



Power Distribution Units (PDUs):

Power monitoring and environmental monitoring to improve uptime and capacity planning

Overview

Corporate America is more dependent than ever on computing resources to handle everything from mission-critical financial transaction applications to storing vast amounts of patient information. Data center facilities are under increasing pressure to flawlessly add significant, reliable computing power whether the data center is experiencing rapid growth, consolidating from multiple locations or trying to extract more capacity out of an existing space.

While blade servers have addressed some of the challenges placed on IT staff, such as cramming more computational power into a limited amount of space, this new technology has also created its own set of problems. Today, both IT administrators and facilities managers are addressing questions like, "Am I getting enough power to the blades?" "Are there racks with excess capacity?" and "Am I getting enough cooling to those racks?"

The fact is, HVAC systems are now being routinely pushed to their operational limits. The amount of power required at the rack is increasing dramatically – in some cases growing by an order of magnitude from 2kW to 20kW per rack.

Plus, the sheer number of server units in a data center is making it more difficult for limited IT staff to manage – much less improve – uptime.

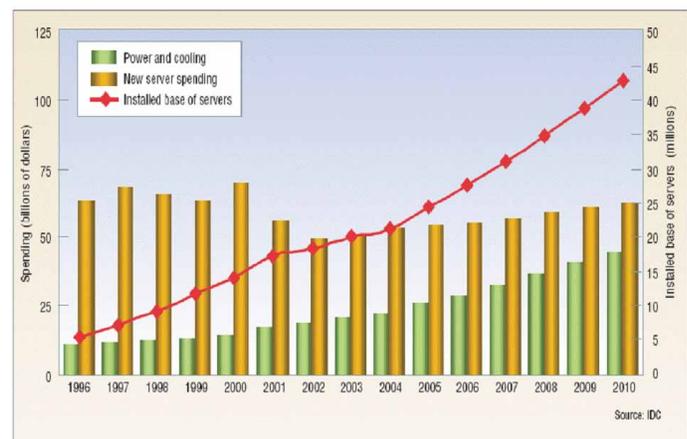
This white paper explores the challenges of increasing computing power in both an inflexible and resource-constrained physical space, as well as centers that are experiencing high growth. We also explore how companies can employ emerging support technology – like intelligent power distribution units (PDUs) – to help manage server uptime and capacity planning.

How We Got Here: The data center as the nerve center of a company

Over the past five years, the pressure to expand computing resources has led to an explosion in the demand for data center servers. This, in turn, has driven the development of new technology, most notably blade servers.

While it's a welcome development for most IT professionals, because it means more resources can be shoehorned into an existing space, there is also a significant downside. As components, like server microprocessors, become more powerful, they consume more power and generate more heat. This has put a strain on the power and cooling infrastructure that supports them. In fact, according to HP, data center power densities have grown from 2.1 kWh/rack in 1992 to 14 kWh/rack in 2006.

This requires both facilities and IT operations to take a closer look at cooling systems and how they can better deal with local "hot spots" within the computer room.



Although new server spending is leveling off, the industry is experiencing double-digit increases in server density, with a corresponding increase in the demand for power and cooling. (Source: IDC)

"Gartner estimates that through 2009, energy costs will emerge as the second highest operating cost (behind labor) in 70% of the data center facilities worldwide."

— Michael Bell, Gartner

Heat and Server Failure

Understanding how to move and cool air in a high density dynamic data center is very important to maintaining uptime. Left unchecked, hot spots could lead – and have led – to unexpected server shutdowns and, over time, premature server failure. This, of course, results in unacceptable downtime, strain on your staff’s time and added pressure on your budget.

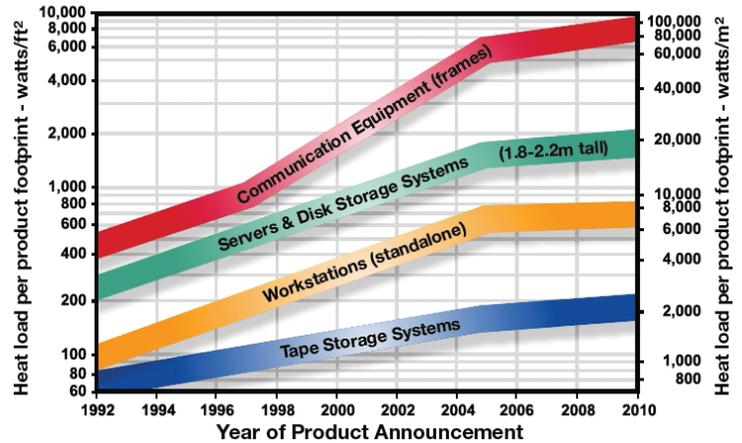
Greening Initiatives

With the growing importance on the “greening of corporate America,” more top-level executives are noticing the effect that power consumption is having on the world around them. They are witnessing:

