Energy-Efficient IT
Incenting Good Practices

Jon Haas
Director
Eco-Technologies Programs

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Agenda

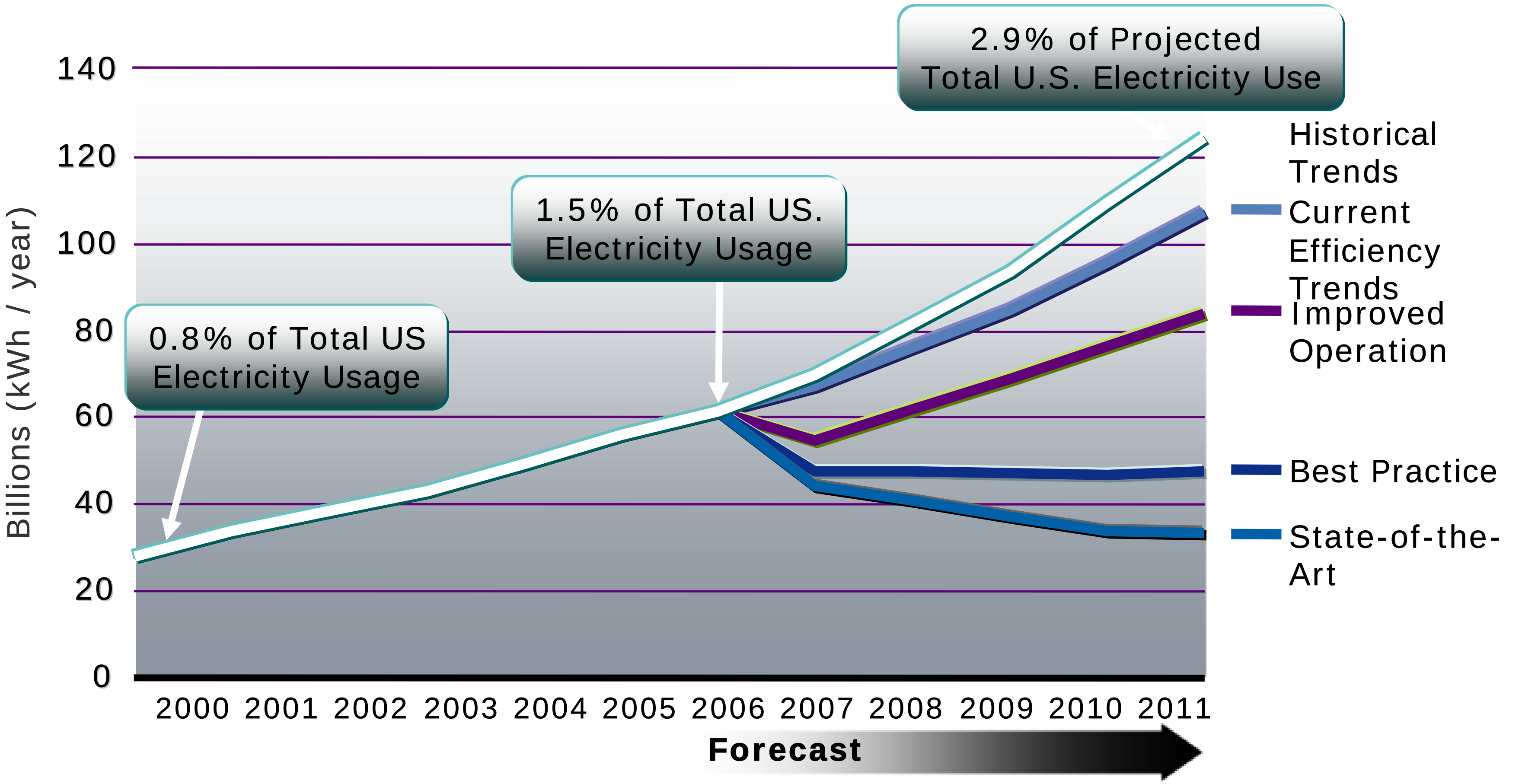
- Energy Efficient IT challenges
- Server incentive example
- Client incentive example
- vPro power management incentive example
- Opportunities for collaboration

IT Challenges Remain the Same

- Server Sprawl
- Power and Cooling
- Under-utilized Assets
- High Operating Costs
- Insufficient Space
- Capital Constraints

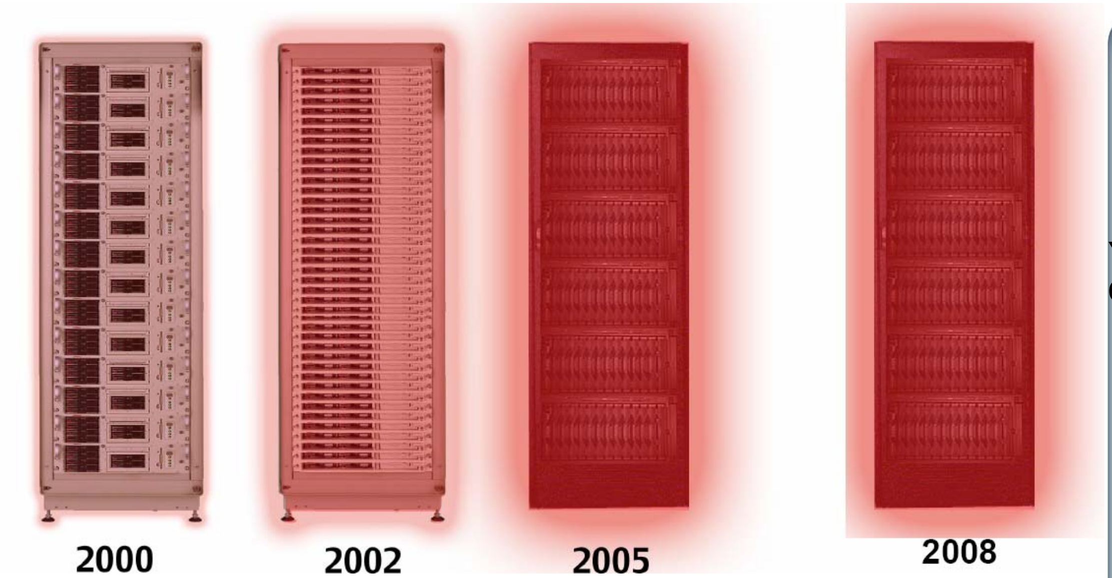
The Opportunity for Energy-managed Data Centers

