White Paper

Intel® Xeon® Processor 5500 Series

Why the Intel® Xeon® Processor 5500 Series is the Ideal Foundation for Cloud Computing

While "cloud computing" appears to be reaching the top of the hype cycle, there are some very real, substantive reasons why companies of all sizes are closely examining the benefits of the cloud. A cloud computing model has the potential to increase the agility of IT infrastructure, lower costs of certain applications, and drive new usage models.

Yet both for service providers and enterprises, building a cloud infrastructure may be one of the most challenging tasks facing IT today: there are intense demands on servers, routers, and storage gear; demand may spike and drop erratically and performance must be maintained under very dynamic conditions. A cloud architecture must be deployed with precision – balancing latency concerns, data protection, energy availability, and overall costs. All the while, users and loads continue to grow and the infrastructure must scale affordably to handle demand.

One of the most critical decisions in cloud computing is the microprocessor architecture. At first glance, this may appear to be a fairly small concern, as the CPU is but one of thousands of components within the modern data center. And since the essence of cloud computing is the virtual pooling of physical hardware, one might argue that the processor doesn't matter.

But the facts don't support this. The microprocessor directly enables both the capabilities of a cloud computing environment and its overall efficiency. By maximizing the performance per watt of a given server, companies utilizing cloud computing are able to optimize the number of machines deployed to provide sufficient horsepower for their business needs. If they choose less capable or less efficient machines, their capital and operations expenses can skyrocket and the cloud service may be less cost effective. In some respects, choosing a processor architecture for the cloud is analogous to an airline's selection of jet engines: it affects the routes that can be flown, fuel consumption, the number of passengers that can be carried, and so on. It's a strategic choice.

In a recent internal study of mega-data center costs, Intel estimated that server acquisition costs and electricity account for nearly 75 percent of the TCO of these large deployments (see sidebar *TCO of Large-Scale Internet Data Centers*). It's no surprise, then, that the largest cloud operators in the world closely scrutinize their server acquisitions and carefully select the best combination of performance, efficiency, and TCO.

The Intel® Xeon® processor line is the ideal foundation for cloud computing infrastructure, offering not only high performance but also world-class efficiency, dynamic flexibility, and intelligent platform capabilities for current and future cloud environments. Intel's latest server processor, the Intel® Xeon® processor 5500[Δ] series (formerly code named "Nehalem") is currently being evaluated by the world's largest cloud infrastructure providers.

The processor you choose for your cloud infrastructure does matter. Here is why the Intel Xeon processor 5500 is ideally suited for the cloud:

Excellent performance per watt. In the cloud, performance per watt is one of the most important metrics – as each watt saved flows straight to the bottom line. The Intel Xeon processor 5500 can deliver up to 2.25X the computing performance at roughly the same system power compared to the previous-generation Intel Xeon processor 5400 series.[1] Industry benchmarking of performance per watt – as measured by SPECPower* – also testifies to the Intel Xeon processor 5500's leadership in efficient performance, as servers based on this new generation of processors have leapfrogged the previous top dual-socket score (based on Intel's own prior-generation Intel Xeon processor architecture) by at least 64 percent.[2] For cloud architects seeking to maximize performance and efficiency, the choice of Intel Xeon processor 5500 is quite clear.

