## **Data Center Strategies for Energy Reduction**



## Energy-Saving Opportunities in Small Data Centers

Steve Greenberg, PE Lawrence Berkeley National Laboratory August 17, 2017

Tampa Convention Center • Tampa, Florida

## Agenda

- Why small data centers are important
- Simplest Measures
  - Turn off unused servers
  - Improve server power management
  - Improve air management
  - Increase temperature setpoints toward the high end of the ASHRAE range
  - Turn off active humidity control
  - Minimize UPS requirements
- Still simple, a little more work
  - Refresh the oldest IT equipment with new high-efficiency equipment
  - Consolidate and virtualize applications

(continued)



## Agenda, con't

- Higher-level investment, but very cost-effective
  - Move to higher-efficiency internal or external data center or to the cloud
  - Implement IT and infrastructure power monitoring
  - Install Variable-Speed Drives on cooling system fans
  - Install rack and/or row-level cooling
  - Use air-side economizer
  - Implement dedicated room cooling (vs. using central building cooling)
- Training for IT and Facility Staff
- Resources



## Why Small Data Centers are Important

- Definition: "Small" is less than 5000 square feet of computer floor
- Have almost half of the total servers
- Use 40 billion kWh/yr
- Have challenges
- Have large energy-saving opportunities (20 – 40%)
- Guide:

datacenters.lbl.gov/resources/small-datacenters-big-energy-savings





## **Turn off unused servers**

- Known as "comatose" or "zombie" servers: they do no useful work, but use
  - Power
  - Space
  - Cooling
- Estimated 20-30% of servers are comatose
- An idle server uses ~50% of full-load power and ~75% of one loaded at 25%
- Establish and maintain a list of what's running on each machine
- Shut down unused servers



Energy Efficiency & Renewable Energy

#### **Improve server power management**

- Most servers are shipped with power management turned on
- Most servers in use have power management turned off
- Check power management settings and enable
  - Processor
  - OS/hypervisor
  - BIOS

Dell Inc. (www.dell.com) - PowerEdge 2978 BIOS Version 0.2.12		
Service Tag:		Asset Tag:
System	Date	Thu Sep 14, 2006
Memor CPU 1	64-bit	Yes 🔺
SATA	Core <u>Speed</u> BUS Speed Demand-Based Power Managemen	2.88 GHz 1808 MH2 otDisabled
Boot USB F	Trossecor 1 ID [Dual-Core AMD Opteron(tm) Level 2 Cache Number of Cores	F12 Processor 2212 J 2 MB 2
Integ	Processor 2 ID [Dual-Core AMD Opteron(tm)	Processor 2212 ]



## Improve air management

- Cool supply air *ideally* gets from cooling equipment to the IT inlet without mixing with hot discharge air
- Hot discharge air *ideally* returns from the IT exhaust to the cooling equipment without mixing with the cool supply air





## Improve air management, con't

- Clear the desired air path (abandoned and cluttered cables, e.g.)
- Block the undesired air paths
  - Within and between racks
  - Cable and conduit cutouts from under floor and into ceiling plenum
  - Rack tops and row ends



Pictures courtesy of ANCIS Incorporated

- Allows increased supply air temperature
- Allows reduced air flow



# Increase air temperature setpoints toward the high end of the ASHRAE range

- IT inlet temperature is what matters
- ASHRAE recommended range (rounded): 65 to 80° F;
  Allowable (A1) range: 59 to 90° F
- NOT the same as CRAC or CRAH setpoint (especially for units controlled on return air)
- Ensure good air management first
- Enables savings in chiller or CRAC compressor energy



## Turn off active humidity control

- Wider ASHRAE range means little if any control required
- Recommended range: 15.8° to 59° F dewpoint RELATIVE HUMIDITY and 60% RH (vs. typical 45-55% RH)
- Humidification savings
- Dehumidification savings
- Often both





#### Minimize Uninterruptible Power Supply (UPS) requirements

- Unnecessary redundancy leads to inefficiency
- Many applications can be shut down and restarted without adverse effects
- Critical applications should be considered for moving to a larger data center or the cloud
- Analyze UPS needs
  - Minimize number and size
  - Use ENERGY STAR UPS units
  - Use Eco-mode





