Dynamic Power Management in the Data Center

IBM Power and Cooling Symposium
Raleigh, NC
04 October 2007

Bharat S. Shah
Emerson Network Power

Bharat.Shah@EmersonNetworkPower.com
Agenda

- Power Management Challenges
- IT Equipment Power Reduction Schemes
- Facility Infrastructure Power Improvements
- Dynamic Power Management System
- Summary
Power Management Challenges

- Over the next five years, power failures and limits on power availability will halt data center operations at more than 90% of all companies (AFCOM (DCI))

- By 2008, 50% of data centers will have insufficient power and cooling capacity to meet the demands of higher density equipment (Gartner)

- Power and cooling spending will exceed server spending within 2 years (IDC, Gartner)

- Power associated with servers, storage and network equipment will increase from 1.5% of total US energy consumption to 2.5% by 2011 (EPA)

Source: EPA, Andrew Fanara
Current Data Center Power Consumption

- **Cooling**: 25%
- **Air Movement**: 12%
- **Electricity Transformer**: 10%
- **UPS**: 3%
- **Lighting, etc.**: 8%
- **Other IT Equipment**: 8%
- **Servers**: 42%

Source: EYP Mission Critical Facilities Inc., Emerson estimate

---

**PUE**: Power Usage Effectiveness
**DCE**: Data Center Efficiency

- Building Load: Demand from grid
  - Total Facility Power
    - Power: Switchgear, UPS, Battery backup, Etc.
    - Cooling: Chillers, CRACs, Etc.
- IT Load: Servers, Storage, Telco equipment, Etc.

\[
PUE = \frac{\text{Total Facility Power}}{\text{IT Equipment Power}}
\]

\[
DCE = \frac{1}{PUE} = \frac{\text{IT Equipment Power}}{\text{Total Facility Power}}
\]

Source: Green Grid
Feb 2007
**Current Data Center Power Management**

No System Linkage
- Workflow Processes at Best
- Typically E-Mail/Phone Communication
- Reactive Mode at Worst

---

**IT Management System**
- Servers
- Routers
- 3rd Party
- Storage
- Switches

---

**Facility Management System**
- UPS
- Cooling
- ATS
- GenSets
- 3rd Party
Agenda

- Power Management Challenges
- IT Equipment Power Reduction Schemes
  - Server Hardware
  - Virtualization Software
  - Dynamic Efficiency Control
Server Hardware Architecture Example

AC-DC / PFC
Power Supply

Dynamically optimize IBV

48 Vdc

12 Vdc

Dynamically optimize efficiency

Processor, memory and I/O loading

DC-DC/VRM
DC-DC/VRM
DC-DC/VRM
DC-DC/VRM
Virtualization Software

Putting Virtualization to Work: NewsCorp

- Four 4P AMD Opteron™ processor-based servers (single core without AMD)

Source: NewsCorp
IDC Virtualization Forum, Feb 2006
Dynamic Efficiency Control
Digital Power Supplies

- Dynamic efficiency enhancement based on load fluctuation thru virtualization (via digital power supplies)

Efficiency Curve Shaping: This is an optimized 760W 1+1 power supply for a data center application. It is optimized for efficiency at 20% to 50% load – the range in which it will operate for 98% of its service life.

Source: Emerson Internal
PMBus™ compliant power supplies provide in-band / out-of-band access to sensors, reporting power consumption data via SMBus.

GUI displays system power consumption reported by Digital Power Supply.

Source: Intel
*Intel Developers Forum, Apr 2007*
**Agenda**

- Power Management Challenges
- IT Equipment Power Reduction Schemes
- Facility Infrastructure Power Improvements
  - Digitally-Controlled Compressors
  - Scalable UPS Systems
  - Plug-and-Play Cooling Capacity
Digitally-Controlled Compressors

Continuously variable capacity compressors dramatically reduce the frequency of start/stop cycles – saving energy and significantly increasing MTBF.
Scalable UPS Systems

- Capacity added via software key (enables additional capacity without hardware addition/change)
- Examples:
  - Soft-Scale (fine adjustment)
    - 40kVA → 60kVA → 80kVA
    - 80kVA → 100kVA → 120kVA
    - 120kVA → 160kVA → 200kVA

Scalable systems enable pay-as-you-go capacity without over-engineering for maximum capacity – saving equipment capex and energy opex.
Plug-and-Play Cooling Capacity

Supplemental cooling can be added to hot-spots saving energy and minimizing labor costs.
Agenda

- Power Management Challenges
- IT Equipment Power Reduction Schemes
- Facility Infrastructure Power Improvements
- Dynamic Power Management System
Dynamic Power Management System
Bridging/Optimizing IT and Facility Systems

Power Management System
- Centralized or Distributed Intelligence
- Optimization Policies / Business Rule Engine
- Manual or Auto-Pilot Operation

IT Management System

Facility Management System

Open Bus

Proprietary or Open

3rd Party

Open
Dynamic Power Management System

- **Reduce Energy Costs**
  - Equipment power control (on/off/standby) and equipment provisioning in response to dynamic computing demand

- **Reduce Cooling Needs**
  - Balanced cooling based on dynamic IT workload conditions

- **Improve Capacity Planning**
  - Scenario planning of power/cooling infrastructure changes in response to computing load changes
Dynamic Power Management Systems
Reduce Energy Costs

- Optimize energy consumption across the entire data center in response to IT workload variations
- Capture additional savings based on utility availability or rate structure

Optimize power consumption from CHIP to GRID.
Dynamic Power Management Systems
Reduce Cooling Needs

- Set rules to adapt cooling to the load
  - Manage compressor load across units
  - Manage humidification & dehumidification
  - Cycle units, rotate standby units

Further reduce energy costs and extend life of cooling equipment.
Dynamic Power Management Systems
Improve Capacity Planning

- Match power / cooling capacity with computing resource consumption
  - Determine if additional computing resources can be added within a specific power and cooling budget in the same physical space
  - Or if new space is required to house these additional computing resources

Avoid reactive crises through proactive planning of computing and infrastructure change scenarios.
Dynamically Optimized Data Center

- **2007-2008**
  - Real time monitoring
  - Modular systems
  - Adaptive scalable architecture
  - Separate systems for power, cooling,...

- **2008, 2009 -**
  - Integrated, dynamically optimized adaptive systems
  - Virtualization and load balancing linked to power and cooling
  - Intelligent models for control and Optimization/Advance fault notification

**Type of Control →**

**With Power Management →**
Agenda

- Power Management Challenges
- IT Equipment Power Reduction Schemes
- Facility Infrastructure Power Improvements
- Dynamic Power Management System
- Summary
Summary

- IT and Facility equipment continue to evolve intelligently
  - Higher Efficiency, Digital Control and Virtualization
- Current management, monitoring and control software optimize IT and Facility systems independently
- Bridging the IT and Facility systems with an integrated Power Management solution dynamically optimizes efficiency across the entire Data Center