Projected Data Center Energy Use Under Five Scenarios



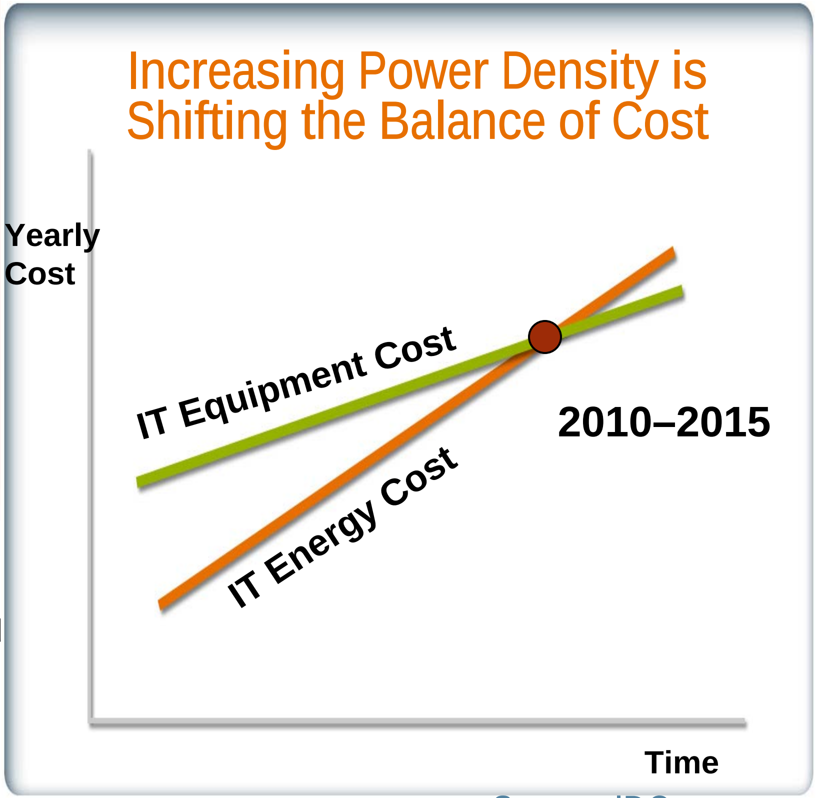
Source: EPA Report to Congress on Server and Data Center Energy Efficiency; August 2, 2007

Cost of Power is changing IT



2000	2002	2005	2008
28x2U Servers 2kW Heat Load	42x1U Servers 6kW Heat Load	6 BladeCenters 24kW Heat Load	6 BladeCenters 30kW Heat Load

Source: Emerson Network Power/Liebert



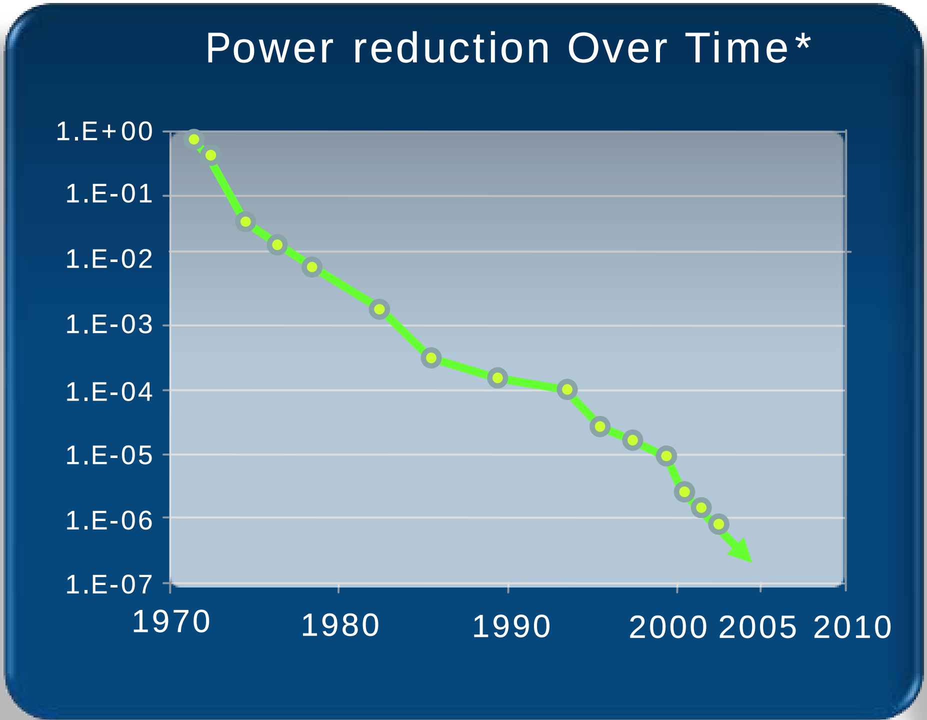
Source: IDC

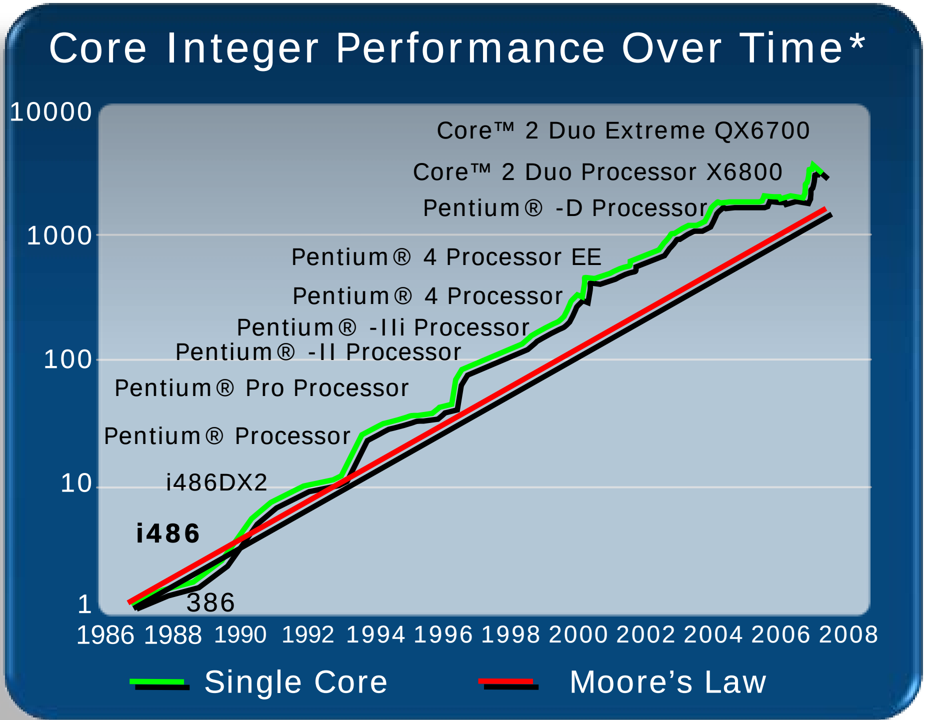
Increasing demand and rack power density are shifting the balance of cost

