SOLUTION BRIEF

Accelerate Discovery with Powerful New HPC Solutions

Achieve Extreme Performance across the Full Range of HPC Workloads

Researchers, scientists, and engineers around the world are using high performance computing (HPC) clusters to push the boundaries of knowledge and innovation—and they need ever-higher performance to solve today's increasingly complex challenges. From desk-side clusters to the world's largest supercomputers, Intel® products and technologies for HPC provide powerful and flexible options for optimizing performance across the full range of HPC workloads.

- **The Intel® Xeon® processor E5 family** provides a leap forward for every discipline that depends on HPC, with industry-leading performance and improved performance per watt. It increases floating operations per second (FLOPS) by 2X[1] versus prior-generation processors, and boosts real-world performance by up to 70 percent.[2,+]

- **The Intel® Xeon Phi™ coprocessor** lets you add up to a teraflop of additional performance for highly parallel applications. It is completely compatible with software written for the Intel Xeon processor E5 family, so you can boost performance for existing highly-parallel applications and code segments without rewriting software or mastering complex new development tools.

Intel provides a variety of additional products and resources that can help you get better performance and higher value from your HPC investments, including Intel® Solid-State Drives and Intel® True Scale Fabric switches and adapters supporting InfiniBand architecture. Intel also develops and supports the highly-scalable Lustre file system and offers software development tools that can help you write and optimize your code more quickly and effectively to achieve higher value on Intel® architecture-based servers, clusters, and workstations.

Creating Parallel Software with Intel

Understanding how, when, and where to introduce parallelism into your software can be challenging. Intel® software development tools can help you identify the best opportunities for introducing parallelism, enable you to use proven methods for parallelizing code, and eliminate the circumstances that can inhibit your success.

Learn more about Intel Software Development Products at www.intel.com/software/products

Get Industry-Leading Performance for the Majority of HPC Workloads

Intel® Xeon® processor E5 family

The Intel Xeon processor E5 family accelerates performance across a wide array of workloads (Figure 1). Compared to the previous-generation Intel® Xeon® processor 5600 series, this processor family—which includes up to eight cores and 16 threads per socket—provides a performance boost of up to 70 percent[2,+] across a range of real-world technical computing applications, including key applications in the fields of digital manufacturing, energy, financial services, healthcare, and weather/climate research.

Up to 2X FLOPS

Floating point operations lie at the heart of many HPC applications, and the Intel Xeon processor E5 family can process up to twice as many floating point operations per second (FLOPS) as previous-generation processors.[3]

The key to this performance boost is Intel® Advanced Vector Extensions (Intel® AVX), which provides new instructions and increases maximum vector size from 128 to 256 bits. Intel AVX significantly accelerates both vector and floating point computations by enabling applications to complete twice as many instructions per clock cycle.[1,+]

Double the I/O Bandwidth

Delivering sustainable performance for demanding HPC applications requires more than fast and efficient processing cores. It also requires fast data movement to keep cores operating at peak efficiency. The Intel Xeon processor E5 family answers this need by integrating the I/O subsystem directly onto the processor die to reduce latency by as much as 30 percent.[4,+] These processors provide up to 80 PCI Express* (PCIe*) lanes per 2-socket server (up to 160 lanes per 4-socket server), and each lane supports the PCIe 3.0 specification.

Intel® Cluster Ready

Purchasing and implementing a cluster no longer has to be a complex process requiring extensive, cluster-specific expertise. Certified Intel® Cluster Ready HPC clusters based on the Intel Xeon processor E5 family make it easier for you to purchase, deploy, and manage an HPC cluster by ensuring registered applications will load and run reliably "out-of-the-box," not only when you purchase them, but throughout the life of your cluster.

Whether you need to answer bigger scientific questions, enhance the detail of crash simulations, run larger seismic models, or accelerate digital content creation, Intel Cluster Ready and the Intel Xeon processor E5 family can deliver the performance you need as part of a robust, reliable infrastructure you can deploy more quickly and with greater confidence than ever before.

