Server Technology, Inc.

Cabinet Power Monitoring, Management & Control Within the Data Center

White Paper STI-100-011
2010-Sept-27

by Calvin Nicholson,
Senior Director Software and Strategic Alliances, Server Technology Inc.

Headquarters
Server Technology, Inc.
1040 Sandhill Drive
Reno, NV 89521
United States of America
+001 (775) 284 2000 Tel
+001 (775) 284 2065 Fax
sales@servertech.com
www.servertech.com
www.servertechblog.com

EMEA
Server Technology Intl.
Sienna Court
The Broadway
Maidenhead
Berkshire
SL6 1NJ
United Kingdom
+44 (0) 1628 509053 Tel
+44 (0) 1628 509100 Fax
salesint@servertech.com

APAC
Server Technology, Inc.
37th Floor, Singapore Land Tower
50 Raffles Place
Singapore, 048623
+65 (0) 6829 7008 Tel
+65 (0) 6234 4574 Fax
salesint@servertech.com

Overview

Increased cabinet densities combined with reduced power availability and greatly increasing power costs are driving power monitoring and management solutions within the Data Center. Only through power monitoring, management and control can greater efficiencies be achieved with the key being "You cannot improve what you are not measuring." As groups like The Green Grid advocate continuous power monitoring at the device level, most IT and Infrastructure Managers are struggling with not only making these measurements, but also what to do with the information.

Intelligent Cabinet Power Distribution Unit (CDU) technology is now widely accepted, installed and operating globally, providing critical power information along with device control and environmental monitoring. CDU applications include:

- Load Balancing
- Capacity Planning
- Device Power Monitoring
- Branch Circuit Monitoring
- Environmental Monitoring
- Identifying Zombie Servers

This article explores the various monitoring systems typically found within the data center ecosystem and how to navigate getting the required power and environmental information needed to make better decisions within your data center facility. It also looks at how and where these measurements are being made and their significance. Finally it explores business application and uses for this information within these systems.

Data Center Monitoring, Management and Control Systems:

Depending on the size, age, sophistication and other variables, most data centers will have one or more existing systems in place for management, monitoring and collecting the data needed to run the facility. These systems are usually broken down as:

- Building Management Systems (BMS)
- Data Center Management Systems (Typically offered by HW Suppliers)
- Independent SW Suppliers with Monitoring/Management Systems
- SNMP Alarm Monitoring Tools (Not addressed in this article -detailed scripting typically required to be useful)

A Building Management System (BMS) is a control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems and security systems. Most facilities have large investments in these systems and some have tried to use them for monitoring all devices within their facility with limited success. A BMS consists of software and hardware; the software is usually proprietary, using protocols such as C-bus, Profibus, etc. to connect with existing products. New vendors and solutions are coming onto the market that use internet protocols and open standards such as Device Net, SOAP, XML, BACnet, LonWorks and Modbus. They include:

