)

Branch Current Monitoring of the PRO2 CDU

Per the UL 60950-1 standard, CDUs rated for more than 20 amps must provide some form of an over current protection device (OCPD) within the CDU. Typically, these are either circuit breakers or fuses, with each type of OCPD having its own advantages and disadvantages. Each branch circuit must be protected at 20 amps per this UL standard.(See Figure 3.)

Typically, in a properly designed CDU, the number of branch circuits and their ratings relate directly to the power infeeds coming into the CDU, so that the CDU is capable of delivering all the power to the load that is being provided at its power infeed.

The key for this information is making sure that at no point does the amount of current drawn exceed the rating of the OCPD, which would take down the branch circuit, the connected devices associated with that branch, and in some cases, the upstream breaker (which would take down the entire CDU). This situation is a common occurrence when using circuit breakers and not doing a coordination study of the OCPD breaker and the upstream breaker at the panel.

To ensure the branch circuit is not overloaded, the current load is measured at each branch and provides both Low Alarm/Low Warning, as well as High Warning/Hi Alarm user-set thresholds.

For more information, see white paper STI-100-003, *Features and Benefits of Implementing Server Technology CDUs in Your Data Center*.

Outlet/Device Monitoring on the PRO2 CDU with Per Outlet Power Sensing (POPS)

Power monitoring at the outlet-level is growing rapidly within data centers as power monitoring increases overall and users better understand the value of the information they are getting. Often monitoring at the outlet in and of itself is not that interesting unless you are looking for a power supply failure, usually shown by the power factor going down, and also depending on the type of power supply failure.

Outlet-level monitoring of more than one outlet can be directly related to a particular device or server. Device power information has value because it helps you look at the power consumption of a group of similar devices and determine which devices are doing useful work and which ones are just sitting idle and wasting power. This approach is often much more feasible than unplugging the network cable on a device and waiting for an angry user to email or call IT support.

Often multiple devices or servers can relate to the power usage of a particular application or group within your organization. This information is also valuable if your organization has considered billing back to different departments for their power usage as a way to reduce costs. Most departments want the world until they are told that they have to pay for the resources they are using. (See Figure 3.)

Capacity Planning

A number of problems can be solved if you know how much power your cabinets require and how much power is available. Common terms used today to describe this information are *capacity planning* and *stranded capacity*. Knowing the IT load is also a key parameter in power efficiency metrics like the Power Usage Effectiveness (PUE) parameter created by The Green Grid. http: //www.thegreengrid.org/

Knowing the amount of power used in a cabinet and rolling up this information into groups of cabinets that Sentry Power Manager (SPM) refers to as *zones*, or by rolling up power information into locations, a number of key metrics are available for decision-making:

Monitoring at the Cabinet Level:

- Knowing power usage lets you identify potential hot spots within your data center.
- Knowing the amount of cabinet power usage also lets you run reports to identify cabinets that have the power and space availability for new devices to be installed.
- You can also determine which cabinets have either exceeded their capacity or will exceed their capacity at some future time period, based on the current growth rate. Again, using SPM and its Predictive Trending tools for both power and temperature allows you to get reliable estimates, based on past growth, as to when power or cooling thresholds will be exceeded.

Monitoring at the Zone Level:

- Knowing power usage at the zone level (by rolling up cabinet-level power monitoring) lets you compare power monitoring information obtained from the UPS or RPP against actual usage at the devices.
- This information can also be used to determine how many additional cabinets can be installed within a zone, since power trends and reports provide the worst case power load levels for planning purposes.

Monitoring at the Location Level:

- Knowing the power usage per location helps with planning and allocation of new cabinets, such as how many more new cabinets can be supported based on either the current infrastructure or adding a new infrastructure.

Stranded Capacity

In many cases data centers believe that they are out of power or maybe approaching this threshold, but they base this belief on allocated power, and without monitoring they really don't know for sure if there is a problem. Power is often allocated but not used at many data center facilities, and many co-location facilities count on the fact that many power whips are underutilized.

Monitoring power usage and understanding whether there is additional capacity in the current facility versus the huge costs of building a new facility, or adding additional capacity at a co-location facility, can have significant ramifications within the organization.

Not only do you have to look at the cabinets equipped with intelligent CDUs, but you also have to take into account cabinets like Storage Area Network (SANs) that may or may not be monitored, so you can fully understand your overall power usage.

In these cases, you can either input a fixed load for one of these devices to ensure that its power usage is included in the overall totals within SPM, or install power usage monitoring devices in-between the SAN and the power infeeds.

