Highly Efficient Power Protection for High Density Computing Applications

IBM Power and Cooling Symposium
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Eaton Corporation
Impact of High Density Computing

• Increased dissipation density. New equipment consumes 5 to 10 times the electrical power of the older equipment
• Power is now exceeding 30% of IT spend and combined with cooling exceeds 50%
• Power is consumed and dissipated unevenly in the Data Center
• Dual corded loads result in <50% power distribution utilization, which results in less efficiencies
• Customers attracted by the benefits of blade computing find themselves faced with limitations in the infrastructure
• Management of the Data Center infrastructure becomes increasingly important
Power Usage Effectiveness - PUE

Look at the Ratio of Building Load to IT Load as a Figure of Merit for the data center.

\[
PUE = \frac{\text{Building Load}}{\text{IT Load}}
\]

Uptime Numbers Suggest:
- PUE = 1.6 → Ideal 0%
- PUE = 2.0 → Target 5%
- PUE = 2.4 → Ave 10%
- PUE = +3.0 → Poor 85%

Building Load
- Demand from Grid
- Power Equipment: Backup generation, switchgear, UPS, Power Distribution.
- Cooling: Chillers, CRACs, etc.

IT Load
- Demand from Servers, Storage, Telco equipment, etc.

Source: C. Malone, C. Belady, "Metrics to Characterize Data Center & IT Equipment Energy Use"
Proceedings of 2006 Digital Power Forum
Large Variation in Performance

Power Delivery in a Datacenter

<table>
<thead>
<tr>
<th>Power Budget for 1U Server</th>
<th>Power (Watts) for 1U Server</th>
<th>Best in class</th>
<th>Nominal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Used for processing</td>
<td>300</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Power Supply Efficiency</td>
<td>85%</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>Input Power to Server</td>
<td>353</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Back-Up Power Efficiency</td>
<td>92%</td>
<td>85%</td>
<td></td>
</tr>
<tr>
<td>Input Power</td>
<td>384</td>
<td>470</td>
<td></td>
</tr>
<tr>
<td>Power for Cooling</td>
<td>288</td>
<td>705</td>
<td></td>
</tr>
<tr>
<td>Total Input Power</td>
<td>672</td>
<td>1,175</td>
<td></td>
</tr>
<tr>
<td>3yr Energy Cost (@10c/KWhr)</td>
<td>$1,766</td>
<td>$3,088</td>
<td></td>
</tr>
</tbody>
</table>

Best In Class Energy Efficiency

- Power Used for processing: 44%
- Power Supply Losses: 5%
- Back-up Power System Losses: 8%
- Cooling: 43%

Nominal Energy Efficiency

- Power Used for processing: 26%
- Power Supply Losses: 6%
- Back-up Power System Losses: 9%
- Cooling: 33%
Eaton Innovation Center Study

Scope

- Analysis and comparison of end-to-end efficiency of six different power topologies for the data center

Model Description

- Model-1: Traditional 480V AC System
- Model-2: Traditional -48V DC System
- Model-3: High Efficiency 380V DC System
- Model-4: High Efficiency 400V AC System
- Model-5: Hybrid High Efficiency 400V AC / -48V DC System
- Model-6: High Efficiency -48V DC System
Loss Comparisons vs. Load, Redundancy

- Focus on how dual corded systems are applied, not compatible with fully loaded efficiencies
- Dual corded UPS is typically loaded 25-45%
- 5-10% point potential efficiency gain with high-efficiency AC UPS or DC
- No Business Process Changes - Safety - Local availability
- Easy choice for client is “high efficiency AC,” while exploring alternatives for the future

![Graph showing system efficiencies for different models and loading scenarios.](image)
Loss Comparisons without Cooling

without cooling

<table>
<thead>
<tr>
<th>Model-1</th>
<th>Model-2</th>
<th>Model-3</th>
<th>Model-4</th>
<th>Model-5</th>
<th>Model-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platform 12V</td>
<td>UPS</td>
<td>DCDC</td>
<td>380V/12V</td>
<td>ACDC</td>
<td>PDU</td>
</tr>
<tr>
<td>Power Loss (Watts)</td>
<td>50.0</td>
<td>45.0</td>
<td>40.0</td>
<td>35.0</td>
<td>30.0</td>
</tr>
</tbody>
</table>
Loss Comparisons with Cooling

cooling COP = 3
Summary of Results

- Inefficient cooling is the largest problem in the Data Center
- High efficiency AC or DC systems can improve efficiency with 5-10% points
- High efficiency AC and DC systems have similar performance
- A future hybrid solution with in-rack -48V DC can improve efficiency an additional 2-3%
- High Voltage DC has over-current, arc flash, and other protection issues related to the safety and the integrity of the power system
- -48V DC infrastructure is not feasible for large scale Data Center due to installation cost but will continue to be the choice for telecom applications
Our response to these issues...

- Design and build leading energy efficient power systems which free up capacity typically lost to the inefficiency of legacy system designs.
- Introduce highly flexible systems allowing scalability of the power system, up or down, based on changing needs in the Data Center.
- Bring the reliability of large multi-megawatt systems to the smallest platforms for distributed deployment in the Data Center.
- Design systems with the smallest footprint per power level, freeing up critical floor space for IT equipment.
Powerware® BladeUPS™

• **Efficiency**: 12kW to 60kW with >97% efficiency will help reduce power and cooling requirements.