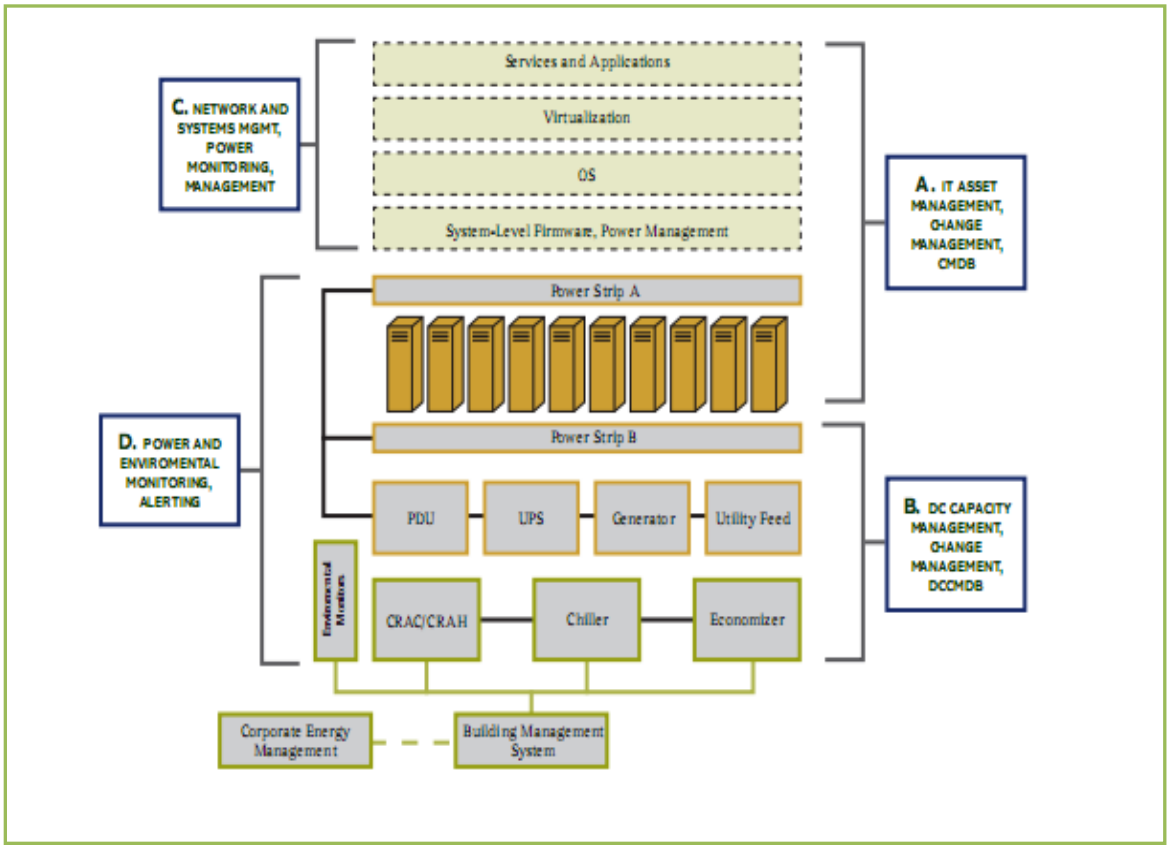
· Honeywell
· General Electric
· Rockwell
· Johnson Controls and
· Siemens.

Data Center Management Software Systems are specific systems related to the support and uptime of the data center and usually tie very closely with the specific manufacturers products. They are different than a BMS which does not typically address the physical infrastructure specifically supporting IT assets. These systems are typically compatible and designed to communicate with devices like PDU's, Switched Gear, UPSs, CDUs, sometimes servers and other devices with the data center to determine parameters like utility power quality, chiller temperatures, UPS status using real-time monitoring, and inventory management tools. Most of these systems will communicate with multiple vendor's devices through common protocols like Standard Network Management Protocol (SNMP) with the wild card being whether the supplier will do the work to support other vendors devices or require the customer to purchase their devices as they are the 'only' devices supported. Third party integration services usually result in a separate charge to the customer.

Third-party independent software suppliers will often bridge the gap between different suppliers' equipment and the systems that they communicate with to solve real world business problems, determine efficiency metrics, and provide inventory or other information within the data center. These solutions will typically communicate with BMSs, Management Software Systems mentioned above and even data center design tools used to model the power infrastructure or data center layout. Each system on the market leverages some unique capability for monitoring, management or control that the other suppliers typically cannot provide and are used by customers looking for a "best of breed" solution that can monitor a large number of devices within their facility. Independent SW Suppliers include:

· FieldView Solutions
· Modius
· Nlyte
· OSISoft
· Rackwise

Figure 1 shows the different areas within the data center ecosystem and how they are grouped based on functionality and support within this environment. It is clear that from network and systems management, IT asset management, power and environmental monitoring, capacity monitoring and change management that a data center is a complex environment with multiple layers. Only by Facilities and IT working together, along with these multiple systems, will these monitoring and management systems provide benefits such as reduced costs and increased up time.



Reference: The 451 Group Tier1 Research, LLC "Data Center Management & Energy-Efficiency Software" Report ECO-EFFICIENT IT

Figure 1: Data Center and IT Management Software

Power and Environmental Monitoring within the Data Center Cabinet:

As noted earlier, specific organizations like The Green Grid are advocating making continuous device (Level 3) power monitoring measurements at the device level. Table 1 shows both the recommended levels and locations for power monitoring within the data center:

Table 1			
	Level 1 (Basic)	Level 2 (Intermediate)	Level 3 (Advanced)
IT Equipment Power Total Facility Power Where	UPS Data Center input power	PDU Data Center input power less shared HVAC	Server,... Data Center input power less shared HVAC plus building lighting, security
Minimum Measurement Interval	1month / 1Week	Daily	Continuous (XX min)

New advancements in CDU technology such as Per Outlet Power Sensing (POPS™) and Per Inlet Power Sensing (PIPS™) allows CDUs to make high accuracy measurements at both the outlet (device) and inlet (branch circuit) from the RPP or Power Distribution Panel. This allows a number of power parameters to be measured or provided including:

