FOUR POINT PLAN FOR GREEN DATA CENTERS

TRENDPOINT™

Energy and Carbon Metrics℠

A FOUR-POINT PLAN FOR GREEN DATA CENTERS

Introduction: With the ratification of the Kyoto Protocol in 2005, a new sense of environmental awareness has swept the globe. It is now understood that electricity and the burning of fossil fuels to create that electricity are a leading cause of climate change and pose a huge challenge to long-term energy sustainability. Data centers are one of the world's largest users of electricity and are expected to be the number one source of greenhouse gas pollution by 2020 according to a recent study by McKinsey & Co.[1] TrendPoint Systems has seen this challenge on the horizon for some time and, with actual customer usage data, now offers the first comprehensive plan and technology solution for heading off this data center energy crisis. Following is the company's *Four Point Plan for Green Data Centers*:

Step One: Set an energy budget –The economic effects of the Kyoto Protocol are being felt by data centers throughout the world. The U.K and other governments are already implementing strict energy use reporting requirements together with a carbon "cap and trade" or carbon tax structure on excess energy consumption. These plans create a heavy incentive to cut energy use and emissions. In the U.K., the Carbon Trust has been established to offer interest free loans and other incentives for products that can help customers control their energy use.

In the U.K. and parts of Europe, "cap and trade" regulations aimed at reducing carbon emissions are already in effect, and are fast approaching in the U.S., especially in California which has taken the lead on this issue and will have a plan in place on 1/10/10. In a "cap and trade" model, a regulatory body sets a limit or a *cap* on the amount of a particular pollutant such as carbon that can be emitted. Companies that need to increase their emissions must buy or "trade" credits from those who pollute less. In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for having reduced emissions by more than was required.

Critics of emissions trading point to problems of complexity, monitoring, enforcement, and sometimes dispute the initial allocation methods and cap. In order to comply with cap and trade regulations or other limits on polluting, such as a direct carbon tax, companies need a comprehensive method for measuring and managing energy use and carbon emissions. Only then, can they comply with, and perhaps even profit from, these new regulations. The fundamental first step is for data centers to be able to set and manage energy and carbon budgets in the same way that they currently manage travel, or any other line item budgets. Until now, energy costs have been considered too difficult to manage as part of the customary budget cycle. In effect, energy costs were given a pass until reality caught up with the system.

TrendPoint has developed a patented technology that brings accurate energy information into the budget/forecast/variance cycle for the first time. This information allows individual users to manage their energy consumption and carbon footprints. No company creates macro goals for office expenses, travel, etc., and then expects the results of all

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1 Will Forest, McKinsey & Co., Revolutionizing Data Center Efficiency, May 2008

departments to magically add up to budgeted targets. Rather, a macro budget is created and then divided among the departments and assigned to department personnel of the company. Managing energy should be no different but, until now, it has not been possible to affordably gather and provide user-level power data – a requirement for setting and rigorously managing an energy budget.

Step Two: Virtualize servers –According to a recent McKinsey study, one of the most significant factors in data center energy use is the underutilization of servers, which it estimates are running at only 6 percent capacity. [2] Other studies corroborate these numbers, estimating that most servers operate at only 5-15% of their total load capacity. This is because most IT organizations have traditionally provisioned one server – or more – for every application or service they deliver. This has resulted in "server sprawl" -- servers taking up more space and using more resources than can be justified by their workloads. According to Forrester Research, servers sit idle more than 80% of the time, while still using about 30% of peak electricity consumption. [3]

The other major factor in data center energy use is the increasing power of CPU chips as described by Moore's Law, which states that the number of transistors on a chip will continually double every two years. What isn't as well known is a principle we have dubbed "Corollary to Moore's Law" which states that the general trend is for maximum power consumption to increase a little over 2 times every four years. This presents an enormous energy challenge to data centers in that the power that a CPU draws -- in watts -- is the same as the heat it radiates in watts. This places a monumental power and cooling burden on data centers. In fact, Gartner estimates that 50% of data centers will soon lack sufficient power and cooling capacity to meet the demands of high-density equipment such as blade servers and storage arrays. [4]

Another exacerbating factor is that the size of servers has been decreasing, leading companies to pack more servers onto each rack, nearly doubling the power density – and hence the power requirements -- per square foot in data centers over the last 10 years. For every watt of increase in power consumption, there is an equal increase in heat radiation, and a corresponding increase in cooling requirements. These factors – server sprawl, increase in CPU power requirements, and increased server density – combined with escalating utility costs have created a "perfect storm" that threatens to overwhelm data centers. Indeed, IDC estimates that utility bills at data centers will soon equal or exceed the amount spent on new hardware. [5] Utility costs in the U.S. and other coal reliant countries will be especially hard hit as the price of coal has tripled in less than one year..