Power might be stranded for a number of reasons, including not enough cooling to support additional equipment, or not enough U space within the cabinet. Though it is often the case that as large data centers grow over time, there is insufficient planning and a misunderstanding about the amount of power required for all the devices – especially if the data center has undergone multiple updates. Only by truly knowing the existing load compared to the amount of available power does it become clear what the stranded capacity is within your data center.

Environmental Monitoring and Management: What are the effects of increasing the temperature?

How much money do you save if you run your data center at higher temperatures? Studies show that data centers can save 4% to 5% in energy costs for every 1° F increase in server inlet temperature.[2] More conservative estimates show that raising the temperature setting 1.8° F (1° C) will save 2% to 4% on the overall energy use of a data center. [3]

However, higher inlet temperatures can in some cases cause the internal server fans to increase their speed in order to cool the server down and this could potentially negate any savings by running the data center facility at higher temperatures.

One other item to consider is that though air containment solutions like hot aisle containment will allow you to run at higher temperatures, there can be drawbacks. For example, if you were to run at the higher end of ASHRAE's operating range in the cold aisle, say (80.6° F), the hot aisle temperatures would be roughly 105° F to 110° F, leading to some uncomfortable working conditions in the hot aisle.

Another item that has been debated is how do higher temperatures affect the life of the server, as any energy savings could be negated by increased device failures and reduced uptime. Overall studies have found that data centers can realize cost savings with minimal effect on IT equipment reliability and availability.[4]

The following list, from Data Center Knowledge[3], shows "The Top 7 Reasons Why Data Centers Don't Raise Their Thermostats."

7. Some HVAC Equipment Can't Handle Higher Return Air Temperatures

6. Co-Location Data Centers Have To Be All Things To All People

5. Fear, Uncertainty, Doubt (FUD)/Ignorance

4. Intolerable Work Environment

3. Cultural Norms and Inertia

2. Concern Over Higher Failure Rates and Performance Issues

1. Thermal Ride-Through Time

The following ASHRAE table presents the recommended and allowable ranges for temperature and humidity:

	Recommended		Allowable	
Year	**2004**	**2008**	**2004**	**2008**
Temperature Range	20-25 C	18-27 C	15-32 C	10-35 C
Moisture Range	40-55% RH	5.5 C DP – 60% RH	20-80% RH	20-80% RH

Table 1. ASHRAE 2004 and 2008 Environmental Guidelines

How long do you have to react if there is a cooling problem?

It is clear that raising the inlet air temperature is a great way to increase efficiency. ASHRAE TC 9.9 Mission Critical Facilities, Technology Spaces and Electronic Equipment has increased both the recommended and allowable temperature ranges each time the standard has been updated, as shown in Table 1. While ASHRAE studies show that increased temperatures don't result in radically increased fan operational costs[5], there are clearly some cost increases in that the fans do run longer and more often.

Also studies by DELL[6] and others show that servers seem to live just as long under increased temperatures, while other studies by ASHRAE[5] and The Green Grid[4] show that there are only moderate increases in failure rates of servers operating at higher temperatures. So, with a typical 3-5 year server refresh rate, and the devices living just as long, why would you not run your data center a little warmer?

One of the biggest questions here is that when higher operating temperatures were first being discussed, the downside was always that if there was a failure in the cooling system and the data center was operating at higher temperatures with increased power densities, that the time to react before there was equipment damage could be as short as one minute or less.

If there is a failure in the cooling system, you don't have enough excess cooling capacity to carry the load, and this greatly shortens your reaction time to deal with any problems that come up. This may not be as big a concern as it used to be, or maybe something changed to help minimize the risk, but this topic now seems to be a non-issue, as lately there is little or no discussion about it. However, know that without chilled water in reserve or another means of available cooling capacity, care should be taken when operating temperatures are increased.

Intelligent cabinet power distribution units and software monitoring tools allow these facilities to easily report and trend on power usage per multiple locations and temperature measurements, within both the back and front of the cabinet. Therefore, this gives the IT group an idea of where any potential hot spots might be located, as well as knowing the ability of the cabinet to support additional hardware. For more information about the current and past ASHRAE environmental guidelines, see Table 1.