- Current (Amps)
- Voltage (Volts)
- Power (Watts)
- Apparent Power (Volts Amps)
- Power Factor
- Crest Factor
- Frequency
- Reactance
- Accumulated Energy (kW – h)

POPS™ (Per Outlet Power Sensing)

In order to manage power usage, the capability to measure and monitor it must be present. The CDU is the most intelligent device in the cabinet (besides the servers themselves) and closest to the IT load, making it an ideal point to monitor power consumption. Intelligent, Smart or Switched, CDUs are equipped with local LED displays that provide useful information at the cabinet when powering up and load testing, however, they provide little useful information over the course of a day, week or month. Since power draw varies, CDUs designed with the ability to be networked (See Figure 2) and to allow power information to be queried, polled and trended at both a circuit and the device level will provide data center and facilities managers a better understanding of actual equipment power usage and identify problems like underutilized equipment. Information can also be rolled up so power usage can be viewed by power supply, device or application.

Using Server Technology PIPS™ (Per Inlet Power Sensing)

Monitoring power at the in-feed of the CDU allows for branch circuit monitoring from the UPS or Remote Power Panel that provides power to the CDU. (See Figure 2) Monitoring power at the inlet of the CDU (See Figure 3) provides for low cost and high accuracy monitoring of each branch circuit attached to the CDU versus making these measurements back at the RPP. This allows power usage for devices to be viewed at an in-feed level, rack level, rows of racks or zones and across the whole data center floor.

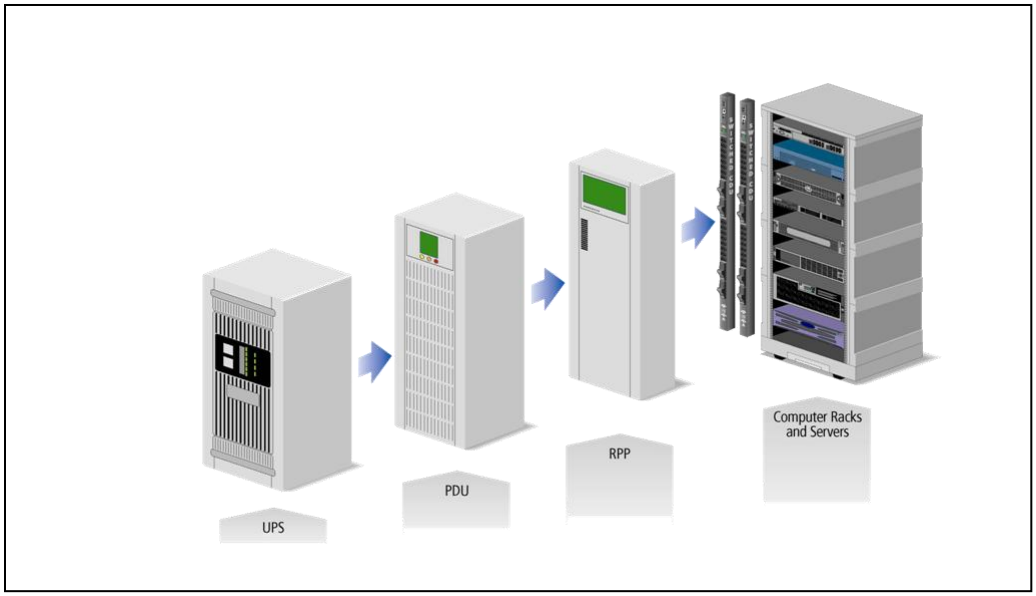


Figure 2: Power Supply Chain to the CDU

Additionally, the accumulated data may be used to calculate The Green Grid's PUE (Power Usage Effectiveness) metric to gauge and analyze power consumption and efficiency. SPM can provide PUE reports based on the users knowledge of their overall power consumption.