Intel® Xeon® processor 5500 vs. Intel® Xeon® processor 5400 on Server Benchmarks

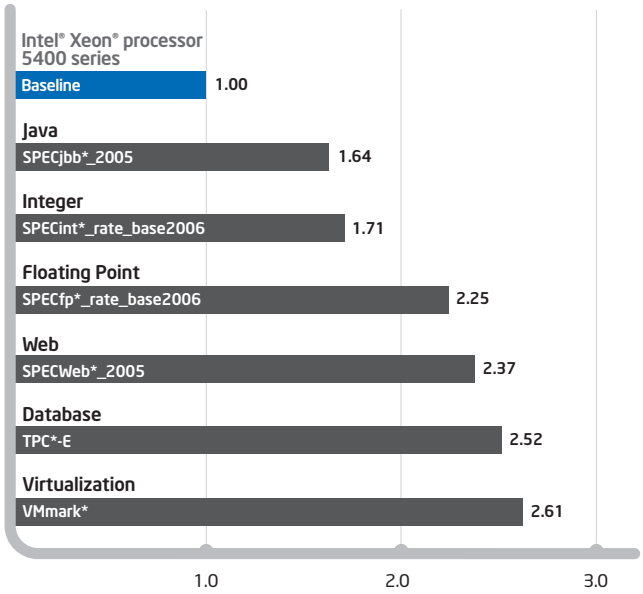


Figure 1. Flexible Horsepower Across Applications. The Intel Xeon processor 5500 series delivers computing performance across a full range of mainstream applications.

TCO of Large-Scale Internet Data Centers

Building a modern data center can cost tens or hundreds of millions of dollars. The costs for electrical substations, UPS generators, and cooling infrastructure are mind-boggling. Yet interestingly, facilities expense is not the leading cost of a large-scale Internet data center. When considering the three-year TCO of a large data center, servers (and associated storage) account for 50 percent of the cost, and the power to run those systems accounts for another 25 percent.[3]

By their nature, these highly virtualized and modular Internet data centers require relatively less labor and licensing costs. An enterprise-oriented version of this TCO model would be somewhat different, but hardware and power will still comprise significant portions of the total pie. And as enterprises adopt more cloud-like infrastructure practices, this model will be increasingly relevant.

Given the cost implications of servers and associated power and cooling, it's critical for data center planners to choose server equipment wisely with an eye towards maximizing both performance and energy efficiency. These considerations make the Intel® Xeon® processor 5500 series the ideal building block for cloud computing environments.

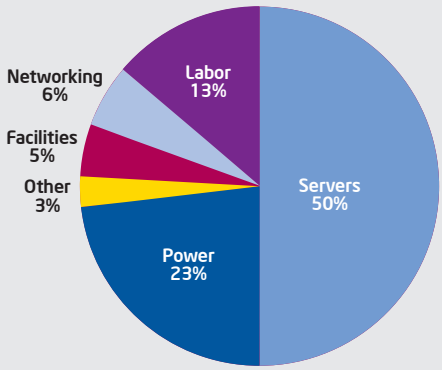


Figure 2. TCO Model – Cost allocated over three-year period

Higher performance across a broad range of workloads. By definition, cloud computing is a general-purpose environment, where many different kinds of applications may be deployed. A cloud architecture should be built to accommodate the range of expected workloads and provide flexibility to handle higher demands or new applications during the useful life of the equipment. Servers based on the Intel Xeon processor 5500 are ideal for handling a very broad range of usage models and workloads, allowing operators to further control costs by minimizing the variety of platforms deployed in the data center. New platform architecture enhancements, such as the integrated memory controller, high-speed interconnects, and hyper-threading allow the Intel Xeon processor 5500 to significantly boost performance on a wide range of industry benchmarks as compared to the prior-generation systems (see Figure 1). Whether the cloud environment will host floating-point-intensive workloads, database workloads, virtualized workloads, or combined workloads, the Intel Xeon processor 5500 delivers outstanding, flexible horsepower.

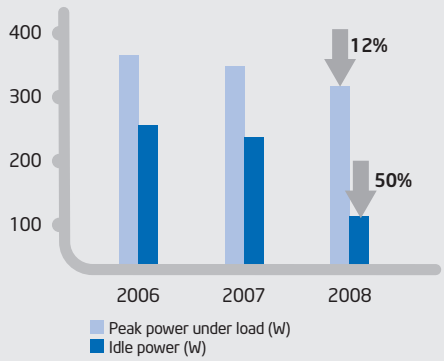
Increased virtualization performance. Cloud computing models that provide virtualized hosting environments are highly dependent on the capabilities of their servers to provide sufficiently powerful virtual machines. From the operator's perspective, the more virtual machines that can be realistically provisioned on a given server, the better the return on investment. The Intel Xeon processor 5500 enables that kind of maximized return by delivering a 2X leap in virtualization performance vs. the previous-generation Intel Xeon processor 5400 series,[4] allowing virtualized clouds to squeeze even more capability out of their infrastructure.

