TECHNOLOGY WHITE PAPER

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Energy Star Specifications for Enterprise-Class Servers

What Application Software Vendors Need to Know and Why the Intel® Xeon® 5500 Microarchitecture Will Help Achieve Compliance

The U.S. Environmental Protection Agency (EPA) developed new Energy Star® program requirements (Version 1.0) for enterprise-class computer servers, which took effect on May 15, 2009. This document defines what constitutes an Energy Star qualified computer/server (i.e., a computer that provides services and manages networked resources for client devices). It contains Tier 1 and Tier 2 compliance specifications focused on power supply efficiencies over given workloads, as well as during idle conditions. Subsequent versions of the document are expected to provide IT buyers with a useful method for comparing the energy efficiency of servers from compliant vendors.

Key Considerations

- This new federal requirement is poised to be a key market differentiator for server manufacturers and their partner software developers. Those quickest to market with compliant solutions will be better positioned to win next-generation deployments.
- Among original equipment manufacturers (OEMs) and their technology partners, compliance with Energy Star requirements will be more easily achieved using platforms based on Intel's Xeon 5500 series microprocessors.
- To conserve microprocessor utilization, software code produced for computationally intensive enterprise applications should be multi-thread ready to make processing and data input/output (I/O) more efficient.
- Software vendors should work with an Energy Star certified value-add integration partner to qualify, activate and maintain full compliance.

Program Requirements

Energy Star was introduced by the EPA in 1992 as a voluntary program to increase energy efficiency and reduce greenhouse gas emissions. The Energy Star label can be found on many different kinds of commercial and office/business products. Computers, monitors and related peripherals were among the first labeled as Energy Star compliant products.

EPA's Energy Star computer server initiative has been in development for years and was originally intended to take effect on January 1, 2009. However, greater than expected feedback from the industry required the EPA to push back its release date to May 15, 2009. At this writing, the Tier 1 standard is to be followed by a more

comprehensive Tier 2 standard that combines computing performance and energy efficiency specifications. Tier 2 is expected to take effect on October 15, 2010. Partner manufacturers will be required to comply with the current Tier specification.

As per Energy Star's Tier-1 document, an enterprise-class server appliance is specified as a self-contained computer server system bundled with a pre-installed operating system and application software that is used to perform a dedicated function or set of tightly coupled functions. The Tier 1 specification coverage is limited to solutions containing at most four processor sockets (i.e. computer servers with 1 – 4 individual processor sockets). Systems with more than four processor sockets are currently ineligible for Energy Star qualification under this specification. The Tier 2 specification may include servers with more than four processor sockets. Energy Star's long-term goal is to measure how efficient computer servers are when deployed and actually computing.

Power Efficiencies

Tier 1 requirements set the minimum efficiency a power supply must meet under four load conditions: 10%, 20%, 50% and 100%. The standard requires, in most cases, greater than 80% efficiency (Table 1). These supplies must also meet a minimum power factor requirement for all loading conditions where the output power is greater than or equal to 75 Watts.

Power Supply Type	Rated Output Power	10% Load	20% Load	50% Load	100% Load
Multi-Output AC-DC and DC-DC	All Output Levels	NA	82%	85%	82%
Single-Output AC-DC and DC-DC	≤ 500 Watts	70%	82%	89%	85%
	> 500 to 1,000 Watts	75%	85%	89%	85%
	> 1,000 Watts	80%	88%	92%	98%

Table 1

Efficiency requirements for computer server power supplies

Idle power allowances are also called out in the EPA's Tier 1 specification. Base computer servers (i.e., systems containing one or two processors, minimal memory, a single power supply, one hard drive and minimal I/O configuration) must adhere to the idle power limits shown in Table 2.

Computer Server System Type	Idle Power Limit
Standard single installed processor (1P) server	55 Watts
Managed single installed processor (1P) server	65 Watts
Standard dual installed processor (2P) server	100 Watts
Managed dual installed processor (2P) server	150 Watts

Table 2

Base system idle power requirements

The EPA defines a Managed Server as a computer server designed for a high level of availability in a highly managed environment with redundant power supply capability and a dedicated management controller (e.g., service processor), whereas a Standard Server does not require such capability. Additional idle power allowances for extra components are specified in Table 3.