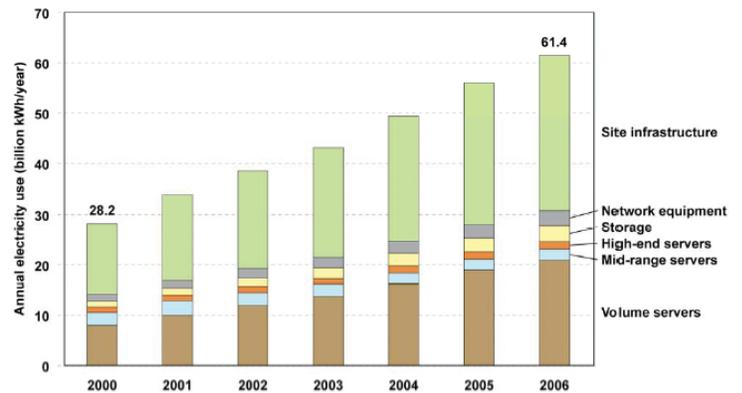
- ▶ Increased emissions, e.g., greenhouse gases, from electric generation
- ▶ Increased strain on the existing power grid to meet the increased demand
- ▶ Increased cost as a result of growing data center power consumption

The data support this trend. A Ziff-Davis Survey conducted in November 2005 found that a full 71 percent of IT decision makers are now dealing with or tracking issues related to power consumption and cooling, while 63 percent are increasing electrical power capacity or expanding the size of the data center. A similar survey by IDC in May 2006 discovered that power provisioning and power consumption are among the top three management concerns in the data center. In the past couple of years, these concerns have become even more important and topical.

For these reasons and more, there has been mounting interest in developing opportunities for improving power capacity planning, uptime and energy efficiency.



Projected heat load increases over time by system type. (Source: The Uptime Institute, Inc.)



Areas in the data center where energy use has increased for the years 2000-2006. (Source: EPA)

“...power will be the number one issue for most large company IT executives to address in the next 2-4 years. Ignoring this issue will NOT be an option. Power consideration must be incorporated into data center planning.”

— Robert Francis Group

The Good News

There are a number of compelling benefits that can be achieved if companies increase their efforts to limit power consumption and improve power efficiency. Namely, management can look forward to:

- ▶ Extending the life of existing data centers and delaying the huge costs associated with building new data centers
- ▶ Gaining control over the growing expenses around powering and cooling data centers
- ▶ Improving uptime and preventing problems before they occur

Clearly, new technologies need to be deployed to help manage change, optimize data center designs and plan for future growth.

How will IT and facilities managers deal with change?

Making a data center more power-efficient takes more than a “one and done” approach. It needs a commitment to design and execute a coordinated, long-term approach that focuses on efficiencies at both the technological and strategic levels.

Some efficiencies can be found in the equipment itself. These can include powerful yet more efficient CPU chips, power supplies, servers, storage devices and networking equipment. There are also software strategies, such as server virtualization, that can play a significant role in reducing overall power consumption.

While all good, there is also a clear need to do more:

- ▶ To be able to “see” and manage the effects of growth and expansion, especially for capacity planning purposes
- ▶ To be able to accurately monitor and measure conditions at the server level to predict and prevent overheating and shut-down
- ▶ To make sure that servers that are up and running and remain so at optimal levels

Few solutions give you a better ability to monitor and control activity both at the server and rack level than the latest intelligent rack PDUs. These power distribution devices come equipped with features that measure power at the outlet level, as well as environmental conditions such as temperature and humidity at the rack. They also provide the IT professional with accurate, real-time data that he or she can then act on.

PDUs: More than just a place to plug in your servers

Today, PDUs come in a number of configurations that help you manage power in the data center. This section will describe the four basic types and provide you with a summary of their strengths and weaknesses.