Adaptability for cloud environments. Cloud architectures represent the ultimate design for adaptability and shifting workloads. Cloud conditions are highly dynamic as some applications scale rapidly while others shut down. To meet such shifting demand, it's critical to have adaptable cloud building blocks. The Intel Xeon processor 5500 is designed from the ground up to adapt to changing conditions and is therefore ideally suited to the dynamic requirements of cloud computing. It has unique new intelligence – Intel® Turbo Boost Technology[§] – that increases performance when needed. In addition, Intel® Intelligent Power Management Technology[3] reduces power consumption when demand falls: the Intel Xeon processor 5500's idle power is up to 50 percent lower than prior-generation systems,[5] which saves more energy cost when utilization is low.

The Increasing Efficiency of Intel® Xeon® Processors

The Intel Xeon processor 5500 series continues the trend of delivering significant increases in efficiency for both peak and idle power vs. earlier-generation Intel Xeon processors. The results include up to 2.25X performance within a similar power envelope and lower IT costs enabled by lower system idle power.[1]

Idle and Peak Power Reductions[6]



Designed for higher temperature environments. Across the data center industry, there's growing interest in running data centers at warmer temperatures to conserve energy. Affirming this trend, the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRE) issued new recommendations in 2008 to increase upper temperature range for data centers by 3.5 degrees Fahrenheit. (For cloud computing mega-data centers, this concept has been in practice for several years.) The Intel Xeon processor 5500 has been designed to run at higher temperatures, thus reducing the demand on cooling and further reducing energy cost. This provides one more piece of the puzzle to enable more efficient cloud infrastructure environments.[7]

Holistic power management that further reduces cost. Intel has incorporated new power technologies into the Intel Xeon processor 5500 platform that open new avenues to managing server energy consumption beyond what's already built into the processor. Intel Intelligent Power Node Manager is a power control policy engine that dynamically adjusts platform power to achieve the optimum performance-power ratio for each server. By setting user-defined platform energy policies, Node Manager can help data center operators increase server rack density while staying within a given power threshold. A recent proof-of-concept with Baidu, a leading search engine, demonstrated up to 20 percent improvement in rack density by using Node Manager.[8]

Through technology leadership and deep relationships with hardware, software, and solution providers, Intel has a unique ability to provide the right technologies to meet the needs of large-scale cloud computing architectures. The Intel Xeon processor 5500 continues this trend and is being adopted by leading service providers and enterprise data centers to meet the ever-growing demands of the marketplace.

For more information

For more information on the Intel Xeon processor 5500 series, visit www.intel.com/xeon or contact your Intel sales representative.

Figure 1. Flexible Horsepower Across Applications benchmarks. All comparisons based on published/submitted/approved results as of March 30, 2009.

SPECjbb*_2005:

Intel® Xeon® processor X5470 based platform details: Fujitsu Siemens PRIMERGY* RX200 S4 server platform with two Intel Xeon processors 5470 3.33 GHz, 12MB L2 cache, 1333MHz FSB, 16 GB memory, Microsoft Windows Server* 2008 Enterprise x64 Edition, Oracle JRockit* 6 P28.0.0 (build P28.0.0-8-109238-1.6.0_05-20090130-1408-windows-x86_64) 4 JVM instances. Referenced as published at 368,034 BOPS. For more information see http://www.spec.org/osg/jbb2005/results/res2009q1/jbb2005-20090220-00583.html.