System Characteristic	Applies to:	Additional Idle Power Allowance
Additional Power Supplies	Power Supplies Installed Explicitly for Power Redundancy	20 Watts per Power Supply
Additional Hard Drives	Installed Hard Drives Greater than One	8 Watts per Hard Drive
Additional Memory	Installed Memory Greater than 4 GB	2 Watts per GB
Additional I/O Devices	Installed Devices Greater than Two on Board, 1 Gbit Ethernet Ports	< 1 Gbit: No Allowance = 1 Gbit: 2 Watts / Active Port > 1 Gbit and < 10 Gbit: 4 Watts / Active Port ≥ 10 Gbit: 8 Watts / Active Port

Table 3

Additional idle power allowances for extra components

To achieve these parameters and maintain Energy Star certification, manufacturers must be able to accurately test, measure and report power usage, thermal conditions and power utilizations under full load as well as idle conditions. Compliant computer servers must be tested in their “as-shipped” configuration. However, Tier 1 specifications are not directly applicable to understanding the total work load efficiency (i.e., the amount of work done per Watt consumed).

Tier-2 requirements intend to explore a *Net Power Loss* specification 2010. It is expected to specify a maximum allowed power loss through the power supply during actual server operating conditions. According to the EPA, an early draft of the Tier 2 standard will be released for commercial review and revision consideration shortly after May 15, 2009.

By-Product of Moore's Law: Lower Power

Intel's new Xeon 5500 series processors are ideally designed for Energy Star computer servers and other embedded low-power applications. The Xeon microarchitecture effectively delivers greater performance and better active and idle power efficiencies. Its four CPU cores can be independently powered down when computational utilization is low, and the power requirements of each core can be programmed to automatically throttle back to an idle state. In terms of overall energy savings, this directly translates to cost savings during typical enterprise operations.

Xeon's improved performance and processing efficiency plays well to the Energy Star power compliance requirement. Each Xeon 5500 core is capable of performing far more "work per Watt" than its predecessors. Computer server manufactures can achieve better performance with a lower power budget and perform as much as 20% to 50% more work at the same processor speed, depending on the application.

Because server platforms spend most of their time in a low-utilization state, the Xeon 5500 is designed to boost efficiency from mid-utilization down to idle levels. Intel's new Intelligent Power Technology will reduce energy costs without sacrificing performance by automatically putting the processor and memory into the lowest appropriate power state.

The Xeon microarchitecture individually lowers clock frequencies core-by-core. Servers designed with such capability and used broadly across enterprise networks and data centers can significantly reduce power demands.

Concerns for Application Software Developers

Energy Star's new compliance specifications and the "Green" movement will require the attention of hardware and software providers alike. For many application software developers, energy and power are unfamiliar concepts. For years, software developers simply focused on using as few cycles as possible in an effort to streamline the processor's execution time. Now with new, stringent demands on energy efficiency, application developers must consider the system's power budget and develop multi-thread applications that best utilize processing throughput – particularly if the code is computationally intensive.

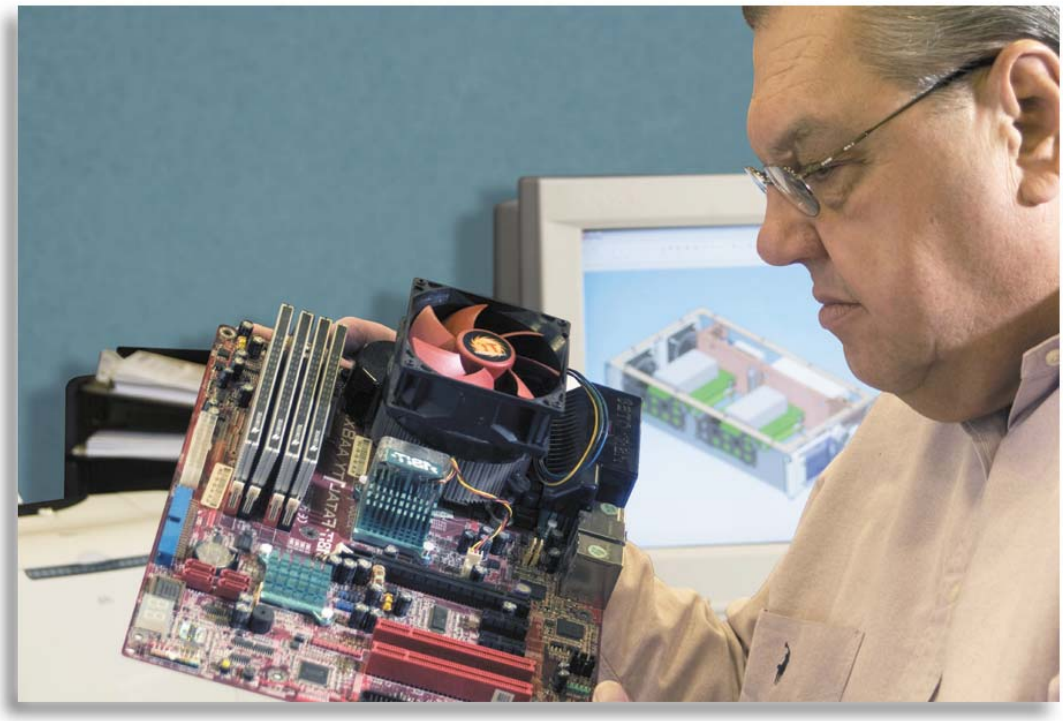

Figure 1

NEI uses standard technologies to manufacture purpose-built turnkey and custom solutions that meet Energy Star requirements.

