7 Best Practices for Increasing Efficiency, Availability and Capacity

Liebert North America
Emerson Network Power: The global leader in enabling Business-Critical Continuity

- Automatic Transfer Switch
- Paralleling Switchgear
- Fire Pump Controller
- Surge Protection
- Uninterruptible Power Supplies & Batteries
- Extreme-Density Precision Cooling
- Row-Based Precision Cooling
- Power Distribution Units
- Data Center Infrastructure Management
- Cold Aisle Containment
- Rack
- Integrated Racks
- Cooling
- Rack Power Distribution Unit
- KVM Switch
- Monitoring
- UPS
Cost of data center downtime by category

- **Business disruption**: $179,827
- **Lost revenue**: $118,080
- **End-user productivity**: $96,226
- **IT productivity**: $42,530
- **Detection**: $22,347
- **Recovery**: $20,884
- **Ex-post activities**: $9,537
- **Equipment repair & replacement**: $9,063
- **Third parties**: $7,008

Source: 2011 National Study on Data Center Downtime
## Top data center concerns

<table>
<thead>
<tr>
<th>Spring 2008</th>
<th>Spring 2009</th>
<th>Spring 2010</th>
<th>Spring 2011</th>
</tr>
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<tbody>
<tr>
<td>Heat Density</td>
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Source: Data Center Users’ Group Survey
The Emerson approach

Incorporate the 7 best practices into the design and operation of your data center

Efficiency Without Compromise™
#1: Maximize Return Air Temperature at the Cooling Units to Improve Capacity and Efficiency
Higher return air temperature equals higher capacity and efficiency

10°F higher return air temperature typically enables 30-38% better CRAC efficiency
Optimizing efficiency and capacity through containment

Hot-aisle/cold-aisle arrangement creates the opportunity to further increase cooling unit capacity by containing the cold aisle
Supplemental capacity through sensible cooling

Refrigerant-based cooling modules mounted above or alongside the rack increase efficiency and allow cooling capacity to be matched to IT load.
#2: Match Cooling Capacity and Airflow with IT Loads
Controlling cooling based on conditions at the server

Variable Fan Speed

Fan Speed Control Sensor

Temperature Control Sensor

- 75-80°F
- 72-75°F
- 70-72°F
Smart Aisle cooling

- Server-centric
- Manages capacity and air volume independently
- Adapts to changing conditions
Global cooling controls enhance efficiency

- Advanced energy saving control algorithms for multiple applications
  - Supply temperature control
  - Underfloor pressure control
  - Smart Aisle control
- Teamwork modes
  - Stops fighting
  - Enhances redundancy
- Standby / Lead-Lag unit rotation
#3: Utilize Cooling Designs that Reduce Energy Consumption
Matching cooling performance to room requirements with variable capacity

- Variable Capacity
- Fans
- Compressors
- Chillers
- Pumps
- Cooling Towers

Energy cost, 10hp fan motor with variable frequency drive (VFD)
Types of economizers

Chilled water systems
- Fluid economizers
  - Parallel chiller tower
  - Series chiller tower
  - Series air cooled
- Air economizers
  - Direct
  - Indirect
  - Evaporative

DX– refrigerant cooling systems
- Glycol system
  - Drycooler
  - Cooling tower
- Refrigerant only System Economizers
  - Pumped refrigerant
The issues—failures happen

Fluid economizers
- Water usage
- Complexity of valve system and controls
- Freezing weather
- Transient change over
- Capital cost

DX Glycol systems
- Hours of free cooling
- “Extra coil” air pressure drop

Pumped refrigerant
- New technology

Fluid economizers
- Humidity control
- Contamination
- Freezing coils
- Transient change over
- Cost of indirect systems
## Cooling only PUE annualized comparisons

### Pumped Refrigerant Economization

<table>
<thead>
<tr>
<th>Location</th>
<th>ASCOP</th>
<th>Cooling PUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Houston</td>
<td>5.89</td>
<td>1.17</td>
</tr>
<tr>
<td>San Francisco</td>
<td>7.91</td>
<td>1.13</td>
</tr>
<tr>
<td>Columbus, Ohio</td>
<td>8.05</td>
<td>1.12</td>
</tr>
<tr>
<td>Chicago</td>
<td>8.32</td>
<td>1.12</td>
</tr>
<tr>
<td>New York</td>
<td>7.64</td>
<td>1.13</td>
</tr>
<tr>
<td>Atlanta</td>
<td>6.62</td>
<td>1.15</td>
</tr>
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</table>
Direct server cooling without server fans