Intel® Xeon® processor X5570 based platform details: IBM Bladecenter* HS22 server platform with two Intel Xeon processors X5570 2.93 GHz, 8MB L3 cache, 6.4GT/s QPI, 24 GB memory (6x4 GB DDR3-1333MHz), Microsoft Windows Server* 2008 Enterprise x64 Edition, IBM J9* 2.4 JRE 1.6.0 (build pwa6460sr5-20090323_04(SR5)) run with 4 JVM instances. Result submitted to www.spec.org for review at 604417 BOPS as of March 30, 2009.

SPECint*_rate_base2006:

Intel® Xeon® processor X5470 based platform details: Fujitsu Siemens PRIMERGY* RX200 S4 server platform with two Intel Xeon processors X5470 3.33 GHz, 12MB L2 cache, 1333MHz FSB, 16 GB memory (8x2GB DDR2 PC2-5300F, 2 rank, CAS 5-5-5, with ECC), SUSE Linux Enterprise Server* 10 SP2 x86_64 Kernel 2.6.16.60-0.21-smp, Intel C++ Compiler for Linux32 and Linux64 version 11.0 build 20080730. Referenced as published at 140. For more information see http://www.spec.org/cpu2006/results/res2008q3/cpu2006-20080901-05156.html.

Intel® Xeon® processor X5570 based platform details: Fujitsu PRIMERGY* TX300 S5 server platform with two Intel Xeon processors X5570 2.93 GHz, 8MB L3 cache, 6.4GT/s QPI, 48 GB memory (6x8 GB PC3-10600R, 2 rank, CL9-9-9, ECC), SUSE Linux Enterprise Server* 10 SP2 x86_64 Kernel 2.6.16.60-0.21-smp, Intel C++ Compiler for Linux32 and Linux64 version 11.0 build 20010131. Submitted to www.spec.org for review at 240 as of March 30, 2009.

SPECfp*_rate_base2006:

Intel® Xeon® processor X5482 based platform details: Hewlett-Packard ProLiant* DL160 G5p server platform with two Intel Xeon processors X5482 3.20 GHz, 12MB L2 cache, 1600MHz FSB, 16GB memory (8x2 GB 800MHz CL5 FB-DIMM), 64-Bit SUSE Linux Enterprise Server* 10 SP1, Intel C++ Compiler for Linux32 and Linux64 version 10.1 build 20080730. Referenced as published at 86.4. For more information see http://www.spec.org/cpu2006/results/res2008q4/cpu2006-20081013-05587.html.

Intel® Xeon® processor X5570 based platform details: Fujitsu PRIMERGY* TX200 S5 server platform with two Quad-Core Intel Xeon processors X5570 2.93 GHz, 8MB L3 cache, 6.4GT/s QPI, 24 GB memory (6x4 GB PC3-10600R, 2 rank, CL9-9-9, ECC), SUSE Linux Enterprise Server* 10 SP2 x86_64 Kernel 2.6.16.60-0.21-smp, Intel C++ Compiler for Linux32 and Linux64 version 11.0 build 20010131. Submitted to www.spec.org for review at 194 as of March 30, 2009.

SPECWeb*_2005:

Intel® Xeon® processor X5460 based platform details: HP ProLiant* DL380 G5 server platform with two Intel Xeon processors X5460 3.16 GHz, 12 MB L2 cache, 32GB memory (8x4G 667MHz ECC DDR2 FB-DIMM), Red Hat Enterprise Linux* 5 (2.6.18-53.el5), Rock Web Server* v1.4.6 x86_64. Referenced as published at 29591. For more information see http://www.spec.org/web2005/results/res2008q1/web2005-20080225-00104.html.

Intel® Xeon® processor X5570 based platform details: HP ProLiant* DL380 G6 platform with two Intel Xeon processors X5570 2.93 GHz, 8 MB L3 cache, 6.4GT/s QPI, 144 GB memory (18x8 GB DDR3), Red Hat Enterprise Linux* 5.2, Rock Web Server* v1.4.7 (x86_64). Result submitted to www.spec.org for review as of March 30, 2009 at 71,045.