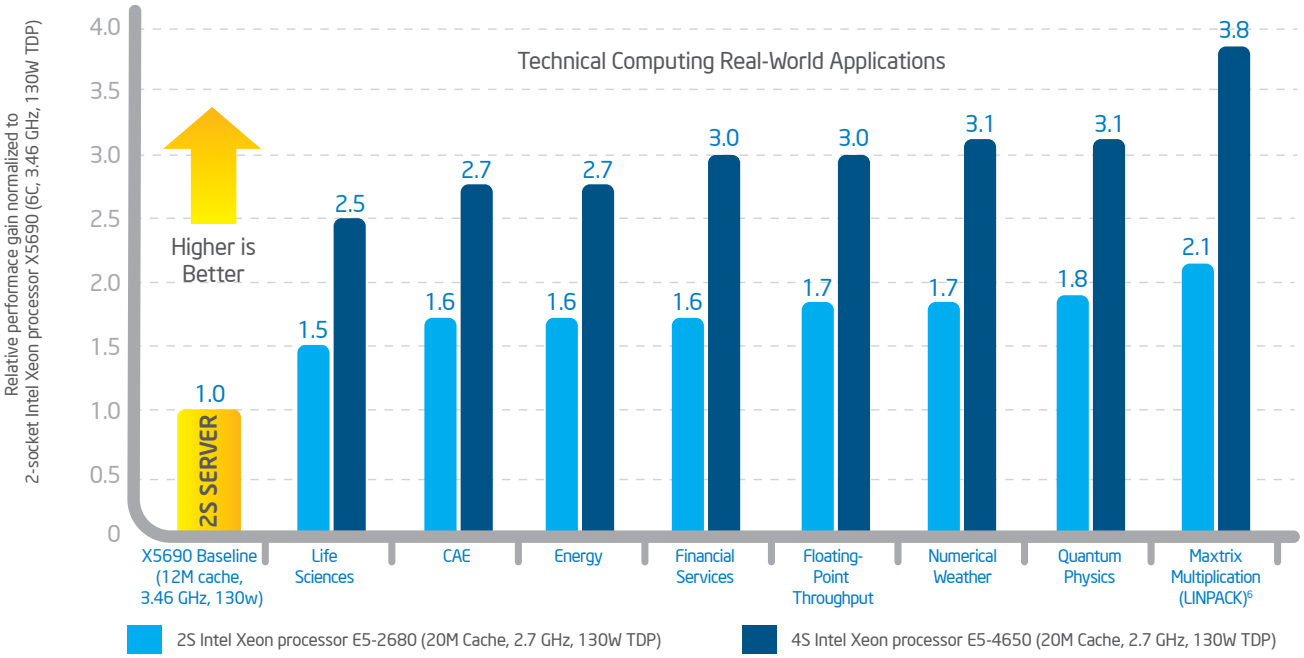
To learn more about Intel Cluster Ready, visit **www.intel.com/go/cluster**

Advanced Security

The Intel Xeon processor E5 family supports the latest Intel security features to help you safeguard your research more easily and effectively. As one example, Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI) provides integrated hardware acceleration for AES-based encryption, so you can encrypt your data with little impact on application response times.[5]

Figure 1. Increase Performance up to 3.8x[2] without Changing Server Form Factors*

Intel® Xeon® Processor E5 Family



* 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. For more information go to http://www.intel.com/performance.

Accelerate Performance for Highly-Parallel Workloads

Intel® Xeon Phi™ Coprocessor 5110P

While the Intel Xeon processor E5 family remains the preferred choice for the majority of applications, Intel Xeon Phi coprocessors provide more efficient performance for highly parallel applications. You can insert one of these powerful coprocessors into the PCIe slot of a supported Intel Xeon processor-based server to accelerate performance for targeted code segments—or for entire applications. A single Intel Xeon Phi coprocessor 5110P provides up to 60 cores and 240 threads and can deliver up to a teraflop of double precision peak performance[7] for code that can run efficiently in a highly parallel execution environment.† Up to eight cards can be used with a single two-socket host server to provide dramatic increases in parallel processing capability.

The Intel Xeon Phi coprocessor is designed to provide maximum flexibility when used in combination with Intel Xeon processor-based systems and clusters (Figure 2). It can operate under the host server's operating system (OS) to accelerate performance for highly parallel code segments. Unlike basic accelerators, it can also function as an independent server node with its own Linux* OS and its own IP address. In this scenario, it can run applications independently and it can offload serial code segments (or moderately parallel code segments) to the host system so they perform more quickly and efficiently.

