OPTIMIZING THE DATA CENTER: NEW DELL SERVERS AND THE DELL ENERGY SMART ARCHITECTURE

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The Dell™ Energy Smart architecture, including new 11th-generation Dell PowerEdge™ servers, provides a comprehensive, system-wide approach to balancing performance with energy efficiency. By focusing on four key tenets—design, measurement, control, and reporting—this architecture can support scalable, energy-efficient infrastructures that can help optimize performance per watt and reduce total cost of ownership.

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Limitations on space, power, and cooling capacity combined with rising energy costs present enormous challenges for IT environments. Even as IT departments deploy high-performance, high-density servers to maximize compute capacity without expanding their server footprint, they must also find ways to effectively cool these power-intensive systems—all while controlling operational costs and contending with increasingly restricted IT budgets.

Overcoming power and cooling problems should not require reworking the entire IT infrastructure, purchasing and deploying entirely new technologies, or relying on expensive consultants to guide the time-consuming process of redesigning or rebuilding a data center. Instead, by following best practices to help maximize overall data center productivity—taking advantage of key metrics to evaluate the infrastructure, optimizing data center design for energy efficiency, implementing virtualization to help maximize hardware utilization, and following aggressive hardware refresh strategies—organizations can optimize their resources to help maximize computing power, minimize energy use, and simplify systems management.[1]

A key part of the Dell approach to overcoming the challenges of data center power and cooling is dynamically balancing actual work performed against power consumption, maximizing measures such as performance per watt, capacity per watt, and throughput per watt. These strategies enable existing data centers to support increased computing power while reducing space, energy use, and cooling requirements—unleashing the true potential of the data center.

Dell Energy Smart technologies span a comprehensive range of Dell hardware, software, and services to help organizations implement this approach throughout the data center. Integrated into new 11th-generation Dell PowerEdge servers, these technologies are designed to dynamically manage system performance, power, and thermals at the platform level to help optimize performance per watt and reduce total cost of ownership as part of an overall strategy for energy efficiency.

DESIGNING FOR ENERGY EFFICIENCY

The Dell Energy Smart architecture in 11th-generation Dell PowerEdge servers is built on four core

[1] For more information on best practices for evaluating and enhancing data center efficiency, see "Compute More, Consume Less: Smart Policies Unleash Data Center Productivity," in *Dell Power Solutions*, March 2009, DELL.COM/Downloads/Global/Power/ps1q09-20090176-Esser.pdf.

tenets: *design*, *measurement*, *control*, and *reporting*. This architecture is primarily based on an out-of-band implementation that supports real-time monitoring and control, and uses extensive platform characterization and advanced features such as Intel® Dynamic Power Technology to help optimize platform-level trade-offs between performance and power consumption.

Design

The holistic, system-wide approach of Dell Energy Smart technologies starts with following efficient design principles across electrical, mechanical, and thermal systems and combining them with intelligent component selection. Electrical contributions to power efficiency include highly optimized power supply units (PSUs), highly efficient voltage regulators (which include static and dynamic phase shedding capabilities), and low-loss printed circuit board layouts and connectors.

Mechanically, Energy Smart technologies are designed for optimized venting and airflow through the platform, helping minimize fan use. Thermal technologies are designed for optimized fan zones, low-power fans, and adaptive fan-speed algorithms. Configuration options for low-power components such as processors, memory, and hard drives help further enhance energy efficiency.

Measurement

Measurement is an integral part of the Dell Energy Smart architecture. Real-time, highly accurate measurements of performance, power consumption, and thermals feed into the Energy Smart control algorithms, enabling the system to make intelligent decisions to help optimize performance per watt. Comprehensive temperature measurements of the ambient air, processors, memory, PSUs, and other areas help optimize fan speeds to the environment and server workload. In addition to these wide-ranging monitoring capabilities, Energy Smart technologies are designed to provide leading-edge monitoring accuracy.

Control

The Dell Energy Smart architecture incorporates firmware running on a high-performance baseboard management controller (BMC) embedded in the system to provide an intelligent, centralized control mechanism. The BMC utilizes Energy Smart measurement technologies to analyze component and platform trade-offs to help determine performance-per-watt optimizations. Power capping, for example, provides a key way for administrators to control energy use by enabling them to define maximum thresholds for power consumption in a given system. Similarly, the Energy Smart thermal algorithm may limit memory throughput rather than allow fan speeds to reach the upper power regions of the fan response curve.

