The Green Data Center: Energy Efficient Computing In The 21st Century

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Abstract
• Data center energy efficiency can curb runaway power consumption, and also accommodate more data center capacity.
• Energy costs are going to rise and computing demand will continue to outstrip technological improvements.
• This session will outline short term and long term strategies for going green in the data center.
Business Case For Energy Efficiency

- The Uptime Institute estimates that building a 30,000 square foot data center can cost up to $300 million today, compared with only $20 million a few years ago.
- 2005 AFCOM survey: Data center power requirements are increasing by an average of 8% - 20% per year. In 2007, 44.5% of AFCOM members’ data centers would be incapable of supporting business requirements due to capacity constraints.

OBSOLETE BY 2010

- According to AFCOM, more than 60% of pre-2005 data center facilities will be unable to handle increased computing demand, rendering data centers obsolete in three years.

Data Centers In The Spotlight

- This isn’t a fad: Traditional energy costs are going to rise. At the same time, demand for new application growth will continue to outstrip computing advances.
- Going green – Crisis or opportunity? All eyes on the data center, from the C-level to Congress. Data center managers are playing a key role in shaping their company’s future and U.S. energy policy.
Does $300 Million Get Your CFO’s Attention?

In order to pursue energy efficiency, you need C-level commitment:
• Understand energy consumption trends
• Develop a strategy
• Implement metrics to measure progress

Measuring IT Energy Consumption

• Server energy use doubled from 2000 - 2005
• Servers in the U.S. burned 23 billion kilowatt-hours (kWh) in 2005
• Every kWh used by servers translates into another kWh of electricity for infrastructure
• Data centers used 45 billion kWh in the U.S. in 2005, $2.7 billion
• In 2010, data center electricity use will be 76% higher than in 2005


What Is Driving Demand?

• New applications: RFID, Web-applications, digitization of business processes
• Increased uptime: 24x7 global business, SOX and other legal requirements and user expectations of always-up systems
• Web 2.0: The Google-plex, user generated content, SaaS and Second Life
The True Cost Of Ownership

- IT managers justify the capital cost of telecommunications, storage and server hardware to support an application -- but not the supporting infrastructure power cost.
- Total cost of ownership is invisible to the people provisioning IT resources because they don't see the power bill.
- The power bill for the data center is the domain of the facility engineering staff -- it is abstracted from the technology decision-making process.

TCO Estimates

- The Uptime Institute: The three-year cost of powering and cooling servers is one and a half times the capital expense of the hardware.
- Gartner: Energy costs will account for more than half of a company’s IT budget in the next few years.

Computers Run On Coal

- Half of all the electricity generated in the U.S. comes from coal-burning power plants.
- By reducing energy consumption, we lessen the demand to build more of these polluters.
- The Union of Concerned Scientists estimates that a 500-megawatt coal-burning power plant generates: 3.7 million tons of carbon dioxide, the primary cause of human-related global warming; 10,000 tons of sulfur dioxide, which causes acid rain; and 500 tons of airborne particles, responsible for respiratory health problems.
Green Consumers

- The green consumer is emerging. End users may demand that companies practice environmentally sound policies -- which could include energy efficient IT operations.

LEED In The Data Center?

- The U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) is the green building standard.
- A few companies have certified LEED data centers, including Highmark in PA and Fannie Mae in Urbana, MD.
- More companies have committed to LEED, including IBM and 365 Main.

The Problem With LEED

- LEED is not designed for data centers and so far the USGBC does not plan to address them.
- LEED drives perverse design incentives in the data center: Gain points for bike racks and daylighting, no points for mitigating bypass airflow or server virtualization.
If Not LEED, Then What?

• The Green Grid, The Uptime Institute and the EPA can lobby and develop a LEED-DC for the USGBC; or develop their own metric and awards system for data centers.
• Get involved: The Green Grid needs user members; TUI is developing opinions and testing ideas; EPA representatives are traveling the data center conference circuit.

Managing Up

• You can't drive efficiency from the bottom up. Nobody gets promoted for unplugging servers.
• Make the business case to the CIO to include energy costs part of annual allocations for computing costs.
• Implement metering equipment for measuring energy use.
• Make it a quarterly reporting item.

Comparative Metrics

• Server metrics: EPA and Spec are developing a rating system and eventually an Energy Star label for 1U-2U servers.
• Data Center Metrics: The Uptime Institute and The Green Grid have developed data center-wide efficiency metrics called SIEER and PUE.
Energy Star for Servers

- Measuring efficiency of the server power supply
- Examining power save features at the OS-firmware level
- Using SPEC benchmark to calculate the amount of energy it takes for various servers to perform a set unit of work. The first workload that the new SPEC power metric will measure is server-side Java. The energy measurements are made at the AC input to the system under test.

Site Infrastructure Energy Efficiency Ratio

- Power "in" to the data center (measured at the utility electric meter), divided by power "out" used to run the IT equipment for computing.
- Uptime: 85 corporate members (the largest financial data centers in the world) have an average SIEER of 2.5. This means that for every 2.5 watts "in" at the utility meter, only one watt is delivered out to the IT load.
- Uptime estimates a best case scenario of 1.6 SIEER for companies with the most efficient equipment and no over provisioning capacity.

Power Usage Effectiveness

- Industry support from The Green Grid and the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE).
- PUE is essentially the same equation as represented in SIEER.
- The Uptime Institute and The Green Grid will likely meld these benchmarks under one name.
Why Metrics Matter

• Metrics like SIEER and PUE will help data center managers make better decisions. “You can’t manage what you can’t measure.” This will give us empirical evidence on which energy efficient “best practices” are really working and allow users to determine ROI on projects.