#### Refresh the oldest IT equipment with new high-efficiency equipment

- New equipment more powerful and more computing per watt plus better power management
- More virtualization potential
- Energy and software cost savings typically justifies a faster refresh rate
- ENERGY STAR
  - Servers
  - Networking
  - Storage
- Solid-state drives (vs. hard disks)
- 80-Plus power supplies (beyond ENERGY STAR requirement)







## **Consolidate and virtualize applications**

- Most servers operate with very low utilization (5-15% on average)
- Servers at typical loads use roughly 75% of average peak power
- Big opportunities for virtualization and consolidation
- Energy savings from power and cooling reductions
- Space savings



#### Move to higher-efficiency internal or external data center or to the cloud

- Energy savings typically possible by moving applications or machines to
  - Larger data center
  - Co-location center
  - The cloud
- Better security
- Better redundancy
- Better efficiency
- In evaluating, consider
  - Mandates
  - Moving cost
  - Total ongoing cost of staying vs. moving





## Implement IT and infrastructure power monitoring

- Doesn't save energy by itself, but it informs the process
- Track performance of power and cooling systems and monitor IT
- Power Usage Effectiveness (PUE) as a metric
  - Ratio of total data center energy to IT energy
  - Over 2—large opportunity
  - Under 1.5—good
  - Under 1.2--excellent
- Data Center Metering and Resource Guide
  - Guide and webinar slides at <u>datacenters.lbl.gov/resources/data-center-metering-</u> <u>and-resource-guide</u>

datacenters.lbl.gov/resources/data-center-metering-

and-power-usage





U.S. DEPARTMENT OF

Energy Efficiency & Renewable Energy

## Install Variable-Speed Drives on cooling system fans

- CRACs or CRAHs typically have constant-speed fans
- Air flows are typically higher than needed, especially once air management is improved
- 20% air flow reduction results in ~50% savings in fan energy
- 22-32% overall cooling system savings in FEMP case studies:

<u>datacenters.lbl.gov/resources/</u> <u>variable-speed-fan-retrofits-computer-</u> <u>room-air-conditioners</u>





## Install rack and/or row-level cooling

- Applicable when racks are being replaced or newly installed
- Moves cooling closer to the heat source
- Various types
  - In-rack
  - In-row
  - Rear-door (shown)
- Less overall heat removal
- Enables higher chilled water temperature





## Use an air-side economizer

- Uses outside air when conditions are suitable
- Needs outside wall or roof
- Can be
  - air-handling unit
  - CRAC or CRAH with outside air capability
  - Exhaust fan with inlet air
- Large energy savings from reduced operation of cooling compressor



Energy Efficiency & Renewable Energy

- Dedicated unit allows main building system and plant to operate on normally occupied schedule instead of continuously
- Use high-efficiency unit (high SEER)
- Specify outside-air economizer
- Control based on IT inlet temperature





#### Training

- Utility companies
- ASHRAE: <u>www.ashrae.org</u>
- FEMP: <u>http://eere.energy.gov/femp/training</u>
- Center of Expertise for Energy Efficiency in Data Centers
- Data Center Energy Practitioner
  - Required by the Data Center Optimization Initiative
  - <u>datacenters.lbl.gov/dcep</u>





#### **Resources: Center of Expertise for Energy Efficiency in Data Centers**



#### datacenters.lbl.gov



Energy Efficiency & Renewable Energy

- Small Data Centers
  <u>datacenters.lbl.gov/resources/small-data-centers-big-energy-savings</u>
- DOE Air Management Tool <u>datacenters.lbl.gov/Tools</u>
- Humidity Control in Data Centers
  <u>datacenters.lbl.gov/resources/Humidity-Control-Data-Centers</u>
- Data Center Metering and Resource Guide
  <u>datacenters.lbl.gov/resources/data-center-metering-and-resource-guide</u>
- Data Center Optimization Initiative (OMB) <u>https://datacenters.cio.gov/</u>
- ENERGY STAR Equipment: <u>energystar.gov/products/office\_equipment/</u>



- Slides will be available at <u>datacenterworkshop.lbl.gov</u>
- For content-related questions after the webinar, please use the Contact Us form on the Center of Expertise website: <u>datacenters.lbl.gov/contact</u>

Steve Greenberg, P.E. SEGreenberg@lbl.gov (510) 486-6971