Reporting

The Dell Energy Smart architecture provides a variety of reporting metrics through in-band and out-of-band management interfaces. The Dell Management Console Powered by Altiris™ from Symantec™ provides in-band reporting, while the standard Web Services for Management (WS-Management) protocol provides out-of-band reporting. The architecture is designed to support real-time collaboration between the platform and OS, enabling compatible operating systems to use performance, power, and thermal constraints in their algorithms to make intelligent decisions and help meet scheduling requirements and service-level agreements. Administrators can also view and graph key metrics through the Integrated Dell Remote Access Controller (iDRAC) in 11th-generation Dell PowerEdge servers.

UNDERSTANDING DELL ENERGY SMART TECHNOLOGIES

New 11th-generation Dell PowerEdge servers feature a variety of energy-tuned technologies designed to increase performance while reducing power consumption. Key features include efficient Energy Smart PSUs, Energy Smart system design, the Dell Active Power Controller (DAPC), Energy Smart power management, and high-efficiency processors and memory.

Energy Smart power supplies

Overprovisioned, inefficient server PSUs that draw more power than necessary are common in enterprise data centers. Dell Energy Smart PSUs are engineered for high efficiency and rightsized for typical environments. Design enhancements enable these PSUs to provide higher efficiency than the PSUs of comparable previous-generation Dell PowerEdge servers (see Figures 1 and 2). For 11th-generation PowerEdge M610 and PowerEdge M710 blade servers, dynamically provisioned PSUs help further avoid unnecessary overhead. Energy Smart PSUs can help reduce

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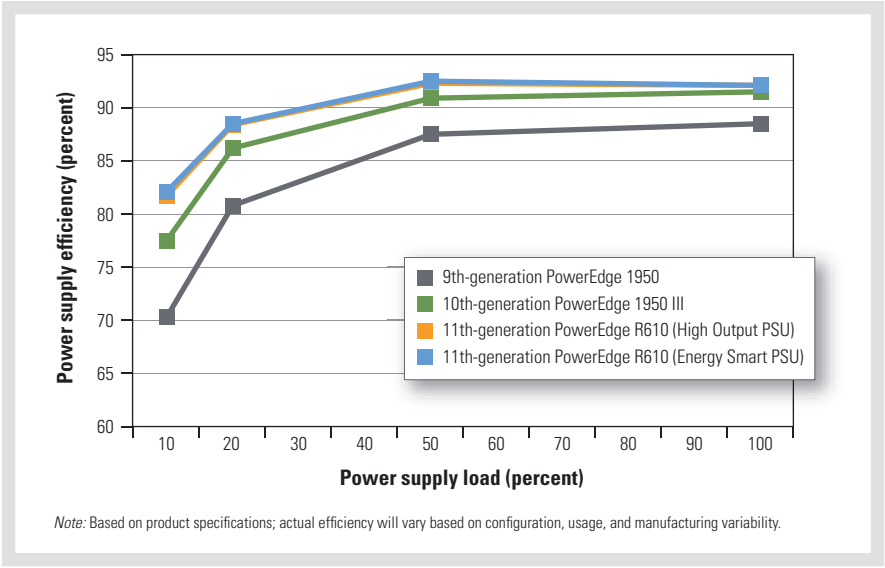


Note: Based on product specifications; actual efficiency will vary based on configuration, usage, and manufacturing variability.

Figure 1. *Power supply efficiency for comparable 1U Dell PowerEdge servers at 230 VAC*

system power consumption by up to 8.4 percent compared with previous-generation Dell server PSUs.[2]