Standard prescriptive incentives needed on a national level

- Currently most IT EE incentives are one off consultant based projects
  - Many times the process is too cumbersome for customers
  - Timing lag and complexity tend to defeat the purpose
- Need standardized incentives for key technologies already proven to save significant amounts of energy
  - Server/desktop/laptop refresh (Energy Star)
  - Virtualization and/or consolidation
  - Power Management (server and client)
  - Data Center infrastructure upgrades
    - HVAC, Economizers, UPS, free cooling etc.
  - New Data Center designs for energy efficiency optimization
    - Incent the right decision up front

Moore's Law drives continuous chip-level Energy Efficiency





1 million x factor reduction in energy/transistor over 30+ years

Smaller, faster transistors = faster AND more efficient chips and computer systems

Source: Intel Corporate Technology Group

Moore's law drives the tick Tock model

Intel® Core™ Microarchitecture		Intel® Microarchitecture codename Nehalem		Future Intel® Microarchitecture
Merom	Penryn	Nehalem	Westmere	Sandy Bridge
NEW Microarchitecture 65nm	NEW Process Technology 45nm	NEW Microarchitecture 45nm	NEW Process Technology 32nm	NEW Microarchitecture 32nm
TOCK	*TICK*	*TOCK*	*TICK*	*TOCK*

2006 to date (Merom–Nehalem) — *Forecast* (Westmere–Sandy Bridge)

Launched in 2006: Intel® Core™ Microarchitecture

- **> 20 terawatts hours less energy consumed**
- **$2B+ in energy cost savings since Q206***

*Estimated, not actual. Source: Intel Blog "The Increasing Value of Energy Efficiency" Sept 23, 2008.
http://blogs.intel.com/csr/2008/09/the_increasing_value_of_energy.php

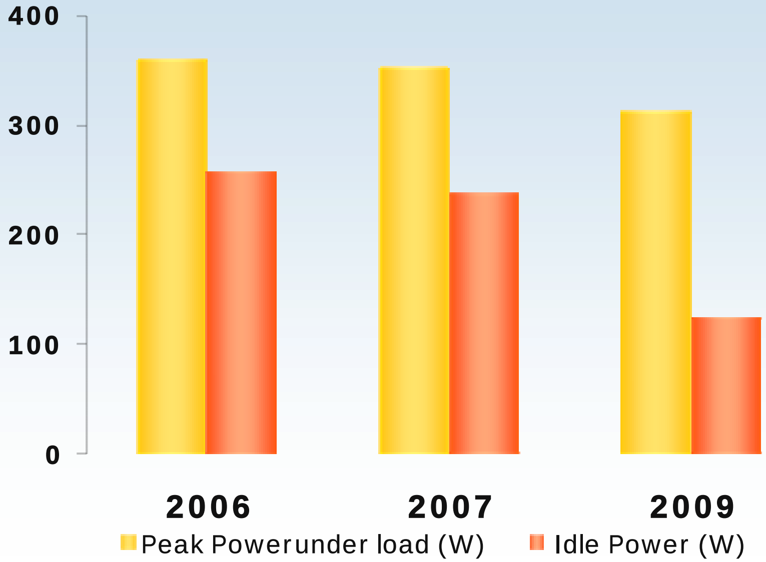
All dates, product descriptions, availability and plans are forecasts and subject to change without notice.

Energy Efficiency Summary: Intel® Xeon® Processor 5500 Series Processor

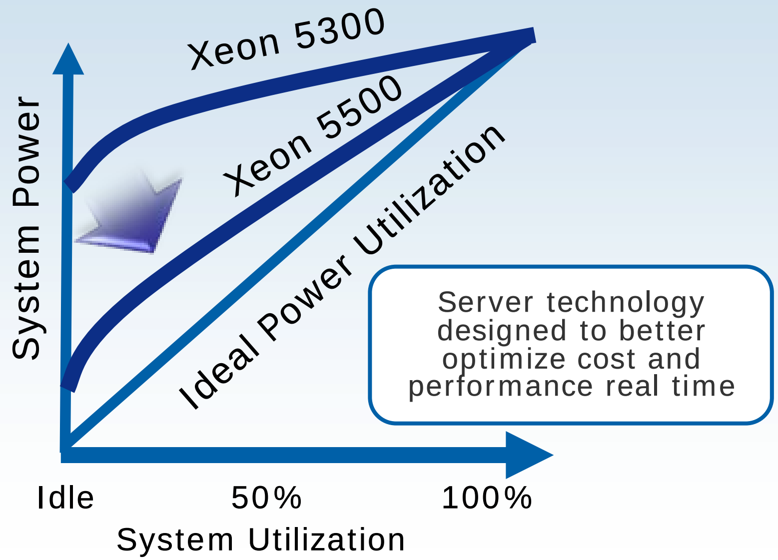
Energy Efficiency

- Up to 2.25x performance, similar power envelope†
- Lower system idle power reduces IT costs
- Dynamically turns cores on/off to meet performance needs

Idle and Peak Power Reductions†



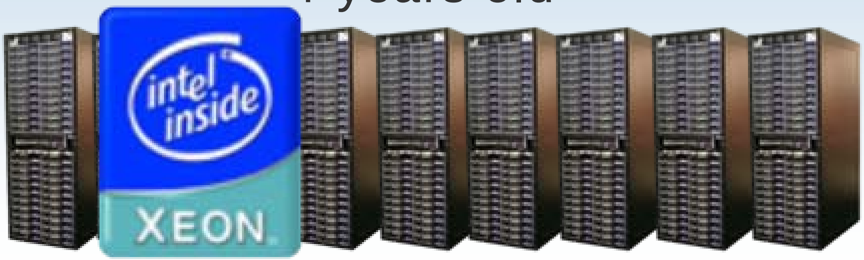
Matching Power Consumed to Performance Delivered