Basic PDUs

Summary: Basic PDUs are power strips that are constructed out of high-quality components for use in critical environments. They generally support distributing correct voltage and current to several outlets.

Pros: Basic, affordable, proven technology.

Cons: Lack instrumentation and are not manageable on any level.

Power Distribution Units (PDUs): Power monitoring and environmental monitoring to improve uptime and capacity planning

Metered PDUs

Summary: Metered rack devices meter the power at the PDU level, e.g., RMS volts, current, etc., and display it locally. Typically, the meter displays information for the entire PDU. A few sophisticated models have user-defined alarming capabilities and the ability to remotely understand PDU-level metering data over a serial or network port.

Pros: Provide real-time remote monitoring of connected loads. User-defined alarms alert IT staff of potential circuit overloads before they occur.

Cons: Most only provide information locally. They also do not offer outlet-level switching or critical environmental data.

Switched PDUs

Summary: Switched PDUs provide controlled on/off switching of individual outlets and load metering (see metered PDUs above) at the PDU level. They allow users to power recycle devices remotely and apply delay for power sequencing and provide some outlet use management.

Pros: Remote power on/off capabilities, outlet level switching and sequential power-up.

Cons: Lack temperature and humidity monitoring. The information provided and functions supported are limited.

Intelligent PDUs

Summary: An intelligent rack power distribution unit can be controlled remotely via a Web browser or command line interface (CLI). It meters power at both the PDU level and the individual outlet level; supports alerts based on user-defined thresholds; provides security in the form of passwords, authentication, authorization and encryption; and incorporates rich environmental management capabilities. Models should also be highly customizable, support the industry's latest standards-based techniques like SNMP TRAPS/SETs/GETs, IPMI and SMASH CLP, and integrate seamlessly to existing corporate infrastructures like LDAP, Active Directory®, RADIUS and NFS servers.

Pros: State-of-the-art devices, they are remotely accessible via Web browser or CLI. Models include all the features of switched devices (remote power on/off capabilities, outlet-level switching and sequential power-up), plus offer real-time environmental data, standards-based management, integration with existing directory servers, enhanced security and rich customization.

Cons: Higher cost relative to basic and metered PDUs, due to their greatly enhanced feature set.



Examples of Intelligent PDUs: LEDs at outlets indicate power ON (above). Zero U LED power meter (right) shows an example of outlet level metering; in this case, 3.4 amps are being drawn at outlet No. 7.

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Global Status

Unit Voltage	RMS Current	Active Power	CPU Temperature
119 Volts	5.02 Amps	554.88 Watts	51 degrees C

Name	State	Control	RMS Current	Active Power	Group Member
Win 2K Dominion KX II.122 (1)	on	<input type="button" value="On"/> <input type="button" value="Off"/> <input type="button" value="Cycle"/>	1.00 Amps	112.05 Watts	no
Win XP KX II.122 (2)	on	<input type="button" value="On"/> <input type="button" value="Off"/> <input type="button" value="Cycle"/>	0.78 Amps	89.72 Watts	no
Fedora Linux KX II.122 (3)	on	<input type="button" value="On"/> <input type="button" value="Off"/> <input type="button" value="Cycle"/>	0.71 Amps	82.09 Watts	no
Cisco 2500 KX II.122 (4)	on	<input type="button" value="On"/> <input type="button" value="Off"/> <input type="button" value="Cycle"/>	0.27 Amps	22.63 Watts	yes
HP ILO/RILO Server (5)	on	<input type="button" value="On"/> <input type="button" value="Off"/> <input type="button" value="Cycle"/>	0.87 Amps	102.52 Watts	no
Dell DRAC Server (6)	on	<input type="button" value="On"/> <input type="button" value="Off"/> <input type="button" value="Cycle"/>	0.68 Amps	48.16 Watts	no
WIN XP Paragon Port 3 (7)	on	<input type="button" value="On"/> <input type="button" value="Off"/> <input type="button" value="Cycle"/>	0.82 Amps	93.80 Watts	no
Win XP Paragon Port 2 (8)	on	<input type="button" value="On"/> <input type="button" value="Off"/> <input type="button" value="Cycle"/>	0.00 Amps	0.00 Watts	no

Environmental Sensors

Temperature 1 27.0 degrees C
 Temperature 2 27.0 degrees C
 Humidity 1 13 rel. %
 Humidity 2 13 rel. %

An example of a Web browser GUI showing outlet switching, outlet metering and environmental information.