- Cooling to the chip with “cold plates”
  - 1U server modified with no fans
  - Pumped refrigerant fluid cooled
  - Performance tested by LBNL
- Efficiency benefit
  - No chiller required for many locations
  - Total energy consumed less than energy of the IT fans removed
- Is that a PUE of <1?
#4: Select a Power System to Optimize Your Availability and Efficiency Needs
# Four tiers of data center infrastructure availability

<table>
<thead>
<tr>
<th>Data Center Infrastructure Tier</th>
<th>Description</th>
<th>Availability Supported</th>
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<tbody>
<tr>
<td>I: Basic Data Center</td>
<td>Single path for power and cooling distribution without redundant components.</td>
<td>99.671%</td>
</tr>
<tr>
<td>II: Redundant Components</td>
<td>Single path for power and cooling distribution with redundant components; N+1 with a single-wired distribution path throughout.</td>
<td>99.741%</td>
</tr>
<tr>
<td>III: Concurrently Maintainable</td>
<td>Multiple active power distribution paths, only one path active. Redundant components.</td>
<td>99.982%</td>
</tr>
<tr>
<td>IV: Fault Tolerant</td>
<td>Dual bus distribution with two paths active providing distributed redundancy</td>
<td>99.995%</td>
</tr>
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</table>

**TIER 1**
- Utility Source
- UPS
- PDU
- Load

**TIER 2 Parallel Redundant**
- Utility Source w/ ATS & Generator
- UPS 1
- UPS 2
- SCC
- PDU
- Load

**TIER 3 & 4 Distributed Redundant**
- Utility Source / Generator #1
- 2nd Utility Source = Tier 4
- UPS 1
- STS
- UPS 2
- PDU
- Load
Increasing number of UPS in N+1 system increases risk of failure
## Transformer-based vs. transformer-free UPS design

<table>
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<tr>
<th>Characteristic</th>
<th>Transformer-Free</th>
<th>Transformer-Based</th>
</tr>
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<tbody>
<tr>
<td>Fault Management</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Low Component Count</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Robustness</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Input / DC / Output Isolation</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Scalability</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>In the Room / Row</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Double Conversion Efficiency</td>
<td>~96%</td>
<td>~94%</td>
</tr>
<tr>
<td>VFD (Eco-Mode) Efficiency</td>
<td>Up to 99%</td>
<td>Up to 98%</td>
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Double Conversion Operation (VFI Mode)
Intelligent Eco-mode Operation (VI Mode)

- Inverter stays in Idle
- Corrects sags and swells but not frequency
- Bypass source is monitored
- Load harmonics profiled
- Learns off-peak times
- 3+% efficiency gain
- VI mode (inverter hot, also an option)
Intelligent paralleling reduces UPS energy consumption

3 Units @ 25% Load Each = 91.5% Efficiency

2 Units @ 38% Load = 93.5% Efficiency
#5: Design for Flexibility Using Scalable Architecture that Minimizes Footprints
Two-stage power distribution provides needed scalability and flexibility
Moving power distribution and scalability closer to the rack

- Modular busway, hot swappable, 100, 225 and 400 amp
- Modular row-based UPS scalable in 45kW cores
- Modular power strip / rack PDU
#6: Enable Data Center Infrastructure Management and Monitoring to Improve Capacity, Efficiency and Availability
Optimizing performance with data center infrastructure management and monitoring

Control begins with a solid instrumentation strategy
Improving availability

Auto track critical infrastructure systems:
alerts, alarms, monitoring & control.
Increasing efficiency

- Track, measure, trend and report on key data points
  - Temperature
  - kW
  - Watts
- Generate PUE metrics
Managing capacity

- Rack
- Row
- Room
- Air
- Power
- Distribution
#7: Utilize Local Design and Service Expertise to Extend Equipment Life, Reduce Costs and Address Your Data Center’s Unique Challenges
Consulting with specialists to apply best practices and technologies

Configuration support and design assistance
Preventive service elevates battery mean time between failure

Battery maintenance and no monitoring experience low reliability

Monitoring experience significantly longer runtime before a failure

Remote monitoring have experienced no outages due to bad batteries – 1.6 million run hours!

Study based on batteries under contract prior to the end of their expected service life
Supplementing preventive maintenance with data center assessments
Apply These Best Practices For Optimal Performance

1. Maximize the return air temperature at the cooling units to improve capacity and efficiency
2. Match cooling capacity and airflow with IT Loads
3. Utilize cooling designs that reduce energy consumption
4. Select a power system to optimize your availability and efficiency needs
5. Design for flexibility using scalable architecture that minimizes footprints
6. Enable data center infrastructure management and monitoring to improve capacity, efficiency and availability
7. Utilize local design and service expertise to extend equipment life, reduce costs and address your data center’s unique challenges

White Paper:
Seven Best Practices for Increasing Efficiency, Availability and Capacity: The Enterprise Data Center Design Guide