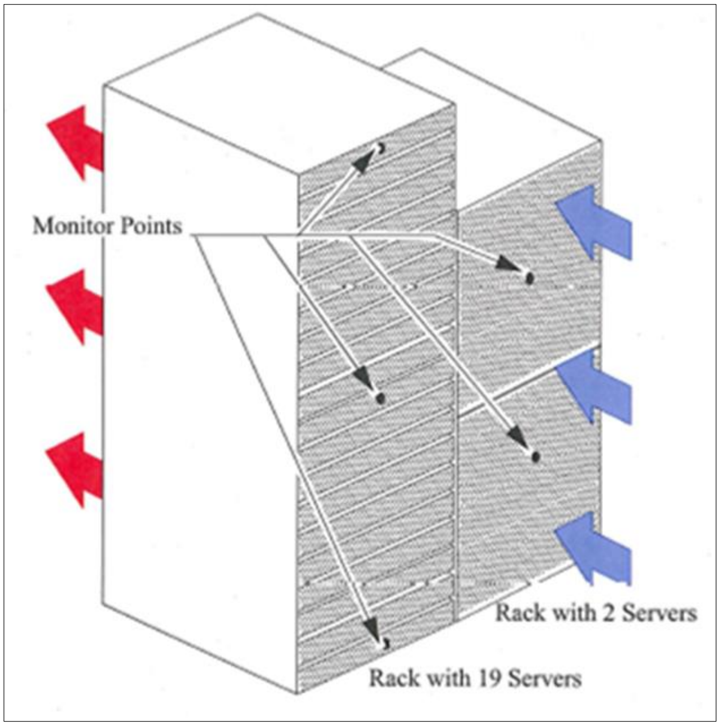


Figure 4. ASHRAE – Recommended Monitoring Points for Configured Racks

Server Technology's PRO2 Cabinet Power Distribution Units (CDUs) allow two temperature and two humidity probes to be connected to the master unit, and the same number of probes to be attached to the link unit, as illustrated in Figure 3. The probes are on 10-foot cables so they can be run to any location within the cabinet, allowing you to meet the ASHRAE guidelines for environmental monitoring, shown above in Figure 4.

As mentioned earlier, one of the key ways that data centers are saving power is by running their devices at higher temperatures. Running at higher temperatures requires closer environmental monitoring and controls to do this safely.

For more information, ASHRAE offers updated guidelines, both on how and what to measure at the data center cabinet: "ASHRAE TC 9.9 – 2011 Thermal Guidelines for Data Processing Environments – Expanded Data Center Classes and Usage Guidance."

Physical Infrastructure – Redundancy and Uptime

The entire physical infrastructure in a data center is designed around redundancy. Typically, two CDUs are placed in each cabinet and in a perfect world, each CDU is powered by a separate and independent utility power source, typically known as a Tier 4 data center configuration, shown in Figure 5.