TPC*-E:

Intel® Xeon® processor X5460 based platform details: Fujitsu-Siemens PRIMERGY* TX300 S4 server platform with Intel Xeon processor X5460 3.16 GHz (2 processors / 8 cores / 8 threads), 2x6MB L2 cache, 1333 MHz system bus, 64GB memory, Microsoft SQL Server* 200 x64 Enterprise Edition, Microsoft Windows Server* 2008 Enterprise x64. Referenced as published at 317.45 tpsE and $523.49/tpsE; availability date August 30, 2008. For more information see http://www.tpc.org/tpce/results/tpce_result_detail.asp?id=12.

Intel® Xeon® processor X5570 based platform details: Fujitsu-Siemens PRIMERGY* RX300 S5 server platform with two Intel Xeon processors X5570 2.93 GHz (2 processors / 8 cores / 16 threads), 8MB L3 cache, 6.4GT/s QPI, 96 GB memory (12x8 GB DDR3-1066), Microsoft SQL Server* 2008 x64 Enterprise Edition, Microsoft Windows Server* 2008 Enterprise x64. Referenced as published at 800tpsE and $343.91/tpsE. Availability date April 1, 2009. For more information see http://www.tpc.org/tpce/results/tpce_result_detail.asp?id=25.

VMmark*:

Intel® Xeon® processor X5470 based platform details: HP ProLiant* ML370 G5 server platform with two Intel Xeon processors X5470 3.33 GHz, 2x6MB L2 cache, 1333MHz FSB, 48 GB memory, VMware ESX* V3.5. Update 3 Published at 9.15@7 tiles. For more information see www.vmware.com/files/pdf/vmmark/VMmark-HP-2008-10-09-ML370.pdf.

Intel® Xeon® processor X5570 based platform details: IBM System x* 3650 M2 Server platform with two Intel Xeon processors X5570 2.93 GHz, 8MB L3 cache, 6.4GT/s QPI, 96 GB memory (12x8 GB DDR3-1066MHz), VMware ESX* beta build 148592. VMmark V1.1. Result measured at 23.89@17 tiles and approved by VMware as of March 30, 2009.

[Δ] Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. See www.intel.com/products/processor_number for details.

[§] Intel® Turbo Boost Technology requires a platform with a processor with Intel Turbo Boost Technology capability. Intel Turbo Boost Technology performance varies depending on hardware, software and overall system configuration. Check with your platform manufacturer on whether your system delivers Intel Turbo Boost Technology. For more information, see http://www.intel.com/technology/turboboost.

[∂] Intel® Intelligent Power Technology requires a computer system with an enabled Intel® processor, chipset, BIOS and for some features, an operating system enabled for it. Functionality or other benefits may vary depending on hardware implementation and may require a BIOS and/or operating system update. Please check with your system vendor for details.

[1] Up to 2.25x performance at similar platform power with as much as 50% lower platform idle power compared to Xeon 5400 series claim supported by multiple performance results including an OLTP database benchmark and a bandwidth intensive scientific computing benchmark (SPECfp_rate_base2006). Intel internal measurement. (Feb 2009) Platform power was measured during the steady state of the performance run.

Configuration details: OLTP benchmark
Baseline platform: Intel preproduction server platform with two Quad-Core Intel® Xeon® processor X5460, 3.16 GHz, 2x6MB L2 cache, 1333MHz system bus, 64GB memory (16x4GB FB DDR2-667), Microsoft Windows Server* 2008 Enterprise x64 Edition OS. Performance measured in transactions per second.

New platform: Intel preproduction server platform with two Quad-Core Intel® Xeon® processor X5570, 2.93 GHz, 8MB L3 cache, 6.4QPI, 72GB memory (18x4GB DDR3-800), Microsoft Windows Server* 2008 Enterprise x64 Edition OS. Performance measured in transactions per second.

