Data Center Efficiency & Power Solutions

David Jenkins
Jay Kyathsandra
DCG Technology Marketing
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Agenda

• Data Center Efficiency Challenges
• Efficiency Priorities
• Intel Approach To Efficiency
• Solutions Overview
  − Server Refresh w/ Intel® Xeon® Processors
  − Intel® 10GbEthernet
  − Intel® Intelligent Power Node Manager
  − Intel® Data Center Manager
  − Solutions in development
    − Power Thermal Aware scheduling
    − High Ambient Temperature Operation
    − Intel® Server Battery Backup Unit
  − Data Center Design
• Summary
Data Center Efficiency Challenges

- WW Datacenter construction spending is increasing – 60% growth (~30$B) over 10 years.. 2011 – MS (C Belady)

- Total power consumed by data centers .. 2-3% of all electricity generated by 2014..EPA

- $27 B/yr spent on server energy costs..IDC 2009

*Intel® technologies and data center optimization solutions will help achieve higher efficiency (lower PUE) and lower total cost of computing*
Data Center Efficiency Priorities

Achieve efficiency and reliability by maximizing available capacity and modular build out for growth

1. **Modernize**
   Efficient IT Infrastructure
   - Power Utilization -(PUE)
   - Operational costs
   - Capital Costs
   - Server deployment time

2. **Manage**
   Measurement and Accountability

3. **Maximize**
   Operational Efficiency

A holistic approach – systems, rack, design and monitoring
Intel Approach To Data Center Efficiency...

- Deliver leading products, technologies and datacenter efficiency solutions that lower Capital Expenditures and Operational Costs

Efficiency Across – Platform, Infrastructure, & Operations

Platform Innovation
System Design
Data center Optimization
Industry/End user Adoption
Improve Your Data Center Efficiency
Modernize, Manage & Maximize with Intel®

**Modernize**
Efficient Infrastructure
- Server Refresh with Intel® Xeon® Processors
- Simplify Network with Intel® 10GbE
- High Ambient Temperature optimized designs
- Battery Backup Unit solutions
- Rack technologies for shared power & cooling

**Manage**
Measurement & Accountability
- Intel® Intelligent Power Node Manager
- Adopt Data Center and container design best practices

**Maximize**
Operational Efficiency
- Manage data center Power and Thermal profile using Intel® Intelligent Power Node Manager Intel® Data Center Manager
- Integrate IT and Facilities management systems with Power Thermal Assessment Scheduling

Technology solutions for ongoing efficiency improvements
Server Refresh: Single Core → Xeon® 5600

2005

15 racks of Intel® Xeon® Single Core Servers

2010

1 rack of Intel® Xeon® 5600 Based Servers

- Efficiency Refresh 15:1 -

95% Annual Energy Cost Reduction (estimated)
As Low as 5 Month Payback

- Performance Refresh 1:1 -

Up to 15x Performance
8% Annual Energy Costs Estimated Reduction (estimated)

Source: Intel measurements as of Feb 2010. Performance comparison using server side Java bops (business operations per second). Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance. For detailed calculations, configurations and assumptions refer to the legal information slide in backup.
The Cost of Waiting in 2010

<table>
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<tr>
<th>Cost Category</th>
<th>Estimated Cost (USD) per Month</th>
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</thead>
<tbody>
<tr>
<td>Software support</td>
<td>$50,920</td>
</tr>
<tr>
<td>Utility costs</td>
<td>$18,380</td>
</tr>
<tr>
<td>Warranty costs</td>
<td>$31,250</td>
</tr>
</tbody>
</table>

**Total estimated monthly cost:** $100,000

Refresh: If not NOW, when?

