Hello Non-volatile DIMMS, Goodbye UPS!

Ron Sartore, CEO
AgigA Tech, Inc

Mechanical Engineering Decision Tree

DOES IT MOVE?

NO

SHOULD IT?

NO

PROBLEM

YES

SHOULD IT?

NO

PROBLEM

YES

NO


Santa Clara, CA
November 2011
UPS vs. nvDIMM Decision Tree

**DOES THE SERVER NEED TO RUN DURING POWER OUTAGE?**

- **NO**
  - ALL CRITICAL DATA ON DISK?
    - **NO**
      - AGIGARAM® NVDIMM
    - **YES**
      - NO PROBLEM

- **YES**
  - ALL CRITICAL DATA ON DISK?
    - **YES**
      - GENERATOR
    - **NO**
      - UPS

UPS Headaches

- Successive Outages
- Efficiency
- Capacity
- System Growth
- Battery Replacement
- Hold Time
- Reliability
Rube Goldberg: accomplishing by complex means what seemingly could be done simply

- Wasted energy while AC powered
- Wasted energy during UPS power

Critical Data

UPS: Total Cost of Ownership (example)

Example:

<table>
<thead>
<tr>
<th>Wasted Power</th>
<th>Rate $/kwh</th>
<th>$/month*</th>
<th>$/year*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>0.49</td>
<td>14.58</td>
<td>177.39</td>
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<tr>
<td>0.15</td>
<td>0.73</td>
<td>21.87</td>
<td>266.09</td>
</tr>
<tr>
<td>0.20</td>
<td>0.97</td>
<td>29.16</td>
<td>354.78</td>
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<tr>
<td>0.25</td>
<td>1.22</td>
<td>36.45</td>
<td>443.48</td>
</tr>
<tr>
<td>0.30</td>
<td>1.46</td>
<td>43.74</td>
<td>532.17</td>
</tr>
</tbody>
</table>

* includes AC power to remove heat (K factor of 2)

Note: PG&E rates ~$0.20 in summer & ~$0.15 in winter

= +$310 per year

95% efficient
2700Watt, 92lbs
3yr life
$1,020 cost

$2K TCO

5% Wasted

Power In

95%
What’s a Nonvolatile DIMM?

nvDIMM: The “Perfect” Memory

- High Capacity
- High Speed
- High Endurance
- High Reliability
- Non-Volatility
- Low Latency
- Low Power
- Low Cost Per Bit
- Mature Technology
### The “Perfect” Memory

<table>
<thead>
<tr>
<th>Feature</th>
<th>DRAM</th>
<th>NAND</th>
<th>Exotics*</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH CAPACITY</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>HIGH SPEED</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>HIGH ENDURANCE</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>HIGH RELIABILITY</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>NON-VOLATILITY</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>LOW LATENCY</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>LOW POWER</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>LOW COST PER BIT</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>MATURITY</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

* PCM, MRAM, FeRAM, RRAM

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### AGIGARAM®: How It Works

![AGIGARAM® Diagram](image)

- **Host**
- **SRAM**
- **NAND Flash**
- **AGIGARAM® Controller**
- **Ultracapacitors**

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**Server Design Summit 2011**
Santa Clara, CA

November 2011
AGIGARAM®: How It Works

Ultracapacitors

Electrochemical Double-Layer Capacitor

Conventional

EDLC

$C \propto \frac{A}{d}$
Ultracapacitor Demo

- Fast Charge
- No Heat
- Safe
- >100K Cycles

Ultracapacitor Reliability
22F 2.7V @ 70 Degrees C

Cap Tests at 85 Degrees C

Not all Ultracaps are created equal!!

Datasheet value

Stored “0” Volts

Same Manufacturer

Voltage “A”

Voltage “B”

1.6 years
Example: UPS vs. nvDIMM

Server Rack w/ UPS
+$2,000 TCO

Server Rack w/ 8 nvDIMMs = +$1,200

- No disposal issues
- Requires less space
- Handles successive power outages
- Less maintenance, no conditioning
- "Green"

Motherboard Support is Needed

nvDIMMs

Use Cases
- NV Write-Cache for RAID
- Hash look-up & coherency
- Block management table
- Whole system persistence
- Flash translation layer

Host System Requirements
- Detect AC power loss
- Flush caches
- Place DRAM into self-refresh
- Command SAVE
- Command RESTORE
- Monitor/communicate w/ nvDIMM

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Conclusions & Predictions

- UPS Cost & Energy Waste
- Speed, Economy, Reliability
- RVDIMM
- MB Platform Support in 2012

For more info www.agigatech.com
Thank you!