Software application vendors who understand that the route to increasing application efficiency runs through multi-threading will have a distinct advantage. Today's x86-based dual and quad processor servers are built to accommodate as many as 16 threads simultaneously.

Multi-thread processing is becoming a fundamental element for deriving the best possible efficiency from the server, in terms of work per Watt. Virtualization handles that efficiency requirement well by allowing multiple virtual environments, operating systems and applications to work on the same platform. This enables multi-threading without necessarily having too many threads per application.

With no real changes to coding, application software can realize an immediate performance boost upon transition to the Xeon microarchitecture. However, any time code is transferred on to a new processor or hardware configuration, regression testing should be performed to ensure proper system stability.

Additionally, in rewriting software for a new processing system, it is important to understand how the processor's clock/instruction cycles and processing speeds may affect code timing and interaction with peripheral (off-chip) jobs. This is common in applications where events need to occur in a particular sequence (e.g., where "A" must occur before "B" can run) and code timing is often addressed by building in cycle wait time. That wait time may need to change in a new processing environment where more work can be done faster.

On the whole, however, if base code works on the previous generation Intel microarchitecture, it should work well on the new Xeon microarchitecture and subsequently benefit from increased performance.

More importantly, if you specifically optimize code around the Xeon 5500, those benefits and performance gains will be even greater. By making the change, you'll be getting the best total performance and efficiencies available.

Affects of Power and Heat Dissipation

How easily can one measure the amount of power consumed in a data center? Power consumption itself is relatively easy to calculate and measure. Fortunately, there are good laboratory tools to measure a computer server's power output in its working environment. Reducing power utilization is ultimately the end-game of Energy Star's initiative. The larger challenge, however, lies in understanding the "affect" of power consumption on a more holistic level.

Power and thermals characteristics go hand in hand and heat dissipation can be a key differentiator at the server level. Each watt of power consumed by a server platform and converted into heat can take as much as 1.2 Watts of additional power to remove the heat from the server environment. At the data center level, waste heat removal requires additional energy to operate air conditioning systems that keep a constant temperature in the server room.

IT departments typically provision power for peak load characteristics, but most systems operate at peak load for a relatively small percentage of each day. New microprocessor technology in the Xeon 5500 enables companies to use less energy and reduce waste heat. That translates into reduced operating costs and more environmentally responsible (a.k.a. Green) network operations.

Notes of Interest

The new Energy Star ratings are expected to provide a good base-level benchmark for power efficiency at different ratings, particularly efficiency as it applies to a computer server's power supply. Energy Star's certified servers must meet EPA minimum standards of efficiency and should allow IT managers to make fair comparisons among the many server platforms available.

The Energy Star specification may be considered more evolutionary than revolutionary and gaining momentum over time. Better performance with lower power consumption is not a new industry expectation. Energy Star's ratings are the early steps along a long path to true energy efficiency, and these specifications are likely to prompt the industry to upgrade (sooner rather than later) to more efficient servers in order to reduce their IT operating expenses.

As Energy Star's criteria are further refined and become more detailed in Tier 2 documentation, industry expectations may rise to the point that Energy Star compliance will be a critical component in data center procurement, and non-compliant vendors will no longer be considered in the purchase selection process.

According to recent reports, the Energy Star program is also developing a data center and office building benchmarking program that will rate a building's energy efficiency from one to 100. To date, the agency has benchmarked close to 100,000 office buildings nationwide. However, as of this writing no deadline has been set for establishing a data center green storage specification. The EPA has published a quick start guide to increasing data center energy efficiency at **http://www1.eere.energy.gov/femp/pdfs/data_center_qsguide.pdf**. The U.S. Department of Energy also offers information at Data Center Energy Profiler (DC Pro) software tool suite, including two free software tools for data center managers.

With the right solution design and integration partner at your side, application software developers can achieve compliance and be well positioned to take full advantage of Energy Star's standards as they evolve.

For more information about the Energy Star Enterprise Server and Data Center energy efficiency initiative, please visit: **http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency**

For more information about NEI's power efficiency program, please contact **sales@nei.com** or visit **www.nei.com**.

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