Potential Energy-Savings by Server Refresh Example 1 (same performance footprint)

2005 184 single core servers

4 years old



2009 21 Intel® Xeon® processor 5500 based servers

Up to
9X
server reduction

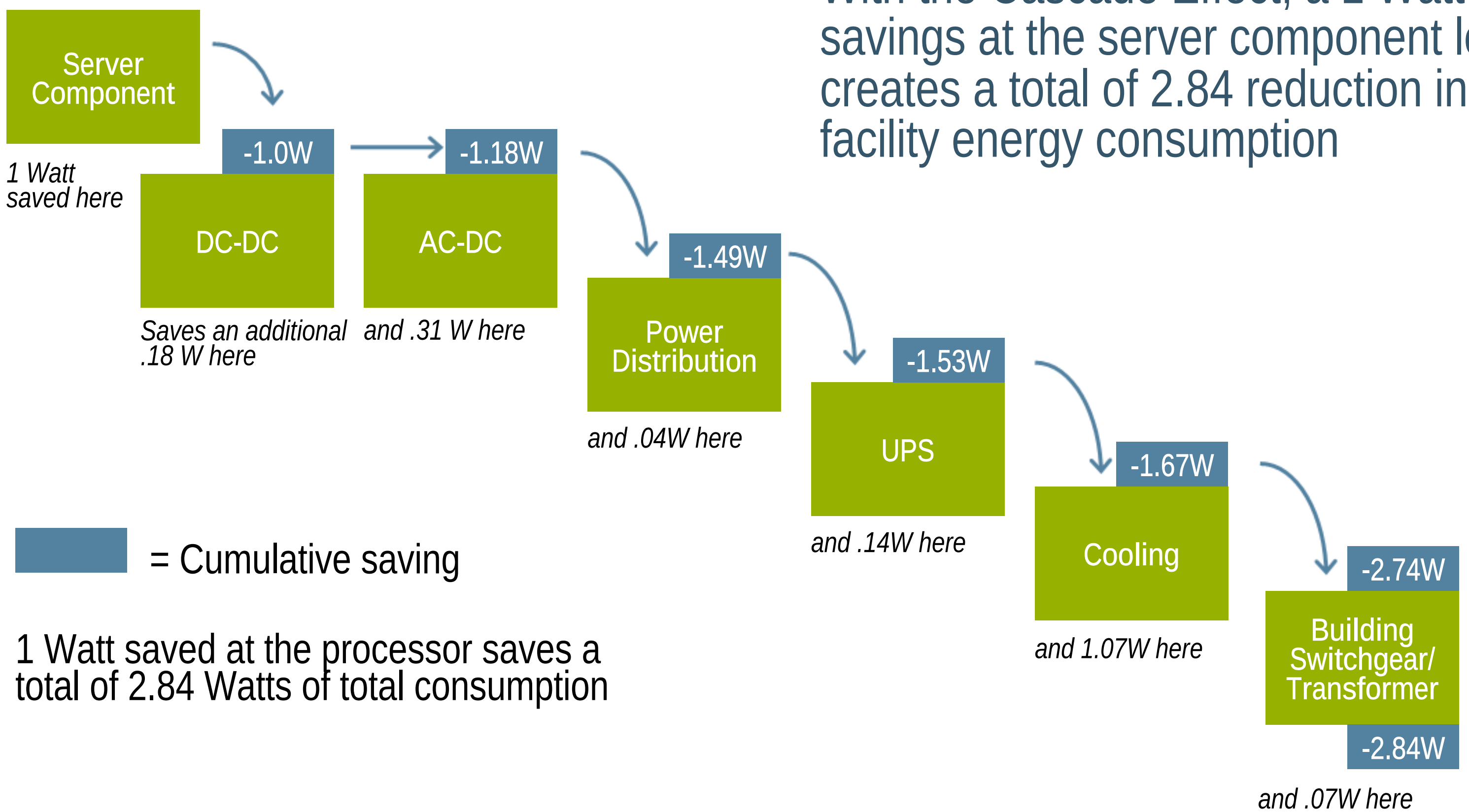
Annual energy costs
92%
estimated reduction

Source: Intel estimates as of Nov 2008. Performance comparison using SPECjbb2005 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.

Strategy: Addresses Impact of IT on Facilities

The Cascade Effect

With the Cascade Effect, a 1 Watt savings at the server component level creates a total of 2.84 reduction in facility energy consumption