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1. Monthly Savings in utility and SW support costs determined by comparing the incremental costs associated with not refreshing 50 older single-core servers purchased back in 2005 vs. refreshing on an approximate 15:1 ratio with a Xeon 5680-based servers in Year 1. Warranty cost assumed $750/year if purchased after the initial OEM warranty period has expired. Actual total cost is $100,750. Source: Consolidation ratio calculated using the Xeon® Server Refresh Savings Estimator (www.intel.com/go/xeonestimator) and uses publicly available RHEL OS support costs, default utility settings, and SPECint_rate_base2006 performance and power data for the Xeon® X5680 as found in the backup.

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INTEL CONFIDENTIAL
A Unified Network with Intel® 10G Ethernet Solutions

GbE Server Connections

estimted

45%
Reduction in Power per Rack

estimted

80%
Reduction in Cables and Switch ports

10GbE Server Connections

estimted

15%
Reduction in Infrastructure Costs

estimted

2x
Improved Bandwidth per Server

Intel® 10 Gigabit X520
10GbE Dual Port
(x/k Mezzanine Card)

Intel® Ethernet Server Adapter X520-DA2
(with optional 10GbE/Gbe SR optics)

Intel® 10 Gigabit X520-T2 Server Adapter
(10GBASE-T)

Realize the full potential for Xeon® 5600 platforms

Source: Intel 10GBe ROI calculator. See backup for details.
Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.
Managing Data Center Power & Energy

Intel® Intelligent Power Node Manager
Monitor and Control Server Power

- Report system level energy use
- Limit individual SERVER power consumption

Intel® Data Center Manager Manager and Coordinate at the Data Center Level

- Limit total RACK power draw
- More productivity per rack
- Limit aggregated ROW power draw

Aggregated, Policy-Based Power Management for the Data Center
**Node Manager & Data Center Manager Results**

- **Manage**
  - **Power and Thermal Monitoring**
  - **Replace IP power strips and serial concentrators, saving ~$400 per rack**

- **Maximize**
  - **Increased Rack Density**
  - **Up to 40% more servers and performance per rack**

- **Maximize**
  - **Workload Power Optimization**
  - **Up to 30% power optimization without performance impact**

- **Maximize**
  - **Business Continuity**
  - **Continued compute availability through power or thermal event**

**Delivering Results End Users Value**
Solution Choices For Directed Power Management

Node Manager Servers
- ASUS
- SUN
- Dell
- GIGABYTE
- Foxconn
- Lenovo
- Quanta Computer
- MSI
- TYAN
- IESC
- zt Systems

Data Center Solutions
- Inspur
- Mitac
- PowerEdge C
- PowerLeader
- sgi
- Supermicro

DCM Enabled Consoles
- ASG
- PowerLeader
- SiteView
- ssd
- Joulex
- Solution Labs

Growing Choices For Solutions Using Intel® Directed Power Management
Solutions in Development

- Power Thermal Aware Scheduling – **PTAS - Concept**
- Server Battery Backup Unit - **Pilot**
- High Ambient Temperature Operation - **Pilot**
Power Thermal Aware Scheduling (PTAS)

• Achieve efficiency and lower PUE thru a holistic and integrated approach to Data center infrastructure management

Integrate IT and Facilities Management

• Lower operational costs ~20% +
• Recovery up to 50% of unused cooling capacity +
• Reduce DC monitoring instrumentation costs

Maximize Operational Efficiency

Server level – Power, Thermal and Workload Data

Power Thermal Aware Scheduling
Dynamic Provisioning - Workload placement, Cooling systems automation

Making Integration of IT and Data center Infrastructure a reality

*Intel internal estimate
INTEL CONFIDENTIAL
Intel® Battery Backup Solution

- Server BBU – growing trend, leading lower capital spending and increase power efficiency
- Intel solution - Licensing Intel® Server BBU solution architecture to OEM’s, battery and power supply manufacturers

Reduce Data Center Capital Costs

- Reduce UPS related capital expenditure costs ~ 5X\(^1\)
- Recover UPS related power efficiency loss – ~30-40\%\(^2\)
- Easy deployment and time to market solution