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2 Will Forest, McKinsey & Co., Revolutionizing Data Center Efficiency

3 http://www.forrester.com/Research/Document/Excerpt/0,7211,39746,00.html

4 http://www.gartner.com/it/page.jsp?id=499090

5 IDC, "The Impact of Power and Cooling on IT Infrastructure, May 2006

To address this crisis, many companies have opted to use virtualization technology to consolidate the server sprawl that took place over the past decade. IT organizations can reap instant savings by consolidating underutilized physical data servers onto "virtual machines" that act like physical computers. One obvious benefit is a reduction in physical floor space in a data center. But management and energy efficiencies are by far the more important benefits. For example, VMWare touts a 10:1 target for virtualizing individual servers onto one replacement virtualized server. The energy benefits of this approach are compelling, since data centers are paying a premium to power and cool idle or underutilized servers.

But despite these apparent benefits, there is a significant challenge to virtualization in terms of energy use: Without proper cooling management, virtualized servers generate enormous heat as more processes are added and can develop "server thermal inversions" – literally, heat inversions within a server cabinet. Just as smog recycles and builds up in an atmospheric thermal inversion, a server can develop an inversion that causes cool air to be trapped and recycled again and again, wasting cooling resources. Server inversions can do more than cause energy inefficiencies in the cabinets, they can also result in tripped breakers and service interruptions in data centers. Without continuous management of the wattage of heat within each cabinet "server thermal inversion" can eat up significant amounts of planned energy savings via increased cooling costs and, can be a leading cause of costly downtime in a data center.

Step Three: Equalize heat loads, match cooling – Server thermal inversions can represent a significant challenge to cooling efficiencies. But, at the same time, managing heat profiles within a cabinet actually creates significant opportunities to lower cooling costs in a way that heretofore has not been widely known. The challenge lies in changing the heat loading profile within each individual cabinet. Studies have shown that the more uniform the distribution of heat load within a cabinet, as measured in watts, the higher the energy efficiency achieved to cool that load.

A study by Rolander and Yoshi[6] showed that significant cooling savings can be achieved by breaking up servers into just 3 individual zones within a cabinet and balancing heat loads in a proper placement scenario. In this study, a net energy savings of 33% was shown to be achievable, or alternately a user could rack over 50% more power while maintaining an appropriate temperature. The same study showed that without intra-cabinet load balancing, the use of increasing air flow – the most common method of tackling hot spots - is actually very ineffective as an efficient cooling strategy. Intra-cabinet balancing can be achieved by grouping servers within each cabinet in to 3 groups, or we would suggest, even two, for practical reasons, thus corresponding to the number of circuits in even a lightly loaded cabinet or rack.

While intra-cabinet heat balancing can reduce cooling costs on its own, even more savings can be achieved by matching the cooling requirements of the CRAC units to the actual heat generated within any group of data cabinets. A significant number of data

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6 An Approach for the Robust Design of Data Center Server Cabinets, Nathan Rolander, Georgia Institute of Technology, 2005

centers have been shown to actually over-cool their data cabinets because they do not have access to appropriate data. What they need is cabinet-level heat data, along with metrics that measure the performance of cooling units over time. Only then, can heat loads be matched to cooling needs. Ironically, while cooling systems may use the majority of energy in most data centers, almost no cooling systems are monitored for energy usage. We believe that, by monitoring each IT circuit within a data center and assigning each circuit to its appropriate rack and, then monitoring each cooling circuit for the CRAC and chiller units, users have taken the first step to creating active management metrics for reducing energy and carbon usage.

In summary, we have found that by monitoring server heat wattage by circuit in 2 or more zones within a cabinet and moving towards equalized heat loads between the zones, the user will reap cooling savings of up to 33% as cool air passes through with much less thermal resistance. Then, by measuring the wattage of total heat of all circuits within each cabinet and targeting the cooling to match the heat of each cabinet, further savings of 10% - 25% can be realized.

Step Four: Manage to the metrics – The principal of Management By Information (MBI) states, “You can only manage what you measure.” This principal is as vital to controlling data center efficiency as it is to manufacturing and process efficiency. Data centers have literally become heat sinks for power use. In order to gain control over this escalating energy crisis in data centers, IT managers need access to information. TrendPoint has developed the first turn-key energy and carbon management system for data centers. This system provides IT managers with all the information they need to effectively reduce energy use and carbon emissions.

Energy use can be reduced and productivity enhanced by giving data centers the ability to:

- Provide each responsible person with an energy budget and/or a 0 percent down time target
- Measure energy use and heat radiation on a circuit by circuit basis, and then balance them appropriately
- Target each heat load to a specific, matching cooling component.
- Provide IT managers with access to continuous information, forecasts, and alerts to insure that heat loads and cooling are matched, especially as servers are added, moved and changed, often on a daily basis.

These are the core components of a comprehensive data center energy plan that deals with the energy crisis at the root level. If IT managers can not see the cause and effect of cabinet heat and cooling imbalances, it is virtually impossible to gain control of their energy and carbon problems. TrendPoint gives data centers all the metrics and management tools necessary to dramatically reduce energy costs and carbon emissions, avoid power related service disruptions, and manage energy use over the long term to achieve maximum energy efficiency.

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