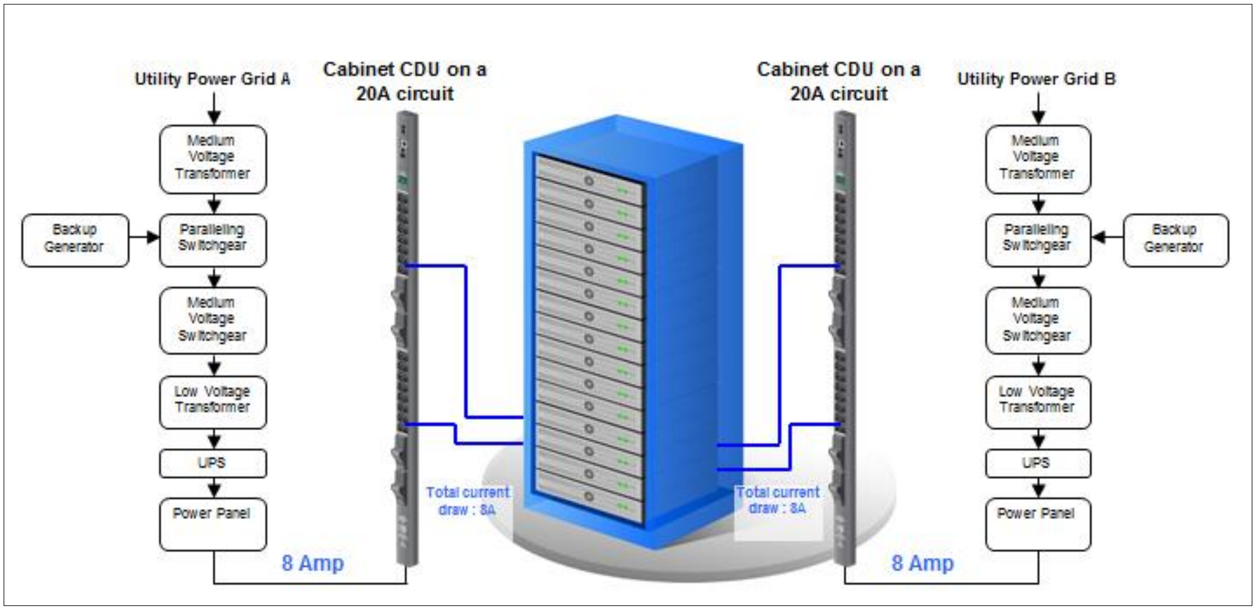


Figure 5. Example of Cabinet Redundancy

In this example, each 20 A circuit is loaded to a total of 8 A. When Circuit-A is lost, the total load on Circuit-B is 16 A, which will not cause a secondary failure. To provide power redundancy for critical systems, the total power capacity at the rack level will need to be at least two times the amount of power consumed by the devices.

Just because a data center has two power infeeds (from different sources) there is no guarantee that the cabinet is cabled properly and therefore truly redundant. More often than not, work tickets are submitted because someone has installed a new device in the cabinet and powered it improperly by plugging both power supplies into the same power source.

Common tests for cabinet redundancy include failing one of the power infeeds and seeing if the other source is capable of supporting the whole IT load. Other ways are to either measure the loads with a clamp meter, or to compare current load readings from a metered CDU. These can be labor-intensive processes and they are not without issues if the devices are cabled improperly.

One way to avoid problems is to use Sentry Power Manager (SPM) software which has a cabinet redundancy feature check to help ensure that if the cabinet is not redundant you are warned in advance so the appropriate action can be taken. This avoids downtime and also the hassle of other time and labor-intensive ways of checking to see which cabinets are redundant.

Monitoring power (at multiple locations) and temperature/humidity within the physical infrastructure requires DCIM-like tools to make sure you get the maximum value from your intelligent PRO2 CDU purchase.

Uptime

As part of your critical physical infrastructure we know how important it is to deliver reliable power within the data center cabinet.

PRO2 CDUs help ensure uptime with new and unique features and design:

- Redundant power from the link unit guarantees network communications are never lost even if power has failed or is disconnected from the master PRO2 CDU.
- When linking multiple PRO2 CDU's a failure of any link unit will not affect the functionality of the other link units.
- After 30 years in business, as power experts, we know power and the conditions that our CDU products are expected to operate under. This has led to extensive testing of the PRO2 products:
  - Reliability Demonstration Testing of all critical components
  - Environmental Testing
  - Power Line and Load Switching Transient Immunity Testing
  - Communications Integrity Testing
  - Safety Agency and Compliance Testing
- Extensive environmental testing with all products rated to a minimum of 60 C

Taking Action to Increase Efficiency

Today it is clear that increasing efficiency is important for many reasons, such as cost savings, meeting corporate edicts to save power and be more green, reduce carbon footprints, or to be seen as a more socially-responsible organization. It is also clear that any money spent in these efforts must have a clear ROI as organizations are not becoming green just for the sake of being green.

These initiatives are also gaining more exposure in many large organizations as they have now added "C" level positions with titles like Energy and Sustainability Program Manager, Safety and Sustainability Manager, and Environmental and Sustainability Engineer. So whether or not you are taking steps to be green, the chances have gone up dramatically of your having to explain what initiatives you have in place to address increasing efficiency.

The mantra first coined by The Green Grid, "You cannot improve what you are not measuring" has never been truer than it is today. A number of organizations have been ahead of this curve and have not only been measuring and monitoring but also using software tools to make these large amounts of data usable and adding value to their organization. Accurate data is critical to effectively running a data center and data that you can use for decision-making is invaluable. Reports, trending, and predictive trending analysis, based on accurate power and environmental information, is key to increasing efficiency and solving other problems like capacity planning, as well as identifying zombie servers in your data center.

LEED Certification

The dominant organization in building performance assessments is the United States Green Building Council's – Leadership in Energy and Environmental Design (LEED) at www.usgbc.org with about 47,000 commercial and institutional projects now underway in 50 states and 120 countries. Many jurisdictions now offer tax credits and other incentives for new construction and retrofit projects incorporating LEED design and construction principles, from government buildings and skyscrapers to neighborhoods and single family homes.