Built for Power Resiliency

Integrates with most systems...enhanced with Intel® Intelligent Power Node Manager

1\(\text{Intel internal estimate}\)
2\(\text{APC whitepaper # 108}\)

Simplifies infrastructure and increases flexibility for modular build out

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.
High Temperature Operation (HTA)

- Operate at optimal datacenter temperature set point. Typically at ~21°C, trending to ~30°C
- Benefit - Decrease chiller energy costs by operating at higher temperature

Google: Raise Your Data Center Temperature..80°F

- Sun – 4% savings in chiller energy costs for 1°C in upward change

Facebook Saves ~229K/yr in energy bill by retooling its Cooling..to 81°F

Yahoo Computing Coop: Shape of Things to Come?..– No Chiller - Estimated PUE - 1.1

- Microsoft saved 250K/yr energy costs by raising 2-4°C

- Intel IT raised to 92°F, for 10 mo (Proof of concept)

2) http://www.datacenterknowledge.com/archives/2008/10/14/google-raise-your-data-center-temperature
4) Intel internal estimate and based on market data analysis
**Intel Solution For HTA**

Intel Solution - Integrated solution tools and methodology to achieve optimal set point – Component selection, system design & datacenter infrastructure

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**Reduce Cooling Costs**

- ~ 4-5% cooling related reduction / 1 0c increase in temp
- Optimize for IT & Facilities infrastructure

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**The Right Temperature Set Point Varies**

- **Choice of Platform**
- + Intel® Intelligent Power Node Manager

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**Leading OEM’s delivering HTA capable systems on Intel® Xeon® processor based platform**

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1 Source: Sun http://www.datacenterknowledge.com/archives/2008/10/14/google-raise-your-data-center-temperature
Summary

• Achieving significant improvements in data center efficiency requires IT to modernize, manage and maximize IT and cooling infrastructure
• Intel delivers leading edge products & technologies that address customer power and cooling needs
• Develop innovative solutions that improve Data center efficiency lower Capital costs and operational costs
• Engage actively with Industry to accelerate adoption and support end users to test, validate and incorporate solutions in their data centers
Back Up
Intel® Intelligent Power Node Manager

- **Second generation** power reporting and capping technology from Intel®
- Provides **directed power management** features that compliment a BMC or manageability controller functionality

- Monitors and reports system level and processor and memory power consumption
- Enforces power caps by adjusting processor or memory power or dynamically allocating processor cores

**Delivers Platform Level Instrumentation Required To Improve Data Center Power Efficiency**
Intel® Intelligent Power Node Manager

Use Case Evolution

**Power and Thermal Monitoring**
- Workload Power Characterization
- Facilities Planning
- Chargeback Models
- IP Power Strip & Concentrator Replacement

**Static Power Capping**
- Increased Rack Density
- Workload Power Optimization
- Boot Power Spike Management
- Power Supply / System RAS

**Dynamic Power Capping**
- Business Continuity Chiller Event
- Business Continuity Power Event

**Integration**
- Power & Thermal Aware Scheduling
- Power & Thermal Aware Balancing
- Close Coupled Cooling

Start With Basics – Move To More Advanced Cases with Time & Experience
More Compute/Fixed Power Infrastructure

Maximize ROI for Available Rack Power and Capital Expenditure

Set rack level power cap policy 14A (3,080W)

Increased Rack/Compute Density

- Additional 40% rack density captured through power capping, minimal performance impact

- Increased rack density 10-30%, saving $500/server over 4 years with no major performance impact

Baidu current rack density unites server per rack, 385W power consumption budget for per server.

Stable rack density increase policy 8 to 9, 342W power consumption budget for per server.

More efficiency rack density increase policy 9 to 10, 308W power consumption budget for per server.

*Publicly available white papers. See backup for details
Power Optimization results are dependent on the system configuration and the workload – results will vary accordingly.¹ Public whitepapers available for download.