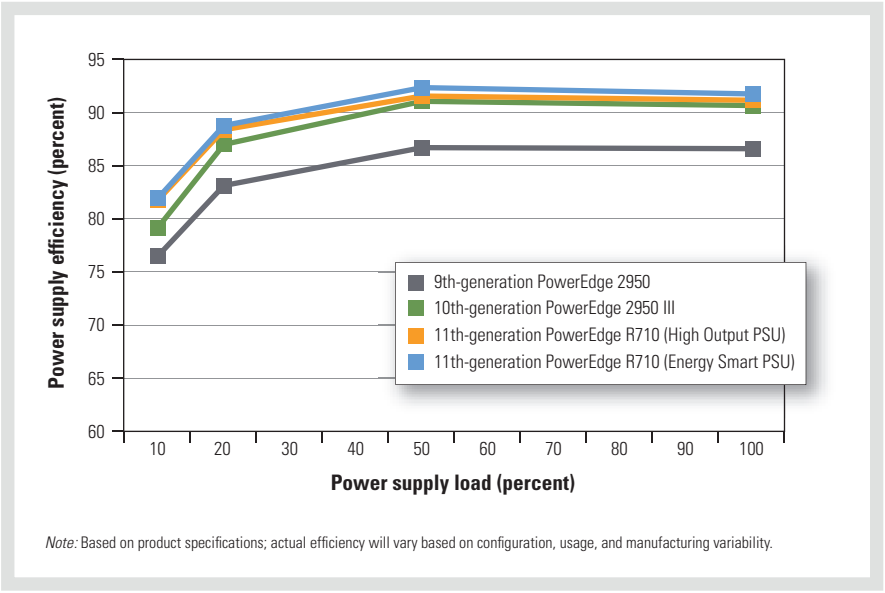
The majority of typical 11th-generation Dell server configurations can be supported by Energy Smart PSUs, helping to immediately lower energy requirements at the server level. For organizations with higher-than-normal performance requirements, optional High Output PSUs are also available for 11th-generation PowerEdge servers. In either case, rather than being locked into a single PSU for a given server, IT departments can choose the PSU that meets their needs. Both Energy Smart and High Output PSUs are 80 PLUS certified, meet Climate Savers Computing standards, and are expected to meet the U.S. government's Energy Star program requirements.[3]

Energy Smart system design

The breakthrough system-level Dell Energy Smart design provides a simplified solution to help overcome inefficiency at the core of the data center: the systems themselves. Incorporating multiple engineering enhancements over previous generations—including high-efficiency voltage regulators, increased venting and airflow, low-flow fan algorithms, and enhanced resource management—this design can help lower overall power consumption and optimize performance per watt in 11th-generation Dell PowerEdge servers. As a whole, Energy Smart system design enhancements can help reduce system power consumption by up to 16 percent compared with previous-generation PowerEdge servers.[4]

Dell Active Power Controller

The DAPC is an OS-independent processor power manager designed to maximize performance per watt starting from the moment the server is powered up. By monitoring the processor and lowering system-level power draw at times of low utilization, it can help reduce system power consumption by up to 15.7 percent compared with OS power management alone.[5]



Note: Based on product specifications; actual efficiency will vary based on configuration, usage, and manufacturing variability.

Figure 2. *Power supply efficiency for comparable 2U Dell PowerEdge servers at 230 VAC*

[2] Based on AC power measurements taken by Dell Labs in November 2008 using an Extech 380803 Power Analyzer and comparing total AC load results for a Dell PowerEdge 1950 III PSU with those of a Dell PowerEdge R610 Energy Smart PSU using redundant configurations and a fixed total DC load of 75 W. Actual performance and power consumption will vary based on configuration, usage, and manufacturing variability.

[3] For more information, visit www.80plus.org, www.climatesaverscomputing.org, and www.energystar.gov.

[4] Based on AC power measurements taken by Dell Labs in July and November 2008 using an Extech 380803 Power Analyzer and comparing a Dell PowerEdge 1950 III with a Dell PowerEdge R610. The stated energy savings includes contributions by voltage regulation and fan improvements, respectively. Measurements were taken at 25°C ambient temperature and at 20 percent system load and idle, respectively. The PowerEdge 1950 III was configured with two quad-core Intel Xeon 5160 processors at 3.00 GHz, eight 1 GB fully buffered dual in-line memory modules (DIMMs) at 667 MHz, and two 73 GB, 10,000 rpm, 3.5-inch Serial Attached SCSI (SAS) drives, and ran the Microsoft® Windows Server® 2003 Enterprise x64 Edition OS; the PowerEdge R610 was configured with two quad-core Intel Xeon X5570 processors at 2.93 GHz, twelve 4 GB DDR3 DIMMs, and six 10,000 rpm, 2.5-inch SAS drives, and ran Windows Server 2008 Enterprise Edition. Actual performance and power consumption will vary based on configuration, usage, and manufacturing variability.

[5] Based on testing performed by Dell Labs in February 2009 using an industry-standard performance/power benchmark comparing the Dell PowerEdge R710 running Microsoft Windows Server 2008 with SP1 with DAPC enabled versus Microsoft Windows® Balanced power management enabled.