New LEED v4 with Additional Performance Management Features

LEED v4 as the successor to LEED 2009 (which remains in effect until June 1, 2015), provides additional performance management features to help projects measure and manage energy and water use with finer granularity. LEED 4 also includes new market sector adaptations for data centers, warehouses, distribution centers, hospitality, existing schools, and existing retail and mid-rise residential projects. Other changes in LEED 4 include revised credit weightings, better ease of use, increased technical rigor, and increasing energy efficiencies across the board.

Listed below are the Energy and Atmosphere (EA) and Water Efficiency (WA) credit areas that are new to LEED v4, in which metering and other energy data collection devices will now be needed[7]:

- ***Building Level Energy Metering –*** Intended to support energy management and identify opportunities for additional energy savings by tracking facility-level energy use. This new EA prerequisite impacts a broad range of facility types under the Building Design and Construction (BD&C) and Existing Building Operations and Maintenance (EBOM) rating systems. Requires permanently installed metering capability of aggregating whole facility energy use, including electricity, gas, water, steam, chilled water, BTU, and more. This new prerequisite requires minimum monthly or utility billing period interval data of consumption (kWh) and demand (kW). Data must be shared with the USGBC for five years, with certain caveats applying. Applicable to BD&C and EBOM, the latter system also accepts manual or remote meter readings and requires monthly and annual summary data reports.

- ***Advanced Energy Metering –*** Similar in intent to building level energy metering objectives, the Advanced Metering credit raises the bar by requiring substantially greater granularity of meter data across a range of BD&C, EBOM, and Interior Design & Construction (ID&C) – impacted facility types. In addition to whole building metering, **any particular energy use representing 10 percent or more of the facility total must also be metered**. Moreover, the Advanced Metering credit **requires the permanent installation of meters capable of 60 minutes or less consumption (kWh) and demand (kW) interval data, remote communications and interface capability to a LAN, building automation system, wireless network, or other advanced communication infrastructure**.

- ***Demand Response (DR) –*** Intended to increase participation in DR technologies that make energy generation and distribution systems more efficient, increase grid reliability, and reduce greenhouse gas emissions. Impacting the BD&C and EBOM rating systems, points are given based on the level of implementation, for example, 1 point for “not available but has infrastructure in place” and 3 points for “actual participation in a DR program.”

- ***Water Metering –*** With the same intent as above for BD&C projects, a WE credit is given for permanently installed sub-meters to monitor two or more of the following water subsystems: irrigation, indoor plumbing fixtures and fittings, domestic hot water, boilers, reclaimed ware, and other process water.

- ***Building Level Water Metering –*** Intended to support water management and identify opportunities for additional water savings by tracking consumption, this new WE prerequisite impacts BD&C and EBOM ratings systems.

Metering tools available today on devices like intelligent PRO2 CDUs provide power metering that will give you additional LEED credits toward your LEED certification.

Circuits – used for 3-Phase load balancing

Many organization are up against higher cabinet power densities and the need to increase efficiency. This has resulted in not only an increase in the number of cabinets running 3-phase power but also 400 V 3-phase power (like the rest of the world is currently doing by delivering 230 V power to the devices in the cabinet). There are many white papers that discuss these solutions and the efficiency advantages of running at higher voltages, and we offer several 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.

Within the Sentry Power Manager (SPM) software system, you are allowed to create circuits based on the infeeds from our CDUs, which are the branch circuits coming from the Remote Power Panel (RPP). This feature lets you combine these CDU infeeds by zone – which in your data center translates to a specific PDU, UPS, and RPP. Once a circuit is created, you can easily see if you are in or out of balance. Since there are a number of different power types and levels coming from the RPP, and just because you are phase-balanced at the cabinet in no way implies that you are also load-balanced at the RPP.

The SPM Circuits module lets you plan, track, and manage the physical infrastructure of power systems feeding one or multiple CDUs. The Circuits module provides a summarized view of the defined circuit layout in your data center, as shown in Figure 6. SPM considers a circuit to be a full power line to the data center, either single phase, dual phase, or 3-phase, as you define the circuit.

Since a circuit tracks lines of power across multiple devices, the Circuits module 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. You can see this effect reported in trending over time in the Trend graphs, which assists in assigning thresholds for real-time warnings. You can use circuit trending for aggregated power to analyze 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.