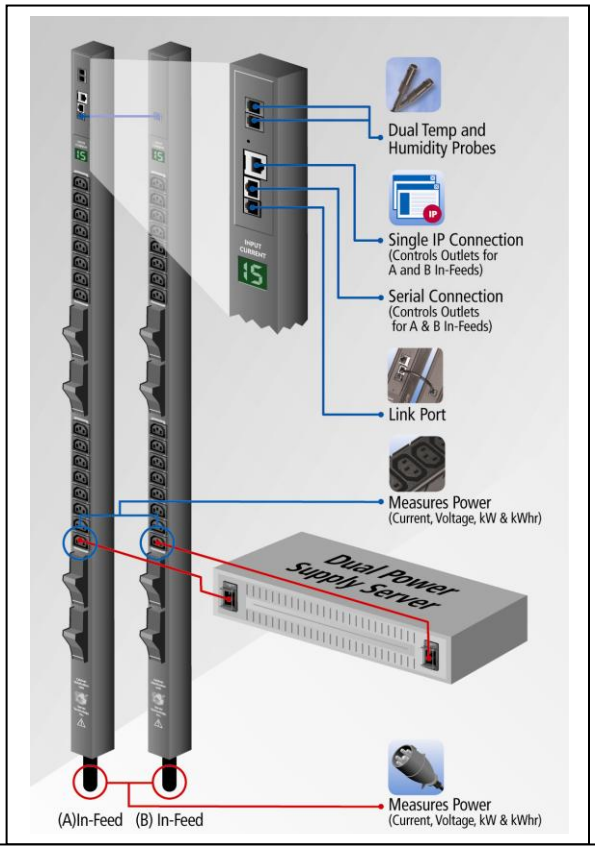


Figure 3: POPS and PIPS Measurement Locations

System Integration and Software Solutions

With a number of very different systems used to monitor a data center users might ask, “Is one more really needed?” We would argue “yes” when it can be installed as “middle ware” accessed when or if needed and designed to perform several key functions:

1) Monitor, Manage and Configure all cabinet CDUs within the data center
2) When this system provides an interface to a number of other systems using an application programming interface (API) that allows all power and environmental information to be shared with other systems using standard SOAP or REST tools.

Using a software system like the Sentry Power Manager™ (SPM) application (See Figure 4) allows each CDU to be managed through a single interface, rather than by individual IP address, saving time and money with configuration and management of a number of CDU’s within the facility. Using an API interface to another system within the Data Center makes sense when one top-level system will be used to provide a single pane of glass for monitoring and management. This is especially true when you have technologies like POPS that provides users thousands of data points per minute as the true value of the information is not at the outlet level but at the device level.

Example: A typical POPS CDU may have 24 outlets with an A and B power in-feed (48 outlets total) while constantly polling and measuring multiple points per outlet, alarms and alerts for items like capacity and other information such as multiple temperature and humidity measurements. This provides a huge amount of power and environmental information that must be aggregated in ways that make it manageable and useful to the user. SPM is the aggregation and management tool ensuring a central location for power related information and alarms viewed and managed either within SPM or by other monitoring tools.

SPM is currently installed globally using an API integration with multiple systems that include standard vendor solutions as well as some custom data center management systems. These custom systems were written and created specifically by and for large global users of data center and lab space used to run their day to day operations.