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Energy Smart power management

Incorporating a significant increase in features compared with 10th-generation Dell PowerEdge servers, intelligent Dell Energy Smart management in 11th-generation PowerEdge servers includes features such as power capping, advanced power policies, power scheduling, and device disablement. Power capping allows administrators to define specific power limits to aid power management, after which system-level controls can monitor actual system energy use to help maintain power consumption below this threshold. By enabling the intelligent management of overall system power usage, the Energy Smart architecture can help significantly enhance data center efficiency.

High-efficiency processors and memory

New 11th-generation Dell PowerEdge servers incorporate advanced processors and Double Data Rate 3 (DDR3) memory technologies to help maximize performance and efficiency. The multi-core Intel Xeon® processor 5500 series is designed to provide up to 2.25 times the performance of the existing Intel Xeon processor 5400 series,[6] and can support Intel SpeedStep® Technology, Intel Virtualization Technology, simultaneous multi-threading, and deep C-states for enhanced power conservation. DDR3 memory helps provide a high-performance interface capable of low-latency response and high throughput.[7]

OPTIMIZING PERFORMANCE PER WATT AND TOTAL COST OF OWNERSHIP

The Dell Energy Smart architecture in 11th-generation Dell PowerEdge servers can provide significant improvements in performance per watt and total cost of ownership compared with previous-generation PowerEdge servers. For example, in March 2009, Dell engineers used an industry-standard performance/power benchmark to evaluate the performance and power consumption of a PowerEdge R710 server with two quad-core Intel Xeon X5570 processors. Compared with tests performed by Dell engineers in February 2008 on a previous-generation PowerEdge 2950 III server with quad-core Intel Xeon E5440 processors, the PowerEdge R710 used less power at comparable performance levels and was able to reach higher maximum performance levels (see Figure 3)—thereby offering significantly higher performance per watt than the previous-generation server.

Dell's own IT infrastructure has benefited significantly from a comprehensive approach to energy efficiency that includes pervasive virtualization, system consolidation, hardware refresh, containment strategies, and Energy

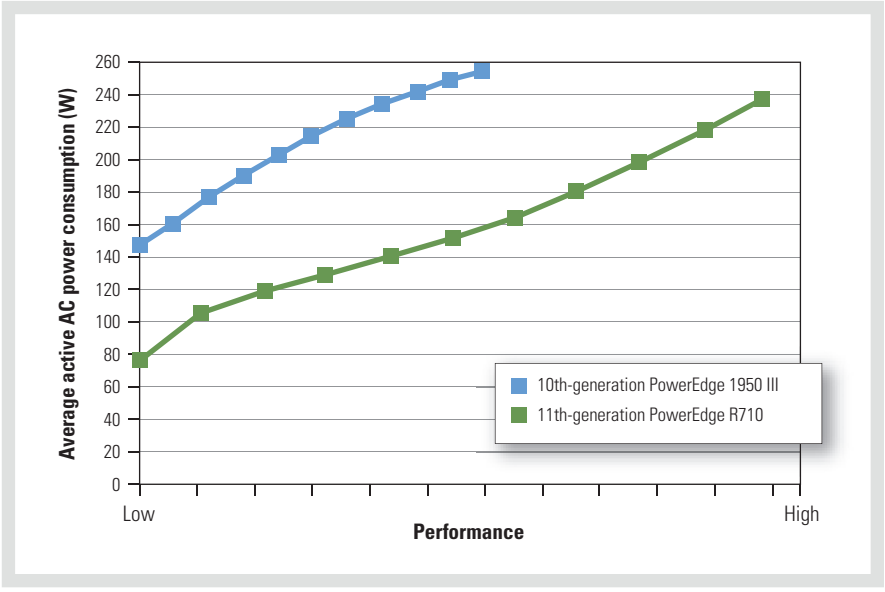

Figure 3. *Performance and power consumption results for a Dell PowerEdge 2950 III server and PowerEdge R710 server*

[6] Based on Intel internal measurements in February 2009; for more information, see "Intel Xeon Processor 5500 Series: An Intelligent Approach to IT Challenges," by Intel, www.intel.com/assets/pdf/prodbrief/321579.pdf. 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 www.intel.com/performance/resources/limits.htm.