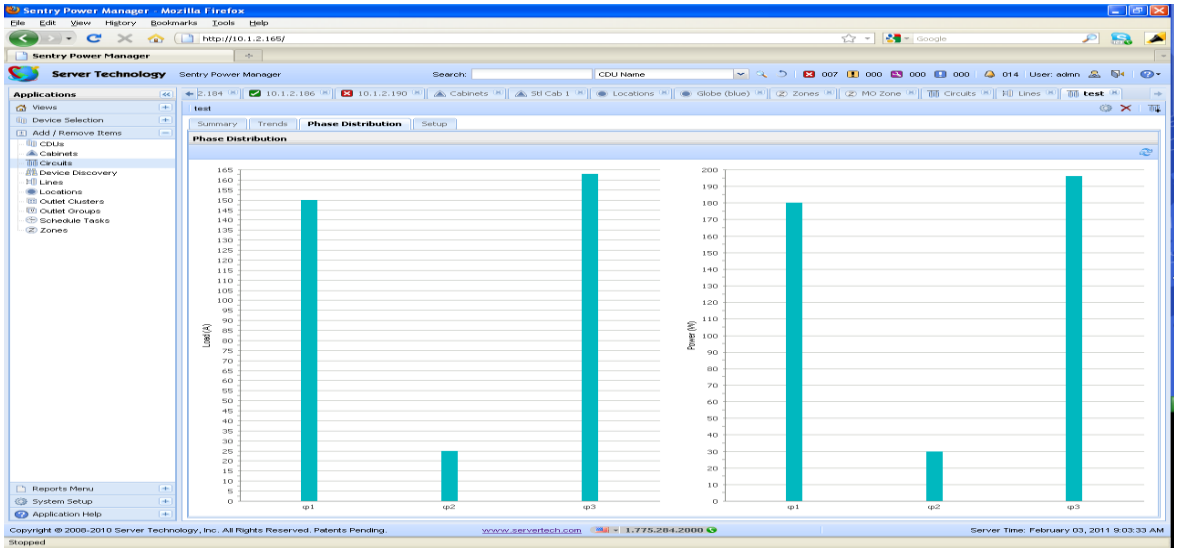


Figure 6. Circuits – 3-Phase Load Example

Locating Zombie Servers

We have heard about the typical level of server utilization within a data center being somewhere in the 15% range, depending on what source you reference. It is also 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. That is why we have seen so many virtualization and consolidation projects today. This is a trend that 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.

PRO2 CDUs today using our Per Outlet Power Sensing (POPS) in combination with Sentry Power Manager (SPM) allow our users to identify like-devices and what their power loads are to quickly and easily determine 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 know when devices are sitting idle for a period of time. The Outlet Low Usage report provides the total energy usage in kilowatt-hours over a user-specified period of time for any outlet that continuously remains below that threshold. Such outlets might indicate zombie devices that do nothing but waste power.

Scheduling to save power (Switched PRO2 CDUs)

Modern software systems like Sentry Power Manager (SPM) come with a number of features and functions to help organizations monitor, manage, and control power and environmental information within the data center. The Scheduling feature more importantly allows you to schedule backups, database maintenance, device discovery, email reports, email trends, outlet actions, outlet clusters, and outlet groups. Outlet control actions, based on a schedule, allow you to automatically shut down specific devices at specific times to save energy and then bring them back online when needed.

Shutting down devices to save energy is something that even a couple of years ago would be unheard of for fear that the devices would not come back on and available. However, today with edicts on government organizations to reduce power consumption, and businesses looking for innovative ways to save money and power, these types of solutions are starting to see the light of day with new legislation coming into effect to help drive these efforts.

For government organizations, the following laws have made energy savings not only a priority but a requirement:

Energy Policy Act 2005 (sec. 102, 104, 109)
Date Enacted: 8/8/2005

Executive Order 13423
Date Enacted: 01/24/2007, Date Effective: 01/24/2007

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

Executive Order 13514
Date Enacted: 10/5/2009, Date Effective: 10/5/2009

Some early testing with one high level government security agency has shown a 40% to 60% savings in energy by shutting down devices not in use in the data centers for defined time periods. See the SPM Scheduling Calendar below in Figure 7.

These same principles can also be applied at many global technology companies that run large lab facilities for integration and compliance testing. Some utilize this equipment 24-7 as they allow groups from other countries to operate the equipment at night while the local groups operate the equipment during the day.

For most organizations only a portion of the equipment is operated at any one time in these labs, so why keep it powered up and running 24-7 if it is not being used?