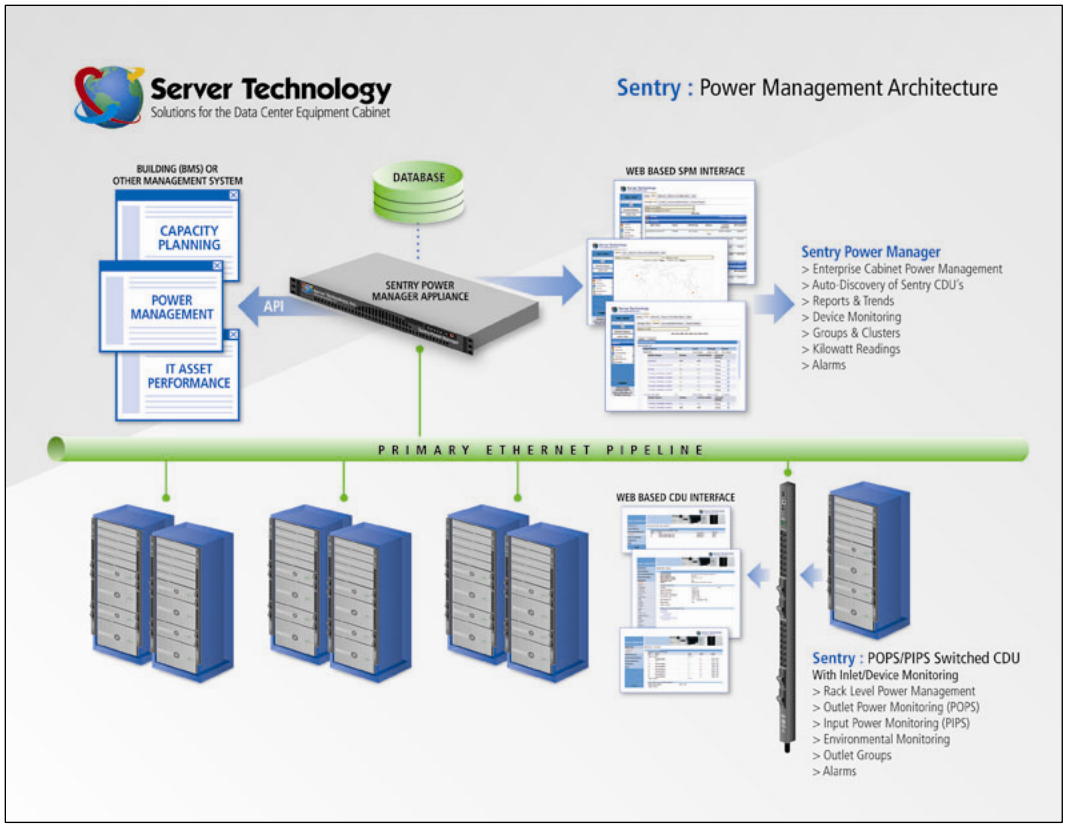


Figure 4: CDU and Sentry Power Manager Architecture

As mentioned earlier, understanding power usage and consumption is the first step in managing power usage and leads directly to greater efficiencies. There are a number of problems that CDUs combined with software tools like SPM and others can help solve within your data center facility:

- Environmental Monitoring **(Up to 4 temperature and 4 Humidity measurements)** per pair of CDU's
- Water sensor and dry contact information and monitoring
- Graphs, trends and reports on key power and environmental information
- Logs of all user actions and changes performed for security and control
- Load balancing and distribution of 3-Phase power
- Billing departments for their power usage and driving efficiency
- Identifying Zombie servers
- Scheduling device shutdowns of devices when they are not needed
- Increased Uptime by alarming when demand exceeds capacity
- Email alerts and SNMP traps
- Alert notification and quick drill down into alarm conditions

A few of these solutions for reducing costs and increasing uptime are explored below.

Environmental Monitoring:

Guidelines for environmental monitoring from organizations like ASHRAE (American Society of Heating Refrigerating and Air-Conditioning Engineers) continue to evolve. However studies show and ASHRAE

recommendations provide for increasing the upper temperature limit, saving huge amounts of energy not required for cooling. With equipment refresh rates of every 3-5 years many organizations have realized significant savings by increasing temperatures without seeing any degradation in the life or performance of their servers. Closely monitoring temperature and humidity along with providing alerts and alarms should thresholds be exceeded provide the ability to realize these sizable savings with minimal risk.

Load Balancing and Distribution of 3-Phase Power:

Three phase power delivers almost twice the amount of power as single phase systems do with only a moderate increase in cost. Additionally, some organizations within North America are also using 400 V 3-phase power for greater efficiency. Ref STI White Paper; "Power Efficiency Gains by Deploying 415 VAC Power Distribution in North American Data Centers.") The increased interest in 3-phase power is due to greater cabinet densities, blade server and other higher density solutions become more common. To avoid problems with unbalanced loads that create heating and efficiency issues, knowing the load of each phase of a three phase circuit through reports and graphs, reduces the costs and problems associated with power losses and downtime.

Scheduling device shutdowns:

In many lab environments, there is no need to keep all the equipment up and running all the time. This is due to the fact that many facilities are either not used at certain times such as evenings or weekends and that during the day not all devices need to be powered up depending on the tests being performed. Power savings upwards of 30% can be achieved by turning off the unused devices. Systems like SPM allow for both shutting down and turning back on devices based on a user configurable schedule.

Conclusion:

Accurate real time power and environmental information at the device, application, cabinet, rows of cabinets, zones or the whole facility is the foundation used to make key power and cooling decisions when deploying new equipment or supporting your existing infrastructure. Only this level of detailed measurement will provide enough information to make informed decisions that will allow costs to be controlled while still maintaining uptime. Using this information for automated control and management is the next frontier as data centers continue to automate based on their processes, systems and demand.

Power Distribution Units

Server Technology, Inc. is the global leader in power distribution units and power management products used in the world's leading enterprise data centers, service providers and branch office locations. For over 25 years, Server Technology has been recognized for innovative, intelligent power distribution, remote power monitoring and power management and measurement. Driven by customer innovation, the company is committed to helping companies reach their power consumption and green initiative goals. Server Technology, Inc. is headquartered in Reno, Nevada with worldwide distribution and regional offices in the United Kingdom, Germany and Singapore. To contact Server Technology call 1-800-835-1515 or visit www.servertech.com.