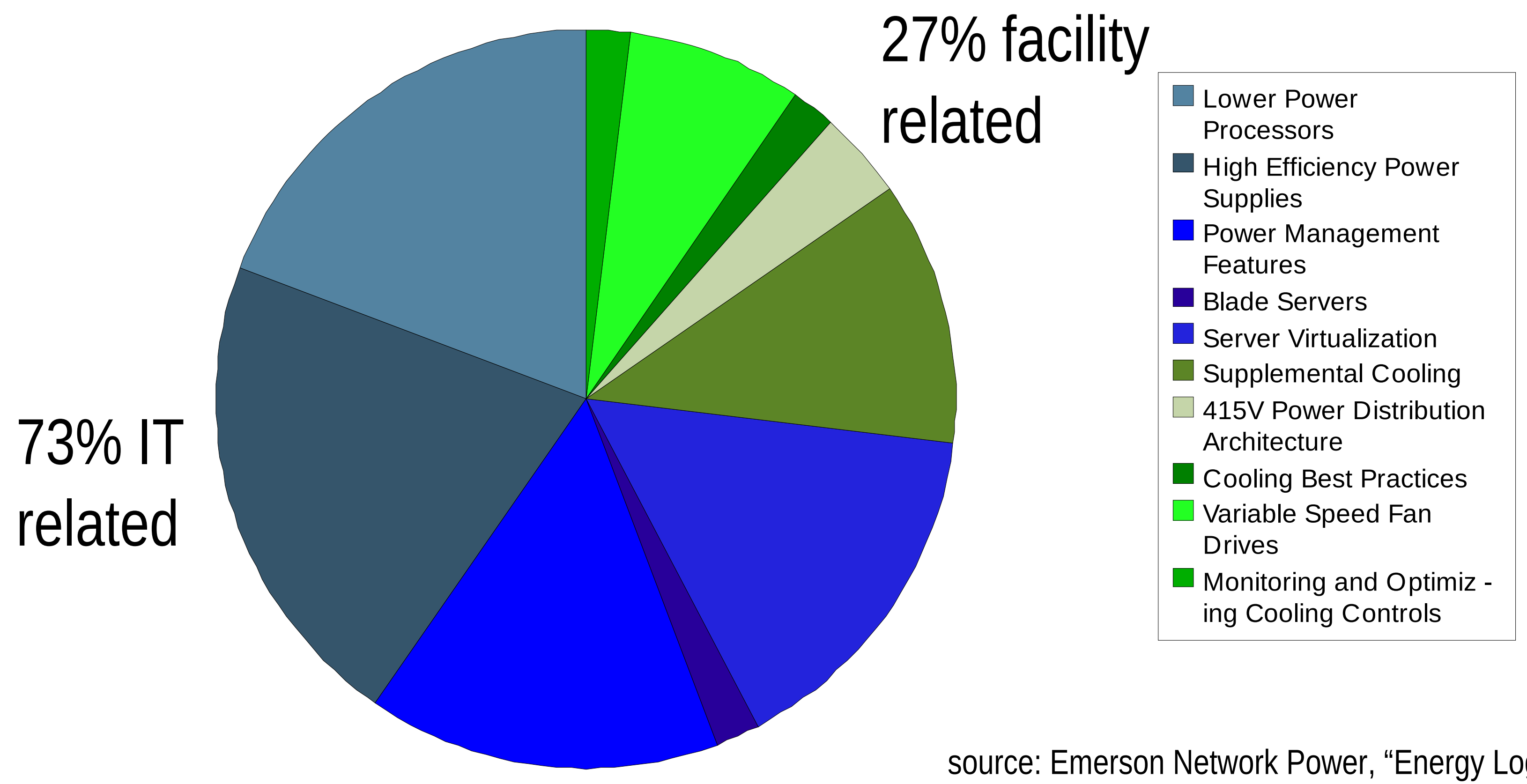


= Cumulative saving

1 Watt saved at the processor saves a total of 2.84 Watts of total consumption

Source: Emerson Network Power, "Energy Logic"

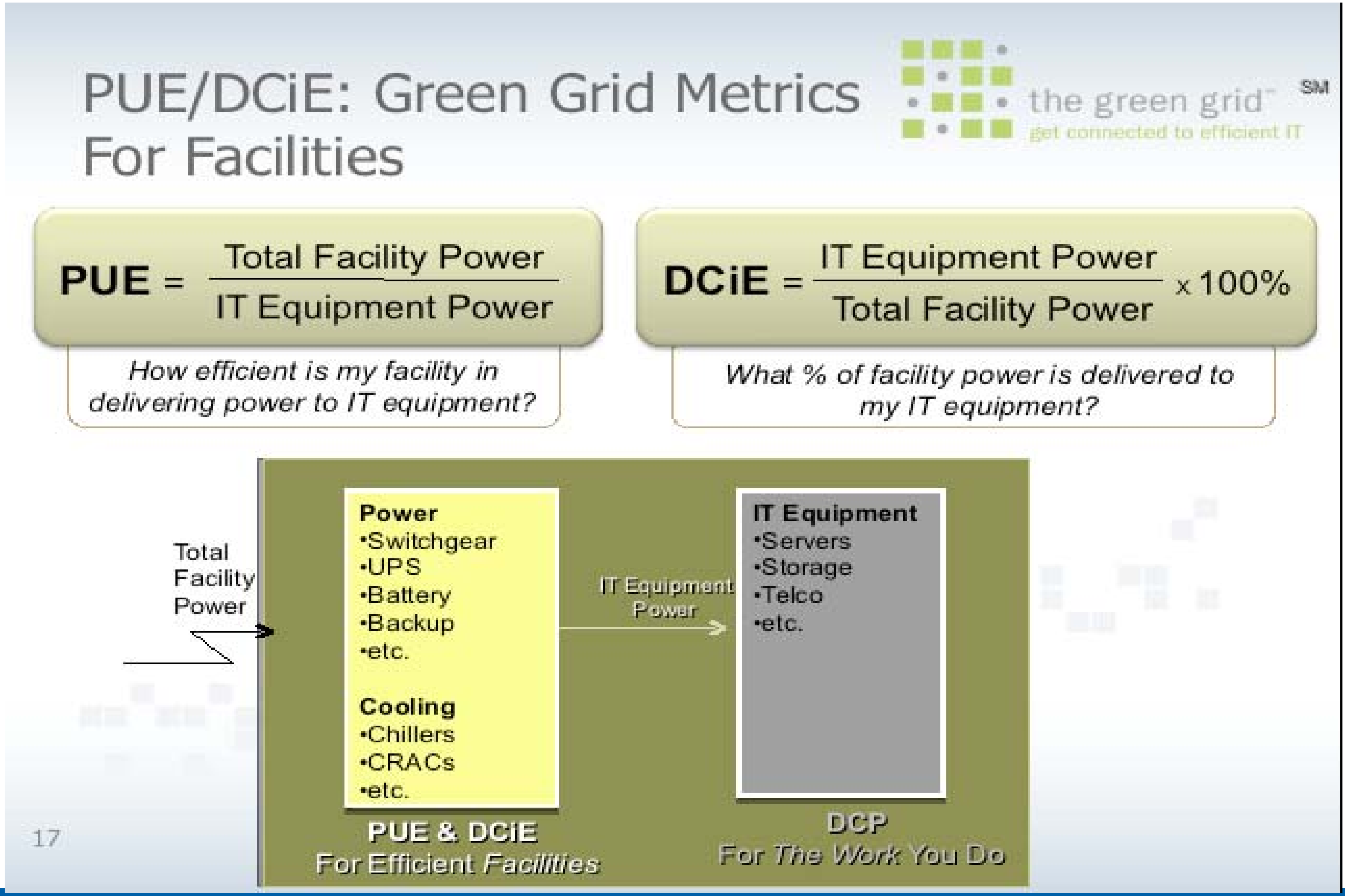
Popular Energy Savings Actions



source: Emerson Network Power, “Energy Logic”