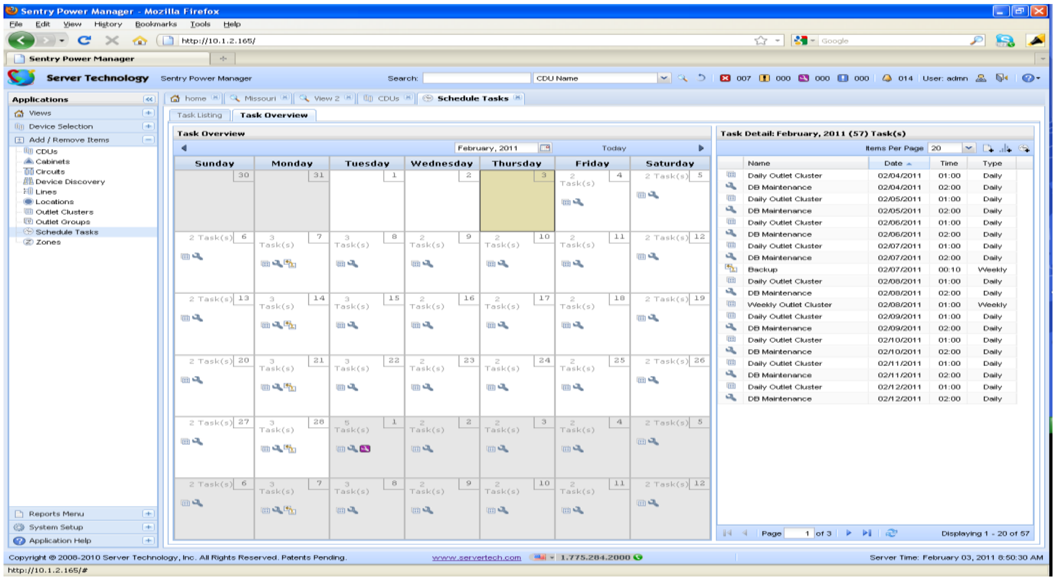


Figure 7. Example of SPM Schedule Calendar – Task Overview

The Overall Monitoring ECO Structure/DCIM and BMS Software

How are customers using monitoring solutions and software tools, including Data Center Infrastructure Management (DCIM) solutions? (The most popular items are listed at the top.)

- 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
- Identifying comatose servers and devices
- Cooling optimization
- Airflow and Computational Fluid Dynamics (CFD) modeling
- Cost modeling, forecasting, and allocation

There are hundreds of DCIM software solutions on the market today with each one having various strengths and weaknesses, and this does not even include Building Management Systems (BMS) and other software solutions that are also currently in data centers around the globe.

There is no product on the market today that we are aware of that does everything well. SPM has the ability not only to provide large costs and time savings for IT and Facilities, but it also has the ability to export power and environmental information via an open Application Programming Interface (API) to other systems in the data center infrastructure.

So, if you are using a DCIM or BMS and want to import information to these systems for your "single pane of glass view" it is a simple and straight-forward process, as illustrated in Figure 8.

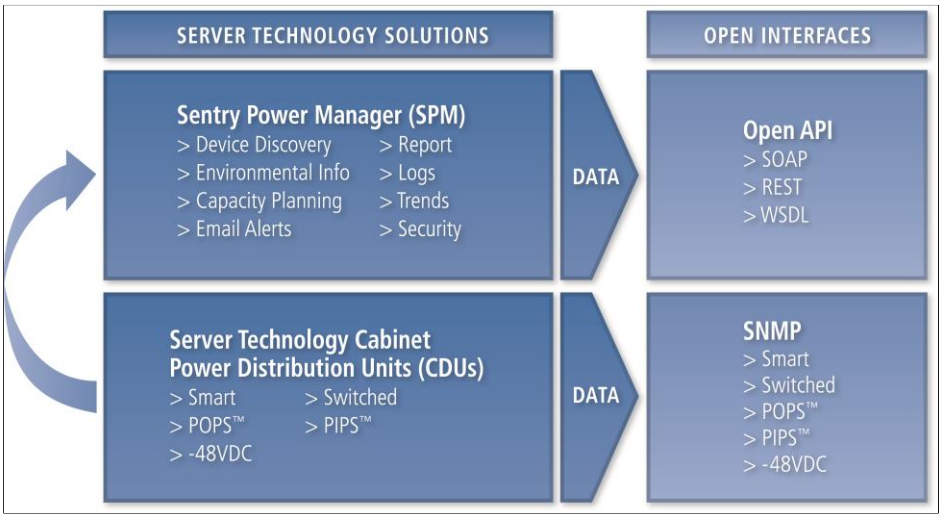


Figure 8. Data Export to DCIM and BMS System

Key power and environmental information is available several different ways but a common method is directly from the CDU via SNMP, if SPM is not available. See Figure 8.