[7] For more information on processors and other enhancements in 11th-generation PowerEdge servers, see "Data Center Workhorses: New Dell PowerEdge Rack and Blade Servers," by Edward Yee, Indrani Paul, Robert Tung, Truc Nguyen, and Chad Fenner, in *Dell Power Solutions*, June 2009, DELL.COM/Downloads/Global/Power/ps2q09-20090246-Nguyen.pdf. For more information on DDR3 memory in 11th-generation PowerEdge servers, see "Optimizing DDR3 Memory Settings in New 11th-Generation Dell PowerEdge Servers," by Paul Benson, in *Dell Power Solutions*, June 2009, DELL.COM/Downloads/Global/Power/ps2q09-20080414-Benson.pdf.

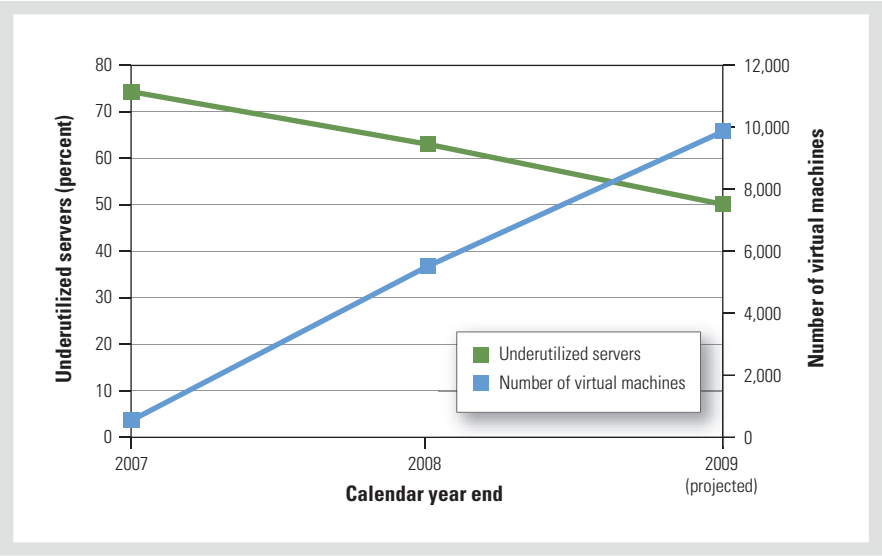

Figure 4. *Total server underutilization and number of virtual machines in the Dell IT environment*

Smart technologies. Figure 4, for example, shows the total percentage of underutilized servers in the Dell IT environment and the number of virtual machines (VMs) being supported by physical hosts at the end of 2007 and 2008, along with projections for the end of 2009. As this figure shows, underutilization has dropped significantly as the number of VMs has grown, helping maximize use of available resources. Dell estimates that its energy-efficiency strategies had saved a total of US$38 million in energy and other costs by the end of 2008, and expects that total to increase even further by the end of 2009. By optimizing its environment for efficiency, in fact, the company was able to avoid the need to build a new data center—a major cost savings.

Upgrading to 11th-generation PowerEdge servers with Energy Smart technology can help lower total cost of ownership in a variety of ways. Organizations can take advantage of the online Dell Server Power and Space Savings Calculator, available at DELL.COM/Switch, to help them evaluate different upgrade scenarios and potential cost savings in their own environments. For example, a single standard 42U server rack with a maximum power consumption of 5 kW can support up to 16 Dell PowerEdge R710 servers, compared with only 12 HP ProLiant DL380 G5 servers. In a data center with 100 servers, this higher rack density means that the Dell servers would require three fewer racks than the HP servers, with a corresponding reduction in power consumption in addition to the advantages of Energy Smart technology. In this scenario, the Dell tool estimates that deploying Dell PowerEdge R710 servers would save up to US$29,947 in energy costs over one year, or up to US$89,841 over three years, compared with the HP ProLiant DL380 G5 servers—a substantial savings.[8]

CREATING SCALABLE, ENERGY-EFFICIENT INFRASTRUCTURES

The Dell Energy Smart architecture provides a comprehensive, system-wide approach to balancing performance and energy use in new 11th-generation Dell PowerEdge servers—capabilities that are critical to simplifying IT and meeting the power and cooling challenges of enterprise data centers. As performance requirements continue to increase, this optimized architecture can help administrators create scalable, energy-efficient infrastructures to support ongoing growth.

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[8] Based on 100 Dell PowerEdge R710 servers configured with Intel Xeon E5504 processors, 24 GB of RAM, and two hard drives, compared with 100 HP ProLiant DL380 G5 servers configured with quad-core Intel Xeon E5410 processors, 24 GB of RAM, and two hard drives. Savings assumes 100 percent system load, power consumption of 5 kW per rack, and an energy price of US$0.10/kWh.