Configuration details: SPECfp_rate_base2006 benchmark
Baseline platform: Intel preproduction server platform with two Quad-Core Intel® Xeon® processor X5482, 3.20 GHz, 2x6MB L2 cache, 1600MHz system bus, 16GB memory (8x2GB FB DDR2-800), SUSE Linux Enterprise Server* 10 SP2 OS. Intel C++ Compiler for Linux32 and Linux64 version 11.0.

New platform: Intel preproduction server platform with two Quad-Core Intel® Xeon® processor X5570, 2.93 GHz, 8MB L3 cache, 6.4QPI, 24GB memory (6x4GB DDR3-1333), SUSE Linux Enterprise Server 10 SP2 OS. Intel C++ Compiler for Linux32 and Linux64 version 11.0.

[2] Source: www.spec.org published results as of May 19, 2009. Previous dual-socket lead score of 1135 based on PowerLeader system with Intel Xeon processors 5430, dated October 14, 2008. New leading dual-socket SPECpower score is 1860 based on an IBM system with Intel Xeon processors X5570.

[3] Source: Intel internal analysis of large IPDC, Sept 2008, of three-year TCO.

[4] Up to 2.10x Virtualization performance compared to Xeon 5400 series claim supported by performance results on VMmark* benchmark. Xeon X5470 data based on published results. Xeon X5570 Intel internal measurement. (Feb 2009).

Configuration details: VMmark benchmark
Baseline Quad-Core Intel® Xeon® processor X5470 based platform details: HP ProLiant* ML370 G5 server platform with two Quad-Core Intel Xeon processors X5470 3.33GHz, 2x6MB L2 cache, 1333MHz FSB, 48GB memory, VMware ESX V3.5. Update 3 Published at 9.15@7 tiles.

New platform: Intel preproduction server platform with two Quad-Core Intel® Xeon® processor X5570, 2.93 GHz, 8MB L3 cache, 6.4QPI, 72GB memory (18x4GB DDR3-800), VMware ESX* Build 140815. Performance measured at 19.51@ 13 tiles.

[5] Up to 50% lower platform idle power compared to Xeon 5400 series claim supported by platform idle power measurement. Intel internal measurement. (Feb 2009).

Configuration details for 50% lower idle power: Intel internal measurements of 221W at idle with Supermicro 2xE5450* (3.0GHz 80W) processors, 8x2GB 667MHz FBDIMMs, 1x700W PSU, 1x320GB SATA hard drive vs. 111W at idle with Supermicro software development platform with 2xE5540 (2.53GHz Nehalem 80W) processors, 6x2GB DDR3-1066 RDIMMs, 1x800W PSU, 1x150GB 10k SATA hard drive. Both systems were running Windows* 2008 with USB suspend select enabled and maximum power savings mode for PCIe link state power management. Measurements as of Feb 2009.

[6] Source: Peak power under load based on Intel internal measurements using SPECjbb2005* as of March 2008. System configurations: 2S, 80W processors, 8 DIMMs, 1 HDD, 1 PSU. 2009 systems used Intel® Xeon® processor X5570 95W processors with Turbo Boost disabled for 50% idle power.

[7] The Xeon 5500 processor is designed to run at higher temperatures to help minimize system power as inlet temperatures increase: it has a higher case temperature specification than the previous generation (Source: Intel Nehalem EP Electrical Mechanical Thermal Specification (EMTS) 362033). Intel Xeon processor 5400 50W processor max case temp is 52°C while NHM-EP 60W max case temp is 70°C.

[8] Public case study on Intel-Baidu proof of concept results available at http://communities.intel.com/servlet/JiveServlet/previewBody/1492-102-1-1723/Node%20Manager%20Baidu%20POC%20WhitePaper%20-%20External.pdf.

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