PART 2: Strategies

Short-term, Mid-term and Long-term Goals for energy savings

Short Term, Low Cost, Low Risk Fixes

WHAT CAN YOU DO TODAY?

• Turn off unused servers
• Consolidate with server virtualization
• Audit hot-aisle/cold aisle design
• Switch power distribution from 120v to 208v
Server Virtualization = Magic?

- Consolidation: Server virtualization is the key to extract more from underutilized servers.
- 3 years ago, 80% of your servers were running at 5%-15% utilization. Today with VMware you can collapse 5-10 operating systems onto a single machine, cluster them for failover protection and use fewer servers.

Server Virtualization (Continued)

- California utilities are paying customers 50% of the cost (up to $4 million) of a virtualization project.
- One user in the pilot program used VMware to reduce the number of servers from 1,000 down to 270. Another is virtualizing 260 physical servers onto 11 VMware hosts.
- Estimates by VMware and the utility companies are that direct energy savings for each server removed run between $300 and $600 per year.

Raised Floor Fundamentals

- Eighteen inches is the minimum raised floor height -- 24-30 inches is better.
- Get rid of the clutter, unused cables or pipes. Hire a service to clean it periodically.
- Seal cable cutouts, spaces between floor and the walls. Replace missing tiles.
- Use rubber gaskets under tiles to fit them more snugly onto the frame, minimizing air leakage.
- Use products to seal up raised floors, including brush grommets and specialized caulking.
Raise The Voltage, Save Power

- Servers will see a 2-3% efficiency gain by using 208V versus 120V power distribution.
- Servers are rated to handle 100-250 volts. They can auto-sense 208V and adjust automatically.
- Most PDUs can deliver 208V and 120V to the same power strip.

Near-term Solutions – 1 Year Out

- Buy Energy Star rated servers with 80-Plus power supply certifications.
- Upgrade to Windows Server 2008 for power down features.
- Consider consolidating Linux onto big iron for mainframe customers.
- Investigate supplemental cooling systems.

80-plus Power Supplies

- The easiest way to gain efficiency is to buy servers with the 80 Plus rating on the power supply -- standards are available and it has zero impact on the processor.
- This component converts AC power at the plug into DC power that a server can use.
- In 1U rack servers, the power supplies convert AC to DC very inefficiently, typically at around 60%-70% efficiency.
80-Plus (Continued)

• Products must run at 80% or greater efficiency at varying server workloads.
• 80-Plus does not extend beyond 1U servers today.
• Google spends $30 extra per server for 90% efficient power supplies which pay for themselves over the life of the server.

Windows Server 2008

• Power management is built into Windows Server 2003, but most users never enabled it.
• Windows Server 2008, shipping February, power management is enabled out of the box.
• New power management features provide finer controls that allow the OS to scale back voltage going to the processor.
• This improves on the current processor power management strategy of putting CPUs to sleep when servers are idle, which can result in latency issues in spikes and lulls in demand.

The Mainframe And Energy

• A mainframe’s average CPU utilization is 90%.
• IBM guaranteed customers that a mainframe uses less energy than the comparable volume servers to do a job.
• In 2005, Nationwide moved 5,000 open system workloads onto Linux on the mainframe and reduced its data center floor space and power consumption by 80%.
• Big Iron seems to be a great consolidation platform for existing customers.
Supplemental Cooling Systems

- High density cooling systems can deliver more cooling than raised floor with less energy; deliver air more evenly up the cabinet; deliver cooling closer to the heat source; and prevent bypass airflow by directing exhaust air directly into the AC unit.
- On the downside these systems can be more expensive and complex to operate. In many cases you still need the raised floor to maintain baseline cooling and humidity. Many top-blow systems need to be ducted, taking up a lot of space.

Long-term – New Construction

THE FUTURE!

- Liquid cooling
- Air-side and water-side economizers
- DC Power

Liquid Cooling Systems?

- Water is about 3,500 times more efficient than air at removing heat.
- Vendors offer all sorts of products... but nobody is buying yet. 65% of data center managers say no to liquid cooling.
- Liquid refrigerants seem to have mechanical advantages over water.
- ASHRAE published a liquid cooling book last year -- first steps to standardization.
Economizers: Free Cooling?

- Air-side economizers bring cold outside air into the data center. This allows you avoid using chillers and compressors.
- Unconditioned air is bad for equipment: Humidity and particulate issues.
- Water-side economizers use outside air to cool chilled water -- a closed loop with less equipment issues.

DC Power: Pros and Cons

- **Pro:** Studies say DC powered data centers are 10-20% more efficient.
- **Con:** You can't just go plugging servers into racks with DC. Every time you plug something in it changes the current draw.
- **Con:** DC UPS systems cost 20% to 40% more.
- **Con:** DC equipment is scarce. Sun, Cisco and Rackable offer a lot of DC products, but HP, IBM and storage vendors are lacking.

Resources & Questions

- eBook: *The Green Data Center – Energy efficient computing in the 21st Century*
- [SearchDataCenter.com](http://www.searchdatacenters.com) – News, expert advice, peer blogging.
- AFCOM, ASHRAE, The Uptime Institute, The Green Grid, EPA
Questions??

• Visit me today at the ATE booth on the exhibit hall floor from 1:30 PM – 2:30 PM