• **Flexibility**: Ability to flex the power system to meet changing business requirements.

• **Reliability**: Highest reliability design, using proven technology from mega Data Center UPS designs… made easy for the IT end user.

• **Power Density**: 60kW N+1 in a single 19” enclosure, maximizes Data Center space for revenue generating business requirements

Efficiency, Flexibility, Reliability, and Power Density to achieve best in class back-up power protection for high density IT Equipment
Energy Efficiency

- Industry leading 97%
- Flat energy conversion efficiency over wide load range. Improved efficiency of 5% to 15% across full load range
- Saves over $6,000 per year on utility bills (for 60kW system at full load)
- Dissipates 2/3rd less heat than comparable systems. Does not add to you cooling problems inside the datacenter

<table>
<thead>
<tr>
<th>UPS Load</th>
<th>BladeUPS Efficiency</th>
<th>Traditional UPS Efficiency</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>90%</td>
<td>80%</td>
<td>10%</td>
</tr>
<tr>
<td>30%</td>
<td>90%</td>
<td>80%</td>
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<td>60%</td>
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<tr>
<td>100%</td>
<td>90%</td>
<td>80%</td>
<td>10%</td>
</tr>
</tbody>
</table>

MPG

- Traditional Car / UPS: 24 city (typical), 34 highway (full load)
- Hybrid Car / BladeUPS: 38 city (typical), 40 highway (full load)
“Programmed for High Efficiency”

- BladeUPS is optimized to work with ITE (Information Technology Equipment) Standards
- Operates in multiple modes to provide the highest protection for the load and reduce losses in the Data Center
- Seamless transition between operating modes
Flexibility and Scalability

- 12 KW Building blocks which can be deployed to provide a range of distributed, zone or centralized back-up power protection.
- Buy only the power you need; but even more, deploy systems as stand alone 12kW UPS’s, then parallel up to 60kW, then if needed, redeploy as single systems.
- Proprietary outlet with breaker- make the BladeUPS™ the only system on the market with scalable UPS and power distribution at the same time.

Scalable from 12kW to 60kW (N+1) in a 19” Rack
Reliability

- **Robust paralleling.** With the patented Powerware Hot Sync® technology, UPS modules work in peer-to-peer fashion when configured in a parallel system, therefore no single point of failure.

- **Eaton's Advanced Battery Management.** The UPS architecture provides parallel (redundant) battery string and optimized battery discharge. ABM® technology significantly extends battery service life with a unique three-stage charging technique.

- **Intelligent maintenance bypass switch.** The internal switch inside the UPS chassis automatically activates bypass mode whenever a power module is removed. This feature ensures that power to protected loads is not accidentally interrupted by human error.

- **Hot-swappable batteries and electronics modules.** Replacing batteries or electronics modules can be done in minutes without interrupting power to IT equipment. This hot-swap capability helps reduce Mean Time to Repair (MTTR) and dramatically improves the availability of the protected IT equipment.
Power Density

- The Powerware BladeUPS offers the smallest footprint of any UPS in its class—double the power density of any other UPS system on the market. This compact design leaves more space for IT equipment in the rack.
- BladeUPS deployment with modular power distribution occupies 200 – 300% less space leaving more space for IT Equipment in small / medium data center

12kW in 6U with battery

Provides 50% more kW/ U space compared to any single module UPS
Modular Power Distribution

Rack Power Module (RPM)

Eaton 42U Enclosure
High Density Data Room Protection

Powerware BladeUPS with RPM distribution system

- High density redundant design brings high availability in a small footprint
- Four IT racks @15kW load per rack (three Blade Center H chassis per rack)
- Configuration offers up to 672 processor cores, replacing over 650 1U single processor servers.
- 30,000 Btu rear door cooling system increases cooling system efficiency.
- Computing footprint reduction of over 4x.
Energy Efficient Data Centers

**BladeUPS or Powerware 9395 UPS**
- Replacing legacy inefficient UPS with distributed BladeUPS or modular Powerware 9395 UPS enable significant increase in number of blade servers

**Fully loaded Blade Server Data Center**
- Eaton® offers other solutions to provide additional power and cooling
- Blade Server PowerChain™ Audit
- Utility upgrades
- Microturbine Combined Cooling and Power solutions
Power Xpert™ Dashboards

**Facility Health**
- Tier I – IV Rating
- Availability
- Generator, UPS… status

**Capacity**
- Power Capacity
- Cooling Capacity
- IT and Network Capacity

**Efficiency**
- Total Data Center Load / Net IT load
- Auditable data base
- Sustainability Initiatives
- Could be down to server level if desired

**Additional Information**
- Floor space
Today’s Power Systems will change… the current waste of energy in the Data Center is not acceptable

Change will not be immediate… current investment cycle too intense and customers need equipment now

Highly efficient UPS and Power Distribution solutions are available

The solution must be fully integrated (including servers), it is not sufficient to address individual components