73% of savings potential comes from IT improvements

Measuring Data Center Efficiency



Source: The Green Grid, http://thegreengrid.org

Server Refresh Example - Efficiency Profiling

A relative ratio of efficiency improvements by simple comparisons

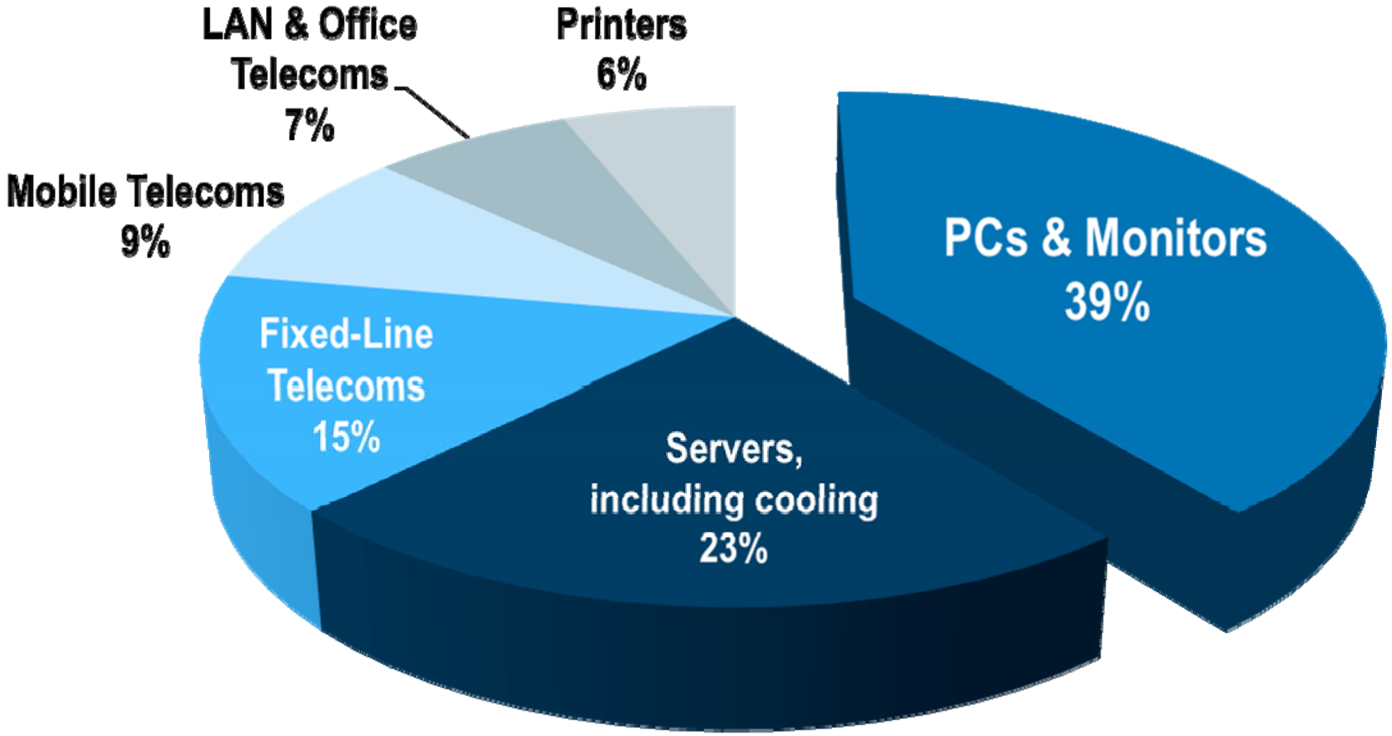
- Relative performance system configurations to replace compared to new system - application performance counters or published benchmark data
  - Multiple old servers retired and replaced with a single new server
    - 4 Year old Server Type 1 = Throughput = 1; Power consumption = 249W
    - 4 Year old Server Type 2 = Throughput = 1.37; Power consumption = 279W
    - New (Replacement) Server = Throughput = 7.77; Power consumption = 320W
    - ~75% of new purchases were to replace type 1 and ~25% were to replace type 2, which gives a 7:1 ratio when replacing 4-year old servers with new servers
- Energy Use configuration comparison
  - Power reduction is ~5.6X to achieve same throughput
    - Total Power consumed by 7 old servers = 1795W
    - Total Power consumed by 1 replacement server = 320W

Incentive recommendation: Power saved/year x electric rate x 4 (lifespan)= incentive per new server

PC Energy Consumption is Important

Global Carbon Dioxide Emissions[1]

Data centers receive a lot of attention because they are an obvious concentration. However, the real area where the greatest overall effect can be made is at the desktop and with client devices.[1]



