A Method and Process to Measure the Energy Efficiency of Storage Arrays

David Floyer CTO & Co-Founder, Wikibon Phoenix, 10/15/2009
Introduction
  – Wikibon
  – Wikibon Energy Lab
  – Vendors & Technologies Measured
• Measuring the Impact of Energy Efficient Technologies on Storage
  – Measurement Method
  – Hardware Example
    • Measurements
    • Hero Report
    • Field Validation
  – Software Examples
    • Measurements
    • Hero Report
    • Field Validation
• Towards an Energy Star Program
• Conclusions, Summary & Discussion
Agenda

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• A growing community of 7,000 IT practitioners
• Goal is to provide an open source platform for practitioners to share knowledge
• Based on a Wiki (2,000+ pieces of content)
• www.wikibon.org
Deep Storage Domain Expertise

David Vellante – former IDC Senior Vice President

David Floyer – former IBM, IDC Research VP

Nick Allen – former Gartner Research VP

Bill Mottram – former Copan/STK Vice President

Dennis Martin – former Evaluator Group / STK

Gary MacFadden – Former Meta, Giga, IDC
Established to help the storage industry qualify for energy rebates from utility companies

Provides validation of vendor lab measurements

Developed Processes in close coordination with PG&E
  – Mark Bramfitt, Principal Program Manager
  – Randy Cole, Senior Project Manager
  – Bill Dunckel, Senior Project Manager

Working with PG&E to extend programs to Seattle, Austin, and other utilities
Storage Vendors & Energy/Power – Saving Technologies Measured

Virtualization & Thin Provisioning

Virtualization & Thin Provisioning

MAID *

Spin-down

Thin Provisioning, Spin-down, Flash Drives

Virtualization & Thin Provisioning, Spin-down

AutoMAID

Vertical Cooling

Virtualization & Thin Provisioning
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Measurement Method

- All measurements in Lab, not on site
- IO Workload defined as:
  - 1/3 Random (small block),
  - 1/3 Sequential (large block),
  - 1/3 Idle
- Storage Array Components Measured Included:
  - Drive-types
  - Drive Chassis
  - Ports
  - Service Processor
  - Controller(s)
- Able to Calculate any Configuration from Sum of Components (accuracy >95%)
- Base-line is Storage Product **without** Energy Saving Technology
Hardware Example: AutoMAID Measurements


Table 2a: Power Input (VA) Savings from AutoMAID on Disk Drives for Nexsan Storage Arrays - Dual Controller, Dual Power Supply

<table>
<thead>
<tr>
<th>Capacity/RPM</th>
<th>Idle</th>
<th>MAID Lv1</th>
<th>MAID Lv2</th>
<th>MAID Lv3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi</td>
<td>500/7200</td>
<td>0</td>
<td>1.6</td>
<td>4.3</td>
</tr>
<tr>
<td>Hitachi</td>
<td>750/7200</td>
<td>0</td>
<td>2.0</td>
<td>5.3</td>
</tr>
<tr>
<td>Hitachi</td>
<td>1000/7200</td>
<td>0</td>
<td>2.2</td>
<td>5.9</td>
</tr>
<tr>
<td>Seagate</td>
<td>750/7200</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Reduction calculated from Idle Disk as Base Measurement

Average Power Required for Different Levels of AutoMAID
Hardware Example: AutoMAID “Hero Report”

Hardware Example: Field Validation

<table>
<thead>
<tr>
<th>Nexsan Storage Use</th>
<th>MAID Levels</th>
<th>Comments</th>
<th>AMD</th>
<th>AM1</th>
<th>AM2</th>
<th>AM3</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Application</td>
<td>Day</td>
<td>Evening</td>
<td>Weekend</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genealogy Data</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>48%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Medical Image Archive</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>52%</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Scientific Images</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>31%</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Email Archive</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>31%</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Medical Research Archive</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>46%</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Test System for delivering rich media</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>46%</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Test System for delivering scientific research data</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>46%</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Storage and backup of rich media</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>40%</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Hours/week</td>
<td>60</td>
<td>60</td>
<td>48</td>
<td>42%</td>
<td>6%</td>
<td>6%</td>
</tr>
</tbody>
</table>

- Nexsan & Wikibon did a detailed study of the “Hero Reports” of eight customers who were analyzing the deployment of AutoMAID across multiple SATABeast arrays
- Savings calculated from # drives and % of time drives in energy saving mode

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Software Example – Virtualization & Thin Provisioning Benefits

Saving of 50%+ in disk capacity

Software Example – Virtualization & Thin Provisioning Array Measurements

Power for Increasing Numbers of Seagate Drives in a 3PAR Drive Chassis with Stress Test of a Representative Mix of Random & Sequential I/O