Workload Power Optimization

- **Baidu**: 30W per server savings with no performance impact¹
- **BMW**: ~19% per server savings without performance tradeoff¹
- **Oracle**: ~35% power savings expected¹
- **Intel**: 100W savings for 4 servers for Microsoft* SQL Server* workload¹
- **FSI**: 22W savings per server on Monte Carlo ZCS workload

1. Equal to or less than
Intel® Data Center Manager
An SDK Datacenter Power and Thermal Management; Easy to Integrate in the Management Console

**MONITORING**
- Real-time monitoring of actual power and inlet temp data* aggregated to rack, row, room and user-defined logical groups

**TRENDING**
- Log power and thermal data, query trend data using filters
- Saves 1 year of history data for capacity

**CONTROL**
- Supports multiple active power policy types, schedule by time of day
- Co-existing policies at multiple hierarchy levels e.g., row, rack, group. Policy accepts SLA priority as directive

Enables Management Consoles To Scale Node Manager Functionality To The Group Level
5 Month Single Core Refresh ROI Claim

- 5 month ROI claim estimated based on comparison between 2S Single Core Intel® Xeon® 3.80 with 2M L2 Cache and 2S Intel® Xeon® X5680 based servers. Calculation includes analysis based on performance, power, cooling, electricity rates, operating system annual license costs and estimated server costs. This assumes 8kW racks, $0.10 per kWh, cooling costs are 2x the server power consumption costs, operating system license cost of $900/year per server, per server cost of $7200 based on estimated list prices and estimated server utilization rates. All dollar figures are approximate. Performance and power comparisons are based on measured server side java benchmark results (Intel Corporation Feb 2010). Platform power was measured during the steady state window of the benchmark run and at idle. Performance gain compared to baseline was 15x.

  - Baseline platform: Intel server platform with two 64-bit Intel Xeon Processor 3.80Ghz with 2M L2 Cache, 800 FSB, 8x1GB DDR2-400 memory, 1 hard drive, 1 power supply, Microsoft* Windows* Server 2003 Ent. SP1, Oracle* JRockit* build P27.4.0-windows-x86_64 run with 2 JVM instances

  - New platform: Intel server platform with two Intel® Xeon® Processor X5680 (12M Cache, 3.33 GHz, 6.40 GT/s Intel® QPI), 24 GB memory (6x4GB DDR3-1333), 1 SATA 10krpm 150GB hard drive, 1 800w power supply, Microsoft Windows Server 2008 64 bit SP2, Oracle* JRockit* build P28.0.0-29 run with 4 JVM instances

- Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, visit Intel Performance Benchmark Limitations.
### Move to 10GbE and Save

#### 10GbE ROI Calculation

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<td>Total</td>
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#### Assumptions:
This ROI calculator is a cost comparison for a highly virtualized solution, using multiple 1GbE connections versus a dual port 10GbE implementation. In the 1GbE solution we use in each server two Intel® Gigabit ET Quad Port Server Adapters, in addition to two LOM connections with a total system bandwidth of 10 Gb. This is then compared with a 10GbE solution, using one Intel® 10 Gigabit AF DA Dual Port Server Adapter and a total system bandwidth of 20Gb. These adapters are connected to a top-of-rack 10GbE switch using passive direct attach twinax cox cables.

[http://www.event-management-online.de/LAD/calculator.aspx](http://www.event-management-online.de/LAD/calculator.aspx)

- **Source:** Intel 10GbE ROI Calculator. This ROI calculator is a cost comparison for a highly virtualized solution, using multiple 1GbE connections versus a dual port 10GbE implementation.
Node Manager Claims Back Up

**Extreme Efficiency: Power Management**

**Increasing Rack Density Proof Points**

**Increasing Rack Density Proof Points**
- Intel IT and FSI results based on Intel internal testing of Intel Xeon Processor 5500 series whiteboxes in an NDA environment.

**Increasing Rack Density Model Baidu Proof Point**

**Power Optimization Model Oracle Proof Point**