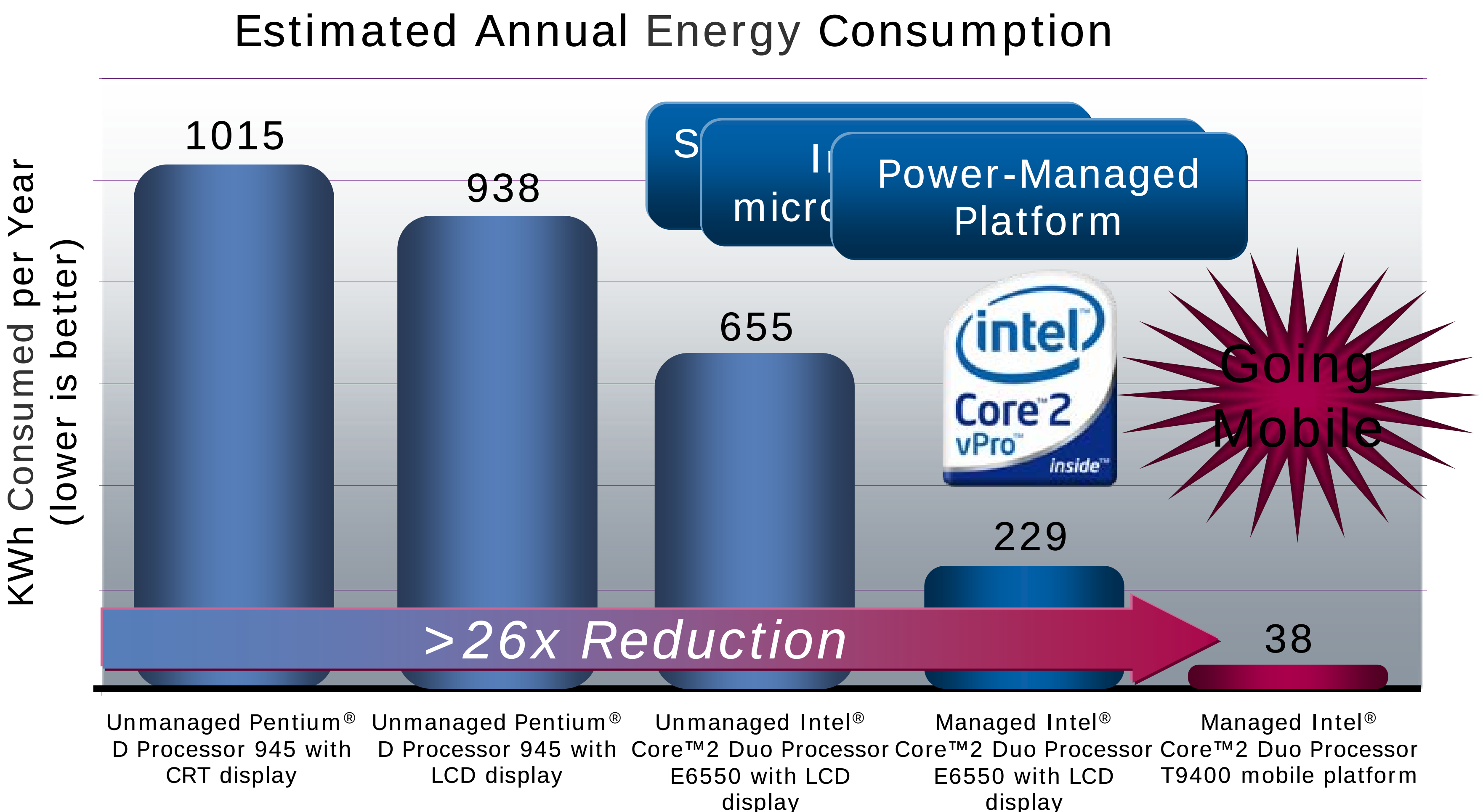
[1] Source Gartner Inc. "Tera-Architectures A Convergence of New Technologies" by Martin Reynolds July 26, 2007

Client Refresh

- Comparative approach to quantify savings can be measured or taken from published data
  - Energy Star, OEM published or customer measurements could be used
  - Performance isn't the comparative point - energy savings is
  - It's about the 1 for 1 replacement of old for new
  - Organizations can take representative measurements to define energy savings or use published data

Incentive Recommendation: Number of systems replaced x energy saved per year x elec. Rate x 4 (lifespan)=incentive

Potential Energy Savings



For system configuration details, please see Appendix on page 51.

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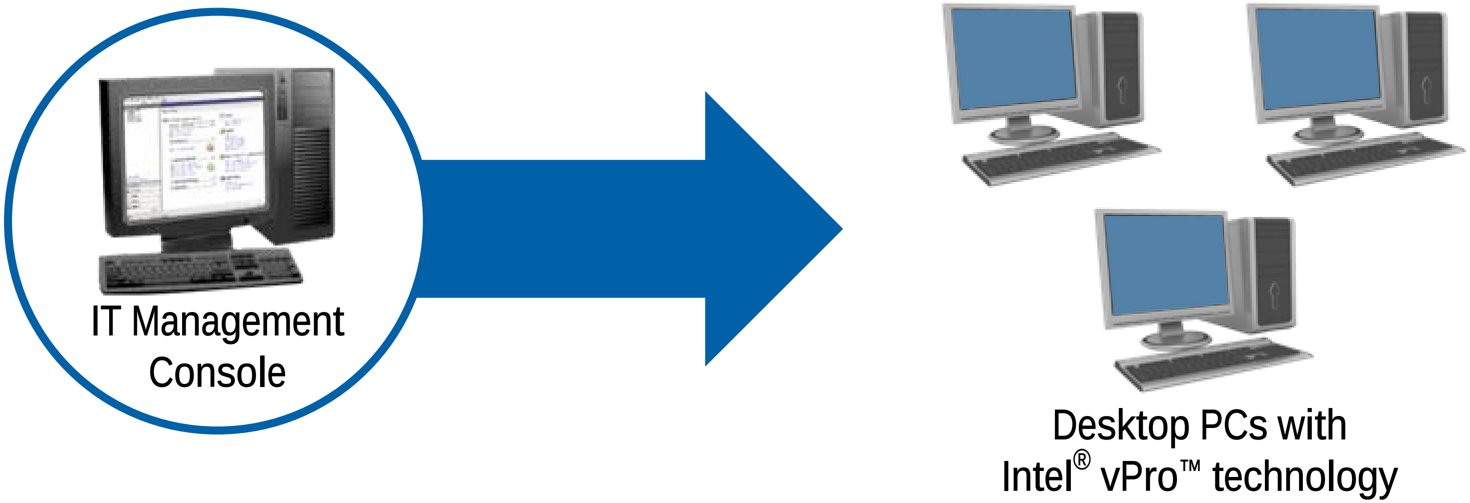
More Manageable PCs Help Reduce Power Consumption

Manage and protect PCs, even when they are powered off, with Intel® vPro™ technology

1. IT Management Console reviews agent software report in management database for client DAT version to identify clients requiring update
2. Unique encrypted **power-on command** issued by IT console
3. Virus DAT file on **PC updated** and rebooted if necessary
4. Encrypted **power-off command** sent to PC



Intel® vPro™ Technology Example

- Schedule PCs to auto power off each night for 8 hours
- Save 1.28 kWh per PC/day
  - Assuming standard PC using 160 watts/hr
- Save 2,800 MWh/year
  - USD 264,000/yr at USD 0.11/k on a total of 5,000 PCs
- USD 52.80 annual power savings on each PC pays for Intel® vPro™ technology the first year

This One Feature Alone Saves a Company USD 264,000 Yearly [and] Pays for the Cost of Adding Intel® vPro™ Technology

Source: Siemens IT Solutions and Services newsletter, 2007

Pre-qualifying Intel® vPro™ Technology for incentives

- vPro allows client systems to be powered off during off business hours and still be managed remotely
  - Potentially saving more than 70% of the typical power of a client that is left on 24/7 with power management turned off
  - Could be calculated by taking the difference of power used in sleep state vs system being totally turned off (measured or manufacturer provided) for 16 hours a day x5 work days and 48 hours over the weekend.