Intelligent PDUs in Action

So how do intelligent PDUs effect change in the data center? Here are a number of situations, scenarios and opportunities to consider.

Identifying Idle or Underutilized Servers

Idle or underutilized servers waste energy needlessly, so it is productive to identify, redeploy and/or decommission those servers as soon as possible.

Since intelligent PDUs have the ability to measure power consumption at the individual outlet level, they can provide kilowatt usage data that, combined with known CPU utilization data, help determine the efficiency metric of any server in the data center. Given this key piece of information, individual servers can be identified as candidates for additional capacity, redeployment or decommissioning, improving overall data center efficiency.

This exercise can also assist with data center capacity planning. By consolidating servers, additional space may be freed up for future expansion.

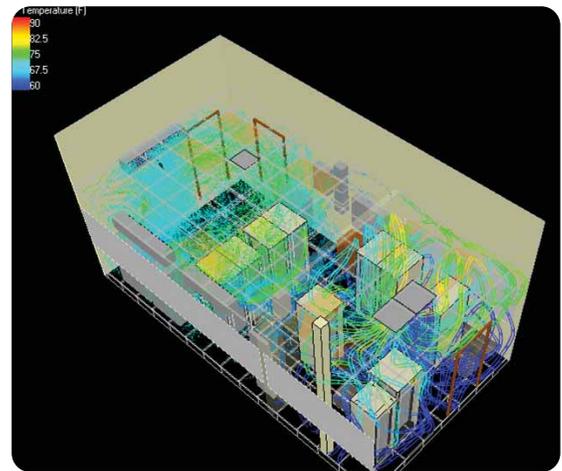
Improving CFD Models of Data Centers

Today, consultants are becoming increasingly sophisticated in designing and modeling new data centers. By applying complex software tools like Computational Fluid Dynamics (CFD), they can better plan cooling infrastructures and address existing data centers that have heat issues.

However, these tools have their drawbacks if they are modeling based on nameplate data and static environmental conditions. In the real world, data centers are dynamic. Server utilization changes over time, which in turn causes power consumption and heat generation/dissipation to change, which in turn requires appropriate cooling to specific racks or rows of computers.

Intelligent PDU technology can help provide information such as inlet temperatures at different locations within a rack over a period of time to aid in the planning of air movement and cooling. It can also provide alerts based on customizable thresholds so that hot spots can be immediately addressed to improve server uptime.

In fact, Raritan is now in the process of conducting one such study with PTS Consulting. Using powerful 3-D CFD software, a model is being created to show how intelligent PDUs equipped with sensors can help data centers and computer rooms of all types and sizes minimize the risk of overheating servers, maximize efficiencies in cooling and increase the overall manageability and performance of the site.



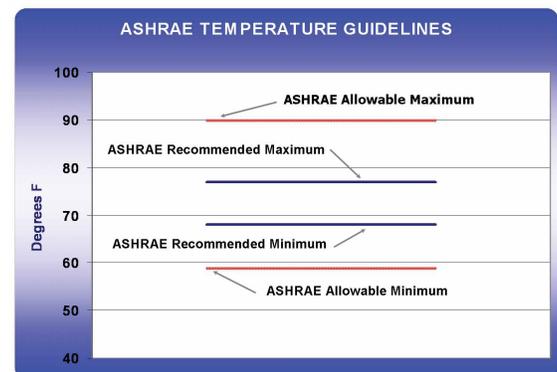
An example of CFD analysis. Using this knowledge can help site designers create a more consistent data center cooling pattern, thus reducing overall costs. (Source: Raritan)

Improving Data Center Cooling Efficiency

A common mistake is overcooling IT equipment in the data center. While it is true that excess heat can shorten the life of IT equipment or even cause it to fail, excessive cooling does not prolong equipment life and is a waste of energy. In fact, according to ASHRAE, temperatures at the rack can now be as high as 77 degrees Fahrenheit as long as it remains relatively consistent in all locations.

By placing intelligent PDU temperature sensors at the bottom, midpoint and top of a rack's cold air inlet, not only can IT administrators determine if the system is overcooling the servers, but whether the cool air is being routed efficiently to each of those levels.