If SPM is being used, then it can provide CDU updates and configuration along with power and environmental monitoring, management, and control. SPM can also export this information using XML-based tools like SOAP and REST, using our open API.

Summary

Power continues to be either the top concern for most IT organizations or in their top three concerns when they list their current challenges. This relates to increased densities as organizations try to keep up with greater and greater demand for computing and storage, higher power costs, or the cooling challenges that are a result of these increased densities. Either way, power cost and availability will continue to drive efficiency within each data center organization for the foreseeable future.

Without the proper monitoring tools in place, you have no idea where you are going as you have no idea where you have been. Solutions that incorporate both hardware (PRO2 CDUs) and software tools (like SPM), which have “grown up” together and are tightly integrated through years of experience and hundreds of installations, typically provide the best results and information.

Continued innovation, not only in advanced monitoring tools but how the information is used, is a must. This innovation is seen every day in the solutions and results being delivered by the tools discussed in this paper, but it is up to you to leverage them to get the maximum value.

Additional PRO2 CDU features include:

- 60 C Rating
- Swivel Power Cord
- Auto Inverted Display
- Locking Outlets
- Branch Current Monitoring
- Redundant Power for Network Card
- Field Replaceable Network Card
- Warning/Alarm Threshold Levels
- OCP Fault Detection Smart Units
- On-Board MIB
- User Can Use Own Security Keys
- Outlet Identification on Smart Units
- Bluetooth® Support
- HDOT Outlet Technology (optional)
- Linking of 4 Units Using 1 IP (see figure 9)

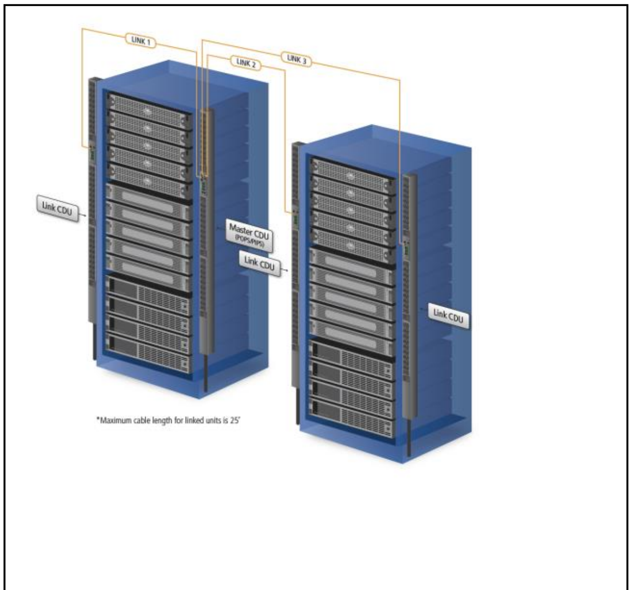


Figure 9. Linking of Multiple PRO2 CDU’s

References

1. Emerson Network Power, White Paper – "Energy Logic: Reducing Data Center Energy Consumption by Creating Saving that Cascade Across Systems".

2. ENERGY STAR: "Server Inlet Temperature and Humidity Adjustments" http://www.energystar.gov/index.cfm?c=powermgt.datacenterefficiencyinlettemp

3. Data Center Knowledge (Industry Perspectives posting, October, 2013), "Top 7 Reasons Data Centers Don't Raise Their Thermostats". http://www.datacenterknowledge.com/archives/2013/10/22/top-7-reasons-data-centers-dont-raise-their-thermostats/

4. The Green Grid, White Paper #50 – "Data Center Efficiency and IT Equipment Reliability at Wider Operating Temperature and Humidity Ranges", Copyright © 2012. http://www.thegreengrid.org/en/Global/Content/white-papers/WP50-DataCenterEfficiencyandITEquipmentReliabilityatWiderOperatingTemperatureandHumidityRanges

5. ASHRAE: White Paper – "2011 Thermal Guidelines for Data Processing Environments – Expanded Data Center Classes and Usage Guidance". http://tc99.ashraetcs.org/documents/ASHRAE Whitepaper - 2011 Thermal Guidelines for Data Processing Environments.pdf

6. Intel: "Reducing Data Center Cost with an Air Economizer" http://www.intel.com/content/www/us/en/data-center-efficiency/data-center-efficiency-xeon-reducing-data-center-cost-with-air-economizer-brief.html

7. United States Green Building Council (USGBC), website www.usgbc.org