<table>
<thead>
<tr>
<th>Drives</th>
<th>0</th>
<th>8</th>
<th>16</th>
<th>24</th>
<th>32</th>
<th>40</th>
<th>Average (excluding Base Chassis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>147 GB 15K 4Hz FC</td>
<td>188</td>
<td>331</td>
<td>450</td>
<td>572</td>
<td>695</td>
<td>804</td>
<td>15.4</td>
</tr>
<tr>
<td>400 GB 10K 4Hz FC</td>
<td>188</td>
<td>291</td>
<td>382</td>
<td>497</td>
<td>594</td>
<td>697</td>
<td>12.7</td>
</tr>
<tr>
<td>750 GB 72K SATA</td>
<td>188</td>
<td>321</td>
<td>411</td>
<td>525</td>
<td>635</td>
<td>752</td>
<td>14.1</td>
</tr>
</tbody>
</table>

**Best of Breed Software Hero Report (Compellent)**

### Green Global Values
- **Cost Per Disk Per Year**: $23.12 (DrivePowerUsed x PowerCost x ConvertToAnnual)
- **kWh Per Disk Per Year**: 192 (DrivePowerUsed x ConvertToAnnual)
- **Lbs. CO2 Per Disk Per Year**: 258 (DrivePowerUsed x CarbonDioxideProduced x ConvertToAnnual)

### WVST01

<table>
<thead>
<tr>
<th>Traditional Disk Size</th>
<th>68.37 GB (Smallest disk size found on the Storage Center)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Space Used</strong></td>
<td></td>
</tr>
<tr>
<td># Disk</td>
<td>32</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td></td>
</tr>
<tr>
<td># Disk</td>
<td>1,187</td>
</tr>
<tr>
<td><strong>Electricity (kWh)</strong></td>
<td></td>
</tr>
<tr>
<td># Disk</td>
<td>1,187</td>
</tr>
<tr>
<td><strong>Lbs. CO2 Produced</strong></td>
<td></td>
</tr>
<tr>
<td># Disk</td>
<td>1,187</td>
</tr>
</tbody>
</table>

### MST04

<table>
<thead>
<tr>
<th>Traditional Disk Size</th>
<th>34.18 GB (Smallest disk size found on the Storage Center)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Space Used</strong></td>
<td></td>
</tr>
<tr>
<td># Disk</td>
<td>61</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td></td>
</tr>
<tr>
<td># Disk</td>
<td>1,410.67</td>
</tr>
<tr>
<td><strong>Electricity (kWh)</strong></td>
<td></td>
</tr>
<tr>
<td># Disk</td>
<td>1,410.67</td>
</tr>
<tr>
<td><strong>Lbs. CO2 Produced</strong></td>
<td></td>
</tr>
<tr>
<td># Disk</td>
<td>1,410.67</td>
</tr>
</tbody>
</table>

Best of Breed Software Field Validation Study

The Effects of Virtualization and Thin Provisioning on Storage Capacity for 3PAR Customers

N>100 Customers

50% of 3PAR customers achieved additional capacity benefits of 150% or more from Virtualization and Thin Provisioning.

This means they would have had to install 2.5 times the storage capacity with traditional storage arrays to achieve the same allocated space.

Could choose less aggressive savings.

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Towards an Energy Star Program (1)

Define Technologies & Array Component Savings

- Define List of Software & Hardware Technologies that can save Significant Energy/Power e.g.,
  - Virtualization
  - Thin Provisioning
  - MAID, AutoMAID & Spin-down
  - Flash Drives
  - Deduplication
  - High Efficiency Power Supplies
  - Etc.
- Collect Measurements of Energy/Power Savings in the field from each vendor for each technology (from “Phone-Home” function). Data maintained centrally with customer/vendor confidentially and savings in storage array components achievable
- Vendors who cannot supply (say) >10 deployments and (say) 30% of base and do not achieve (say) 60% of average savings of all vendors cannot include technology
- Technologies that do not improve Energy/Power by (say) >10% are not included
Towards an Energy Star Program (2)
Define Baseline & Vendor Energy Savings

• Define Baseline for each Vendor/Technology as Storage Array without Energy Efficient Technologies
• Develop a consistent methodology to measure array components
  – Define workload
  – Components within the array
• Measure Configuration with Energy Saving Technologies as defined
• **Either** Measure either Baseline configuration directly
• **Or** Calculate Baseline by adding additional components required to Energy Saving Configuration
• Calculate Vendor Array Energy Savings from Technology

Towards an Energy Star Program (3)
% Savings by Vendor Array

• Calculate Energy Savings from all Technologies in Vendor Array
• Set Energy Star Rating according to % reduction achieved by top 20%
  – >70% (say)
• Change over time as new technologies added
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Conclusions & Discussion

- Pragmatic & Adjustable Approach - No Classification of Array Types Required
- Measurements completed by Vendors with External Review
- Including Hardware AND Software Features will drive up % Savings
- Data on Technology Impact supplied by Vendors (Hero reports & Field Validation) with External Review
- Very fast final process to award Energy Star
- Discussion…………………………