Temperature sensors can also be placed at the rear, or hot air outlet of a rack to monitor the temperature of the exiting air.



New ASHRAE-recommended temperature minimums and maximums. For more efficiency and energy savings, you may want to raise the temperature in your data center. (Source: ASHRAE)

“By 2011, the use of management systems that monitor and balance power and cooling capacities in real time will become a best practice in the data center (0.7 probability).”

— Gartner, 12/2006

By measuring temperatures on both sides of the rack, IT administrators can get a more complete picture of the air flow in and around each server.

This data can also be quite useful when servers, racks or cooling equipment are added or rearranged in the data center, potentially leading to counterintuitive changes in temperature levels. For example, it is not uncommon for air conditioning units to be added to a server room only to discover that, due to altered air flow patterns, some racks receive very cold air while other racks are actually hotter than before the additional air conditioning.

Determining Rack and Server Power Capacity and Assisting Moves/Adds/Changes

Because intelligent PDUs offer both PDU and outlet-level metering, it is possible to accurately determine both the existing and potential power capacity at each rack and at each server.

This information can help IT administrators make informed decisions when deploying new resources in the data center, ensuring that new servers and other IT devices are deployed where they won't overload an existing circuit.

The Effects of Virtualization on Power and HVAC

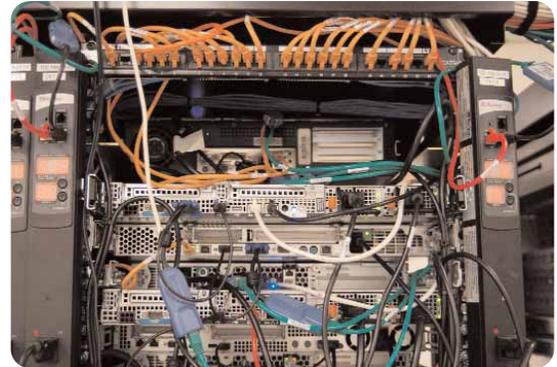
Server virtualization is a strategy that's gaining strength in IT because it effectively reduces the number of devices required to run applications in the data center. It is also an effective tool for capacity planning.

However, virtualization introduces other concerns. Chief among them: with higher utilization rates, the physical servers that are virtualized are running at higher capacities, drawing more power and generating more heat. Additionally, if multiple high computational load applications are running on a server at the same time, it is conceivable that they may reach an operating threshold that threatens to shut the server down.

By being able to measure the outlet-level power consumption of these physical servers over time, IT administrators can deploy applications so they will not exceed set levels, e.g., 70 percent of nameplate capacity.

Conclusion

The increased focus on responsible growth and utilization of data center resources benefits both corporations and the environment. However, yesterday's technology isn't up to the task. Only through the use of innovative new technologies – such as intelligent PDUs – will the data centers of tomorrow reach their full potential.



Intelligent PDUs: Zero U PDUs attached to the rear of the server rack. Temperature sensors may be plugged into the PDUs to monitor cold air into and hot air out of the rack.



An example of a temperature sensor mounted at the cold air inlet of a server rack. Sensor is connected to an intelligent PDU (not shown).

Power Distribution Units (PDUs): Power monitoring and environmental monitoring to improve uptime and capacity planning

With intelligent PDUs leading the way, data center staff will be able to more accurately identify where and when servers are running too hot or too cool, save energy and avoid server crashes; identify, redeploy or decommission servers, to balance power usage more uniformly; and identify trends and opportunities to more intelligently manage change and growth.

In other words, intelligent PDUs can help you know more about your data center so you can better manage your IT operations and resources.

About Raritan

Raritan is a leading provider of secure IT infrastructure management solutions that provide IT directors, managers and administrators the control they need to improve data center productivity, enhance branch office operations and increase overall power management efficiency. In over 50,000 locations around the world, our integrated secure in-band and out-of-band server access, control and power management products help companies better monitor and manage server access, utilization and energy consumption. Our intelligent PDUs offer remote power control and monitoring at the rack and device level, empowering data center owners with information to improve uptime and capacity planning, and efficiently utilize energy to save power and money. Raritan's OEM division provides embedded hardware and firmware for server and client management, including KVM over IP, IPMI, intelligent power management and other industry standards-based management applications.

Based in Somerset, N.J., Raritan has 38 offices worldwide, serving 76 countries. For more information, please visit **Raritan.com**