Energy Efficient Storage

MSST 2008

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Overview

Atrato
Energy Usage in general
Storage Energy usage
Secondary energy usage
Storage design considerations
Why move to smaller disk drives
Design Considerations
Conclusions
Atrato was founded on the idea that we could help people achieve nearly instantaneous access to the data and content they need. Our purpose is to reshape and redefine the markets by challenging the traditional thinking about how data is accessed.

Startup formed in January 2004
Formerly Sherwood Information Partners, Inc., name changed Feb 2008
Based in Westminster, CO
Currently about 70 employees
Focused on
  - Self-maintaining Array of Identical Disks (SAID)
  - High-density packaging of small-form-factor commodity disk drives
  - Highly scalable storage controller – Avenger

Atrato, Inc. is named after the Rio Atrato in Colombia. The Rio Atrato discharges at least 175,000 cubic feet (5,000 cubic m) of water per second making it the fastest river in the world.

www.AtratoInc.com
Energy Usage in General

Data Center Power Consumers

- Processors  The principle consumer in a data center – anywhere from 50% to 90%
- **Storage Devices – about 20%**
- Networks
- Cooling units
- Power Distribution units
- Displays and Misc

Focus here is on Storage Energy Usage, specifically disk drives (no tapes)
Storage Energy Usage

Disk Drive is the primary energy consumer in a storage system

Typical Storage System Components
- Disk Drive
  - Motor
  - Electronics
  - Actuator
- Infrastructure (enclosure, controllers, fans, …etc)

Disk Drive Energy Usage Relative to Each Other
- In a 3.5-inch disk it is about 33/33/33
- In a 2.5-inch disk is it about 20/50/30
Secondary Energy Usage

Cooling

- For every watt used it takes 1 watts to remove the heat
- Air cooling is currently the preferred method
- Water is 4000 times more effective than air for cooling components

Keep the heat out of the box
Get the heat out of the rack
Move the heat out of the data center
Why move toward smaller disks

- Power reduction is non-linear in favor of smaller form factor
- Cooling is simpler because of low power consumption
- Self induced (rotational) vibration modes are significantly reduced
- Pricing takes advantage of the commodity laptop drives
- Reliability and data integrity is a different talk
Why not Move Toward Smaller Disks

<table>
<thead>
<tr>
<th></th>
<th>3.5</th>
<th>2.5</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity Per drive</td>
<td>1TB</td>
<td>250GB</td>
<td>1/4&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Density TB/unitvol</td>
<td>1TB</td>
<td>1.45TB</td>
<td>45% higher</td>
</tr>
<tr>
<td>Space in units of 2.5” drives</td>
<td>5.85</td>
<td>1</td>
<td>~1/6&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>IOPS</td>
<td>77</td>
<td>59 / 236-354</td>
<td>Individually slower Aggregate is much higher</td>
</tr>
<tr>
<td>BW (MB/s)</td>
<td>105</td>
<td>58 / 232-348</td>
<td>Individually slower Aggregate is much higher</td>
</tr>
</tbody>
</table>
In terms of Power...

<table>
<thead>
<tr>
<th></th>
<th>3.5</th>
<th>2.5</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seek/R/W Power</td>
<td>12W</td>
<td>2W</td>
<td>1/6&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Idle Power</td>
<td>8W</td>
<td>0.6W</td>
<td>1/13&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Capacity</td>
<td>83.3 GB/W</td>
<td>125 GB/W</td>
<td>50% better</td>
</tr>
<tr>
<td>Density</td>
<td>83.3</td>
<td>745</td>
<td>9 times better</td>
</tr>
<tr>
<td>Power Density</td>
<td>2 W/UV</td>
<td>2 W/UV</td>
<td>Same</td>
</tr>
<tr>
<td>IOPS</td>
<td>6 IOPS/W</td>
<td>30 IOPS/W</td>
<td>5X better</td>
</tr>
<tr>
<td>BW (MB/s)</td>
<td>9 MB/s/W</td>
<td>29 MB/s/W</td>
<td>3X better</td>
</tr>
</tbody>
</table>
Storage Design Considerations

Performance
- Signal Aggregation
- “We need more disks, not bigger ones”  
  Gary Grider, NNSA

Tight packaging but you must get the heat out
- Heat is the #1 threat to disk drive life
- Bigger disks produce more heat than smaller ones
- Tight packaging can require sophisticated cooling

Vibration management
- 2.5-inch drives have virtually no rotational vibration

Maintenance – Fail-in-place
What it all comes down to

Atrato SAID
• 3RU
• 9.3GB/sec
• 10,000 IOPS
• 40TB raw capacity
• 400Watts

3.5-inch standard packaging (16 drives per box)
• 30RU
• 16GB/sec
• 12,320 IOPS
• 160TB raw capacity
• 2500Watts

Traditional 3.5-inch enclosures
Conclusions

Small disks are non-intuitively better than 3.5-inch disks when it comes to power
- Better performance/watt
- Better capacity/watt

Requires different engineering practices
Requires different maintenance philosophy
Thank-you
Atrato™ SAID

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Traditional 3.5-inch enclosures

IBM 3650