Incentive recommendation: Number of systems w/vPro x energy saved per year x elec. Rate x 4 (lifespan)=incentive for vPro licenses

Opportunities for Collaboration

- Intel resources can help in creating Efficiency incentive programs for IT
  - Local representatives and factory resources
  - Consultative support for approach, data and analysis
  - Pre-qualify products for prescriptive incentives
- Joint sales calls with business customers
  - Bring together energy buyers, IT and Facilities managers
  - Identify opportunities to turn IT Operational Savings into Capital investments for IT efficiency
    - Address organizational barriers to EE IT investments
- Joint seminars and marketing events
  - Education on best practices, incentive programs, product solutions

Together we can educate and incent customers to invest in Energy Efficient IT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Thank You

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- Relative performance is calculated by assigning a baseline value of 1.0 to one benchmark result, and then dividing the actual benchmark result for the baseline platform into each of the specific benchmark results of each of the other platforms, and assigning them a relative performance number that correlates with the performance improvements reported.

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- Wireless N standard currently not available in all countries. Check with your PC and access point manufacturer for details.
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Energy Efficient IT summary

- Organizational challenges are the biggest barrier
  - IT doesn’t pay the bills. Facilities tries to fix the symptoms
  - Bring together Power Buyer, Facilities Manager and IT manager towards a common goal
  - Measure and manage to achieve it (energy and utilization)
- Overcoming capital investment costs
  - Use OPx Savings to drive CAPx investments in EE IT
- IT steps
  - Servers refresh drives cascading amounts of energy savings
  - Virtualization, consolidation, clients refresh, power management
- Facility Steps
  - Cooling – variable speed fans, hot isle/cold isle containment, free air cooling and economizers
  - Power distribution – higher efficiency equipment and best Practices
- Power Buyer
  - engage your utilities for EE IT incentives
  - Shave off peak rates by coordinating generator testing

Platform Selection – Power Basics 1 of 2

- The least power consuming server is not necessarily the most power-performance efficient
  - A least power consuming slower server will take longer to complete a given workload
  - Many slow, less power consuming servers needed to satisfy demand vs. relatively fewer, faster, and higher power consuming servers
  - Fewer higher performing servers will take less number of application licenses offering better ROI
- The highest frequency server may not be optimal for specific workloads
  - Need to find optimal balance between throughput and power needs
    - Highest performance per watt in a given footprint
    - Based on our needs, we use a rack as our foot-print at a given power level
- Efficiency of a server depends on many factors
  - Configuration
    - CPU Frequency and TDP (Thermal Design Point)
    - Size and Type of memory
    - Disk size and types
  - Throughput for a real workload with a specific configuration
  - Server utilization levels
  - Other factors which are system design dependant
    - Form Factor
    - Power Supply/Fan Efficiency

Platform Selection –Process 2 of 2

- Identify most frequently used workloads and configuration requirements (such as memory, disk needs)
  - –Bucket workloads based on per processing core memory needs –This will give different system configurations to be evaluated
  - –Allocate appropriate weight for each workload based on the timeline and quantity of each workload used over typical design life cycle
  - –Use combination of performance gain of workload along with weight to get net throughput
- Identify the right level of computing entity to measure/optimize power during platform selection process, based on volume and purchase model:
  - –A single server level OR
  - –Few servers e.g. Blade Chassis level OR
  - –Rack level OR
  - –Something larger e.g. multiple racks worth of servers (e.g. 10 racks)
  - –In our case, a rack's worth of computing is the right-level to optimize
- On a given set of servers measure Performance and Power consumed for the most frequently used workloads and compute rack throughput
- Select server types with highest throughput in a given power (e.g. 15KW) and space (e.g. one rack worth) and perform TCO (total cost of ownership) analysis to ensure that the server with best TCO is chosen

Details and Assumptions for slide 12 Server Refresh Example 1

	2005	2009	Delta / Notes
Product	Intel Xeon single core (3.8Ghz w/ 2M cache)	Intel Xeon 5500 series (2.93GHz)	
Performance per Server	50,970 bops SPECjbb2005*	447,000 bops SPECjbb2005*	8.8x per/server
kWh per Server/Day	6.704 (382w active / 228w idle)	4.936 (315W active / 151 idle)	Server active 8hrs and idle for 16 hrs per day
Desired Performance Target = 9.4 millions business operations per second			
# Servers needed	184	21	~ 9:1 server consolidation
# Racks needed	9 racks	1 rack	9:1 Rack Consolidation
Total Perf	9.38 million bops	9.38 million bops	Same Performance
Annual kWhr	451,474	37,938	92% lower energy costs
Annual Energy Costs	$90,295	$7,588	$82,707 electricity costs per year. Assumes $0.10/kWhr and 2x cooling factor
OS Licensing Costs	$165,600	$18,900	$146,700 less per year Assumes a RHEL 1yr license at $900 Source www.dell.com as of 12/16/08
Annual Cost Savings of $229,407			
Cost of new HW	n/a	$147,000	Assume $7,000 per server
Payback Period of 8 months			

System Information for "Potential Energy Savings" Example 3 (slide 18)

- Intel Core 2 Duo processor E6550 (2.33GHz, 1333MHz FSB, 4MB L2 Cache), Intel® DQ35JO motherboard with Intel® Q35 Express chipset; 1333MHz FSB, Intel integrated graphics, 2x1GB Micron* DDR2-667 5-5-5-15, Seagate* 320GB/16MB cache/7200rpm, Windows* Vista* Enterprise,.
- Intel Pentium D Processor 945 (3.4GHz, 800MHz FSB, 2x2MB L2 Cache), with Intel 945G Chipset on Intel D945GPM board, Intel Chipset Software Installation File 8.1.1.1010, Dual Channel Micron* PC2-5300U 2x1GB of DDR2 667 5-5-5-15, Seagate* Barracuda* 320GB NCQ SATA2 7200RPM, Windows* Vista* Ultimate RTM Build 6000 NTFS.
- ACER 5720 Intel Core 2 Duo T7700 (2400MHz/800FSB L2 4MB) with Integrated Graphic,2x1GB Hynix DDR2-667, Hitachi 160GB 5,400rpm HDD
- Display power draw values gathered from spec sheets of 10 models of each type of display (CRT and LCD).
- Energy Cost: 7.705 cents/KWh, which is the U.S. average for industrial and commercial customers as of June, 2007. Source: U.S. Department of Energy, http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html
- Intel EEP methodology is described here: http://www.intelcapabilitiesforum.net/EEP/
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