Together, the Intel Xeon processor E5 family and the Intel Xeon Phi coprocessor 5110P offer unprecedented flexibility and simplicity for tailoring server and cluster resources to deliver the best performance for almost any workload. Since they can run the same software, there is no need to rethink or rewrite code from the ground up. And you can optimize your code just once for both processor families. The same parallelization strategies that deliver optimal performance for multi-core Intel Xeon processors also deliver optimal performance for many-core Intel Xeon Phi coprocessors.

Eliminate Bottlenecks with High-Speed Storage

Intel® Solid-State Drives

The extreme performance and reliability of Intel Solid-State Drives keep data flowing at higher speeds to improve processor utilization and time-to-results for data-intensive HPC workloads. With consistently low latencies and a tight distribution of I/O operations per second (IOPS), these high-performance drives help to eliminate the kinds of storage bottlenecks on individual server nodes that often impede HPC response times. They also protect your data more effectively, with multiple secure checkpoints that guard against data loss and corruption. See www.intel.com/go/ssd for more information.

Grow Your Cluster with a Low-Latency, Highly-Scalable Fabric

Intel® True Scale Fabric (based on InfiniBand*)

Maintain peak application performance as you scale demanding applications across large numbers of nodes, processors, and cores. Intel True Scale Fabric was designed from the ground up as an interconnect for HPC, which means HPC applications run faster and scale better than they do using traditional InfiniBand implementations. As additional compute resources are added to a cluster, latency remains low and message rates scale with the size of the fabric, resulting in maximum utilization of compute resources and near-linear scaling of application performance. See http://www.intel.com/content/www/us/en/infiniband/truescale-infiniband.html for more information.

> "Together, the Intel Xeon processor E5 family and the Intel Xeon Phi coprocessor 5110P offer unprecedented flexibility and simplicity for tailoring server and cluster resources to deliver the best performance for almost any workload."

Scale Storage Performance with High-Speed File Systems

Lustre Parallel File System

Lustre is an open-source, massively parallel file system designed for high-performance and large-scale data. It is used by more than 60 percent of the world's top 100 supercomputers.[8] With Lustre, it's common to see end-to-end data throughput on Gigabit Ethernet networks in excess of 110 MB/sec, InfiniBand double data rate (DDR) links reach bandwidths up to 1.5 GB/sec, InfiniBand Quad Data Rate (QDR) links reach over 2.5 GB/sec, and 10 Gigabit Ethernet interfaces provide end-to-end bandwidth of over 1 GB/sec. Lustre can scale to tens of thousands of clients and tens or even hundreds of petabytes of storage. Intel provides support for Lustre and also maintains the open source distribution. For more information, please refer to wiki.whamcloud.com.

Develop Higher Performing Applications with Less Effort

Intel® Parallel Development Studio

Intel provides easy-to-use software tools designed to help developers extract maximum performance and parallelism from their code with reduced effort. Intel Parallel Studio enables developers to design, build and debug, verify, and tune both serial and parallel applications to deliver higher performance on Intel multi-core and many-core architectures. The solution includes powerful parallel programming tools that can be used independently or together to optimize performance and advance all phases of the development lifecycle.

Advanced Processing to Meet the Challenges of Today—and Tomorrow

In the world of HPC, every increase in processor performance creates an opportunity to accelerate the pace of research and development. The Intel Xeon processor E5 family and the Intel Xeon Phi coprocessor 5110P give you ultimate flexibility for tailoring your HPC environment to deliver unprecedented performance for your most demanding applications, so you can solve problems and run simulations faster than ever before.

The Intel Xeon processor E5 family offers 2x the FLOPS of previous generation processors.[1] The Intel Xeon Phi coprocessor lets you add up to a teraflop of double precision peak performance per coprocessor[7] for your most demanding, highly-parallel applications. You can also take advantage of Intel Solid-State Drives, Intel True Scale fabric, and an optimized distribution of the Lustre global parallel file system to help you get the highest possible performance from your cluster environment. Easy-to-use software development tools are also available to help you ensure your code takes full advantage of multi-core and many-core Intel architecture.

The bottom line: The performance you can achieve with an Intel Xeon processor-based cluster has never been greater. If you're looking to extract new scientific insights or deliver breakthrough engineering innovation, Intel can help. Learn more at www.intel.com/go/hpc.

Figure 2. Flexible Execution Models Enable Optimized Performance for All Workloads

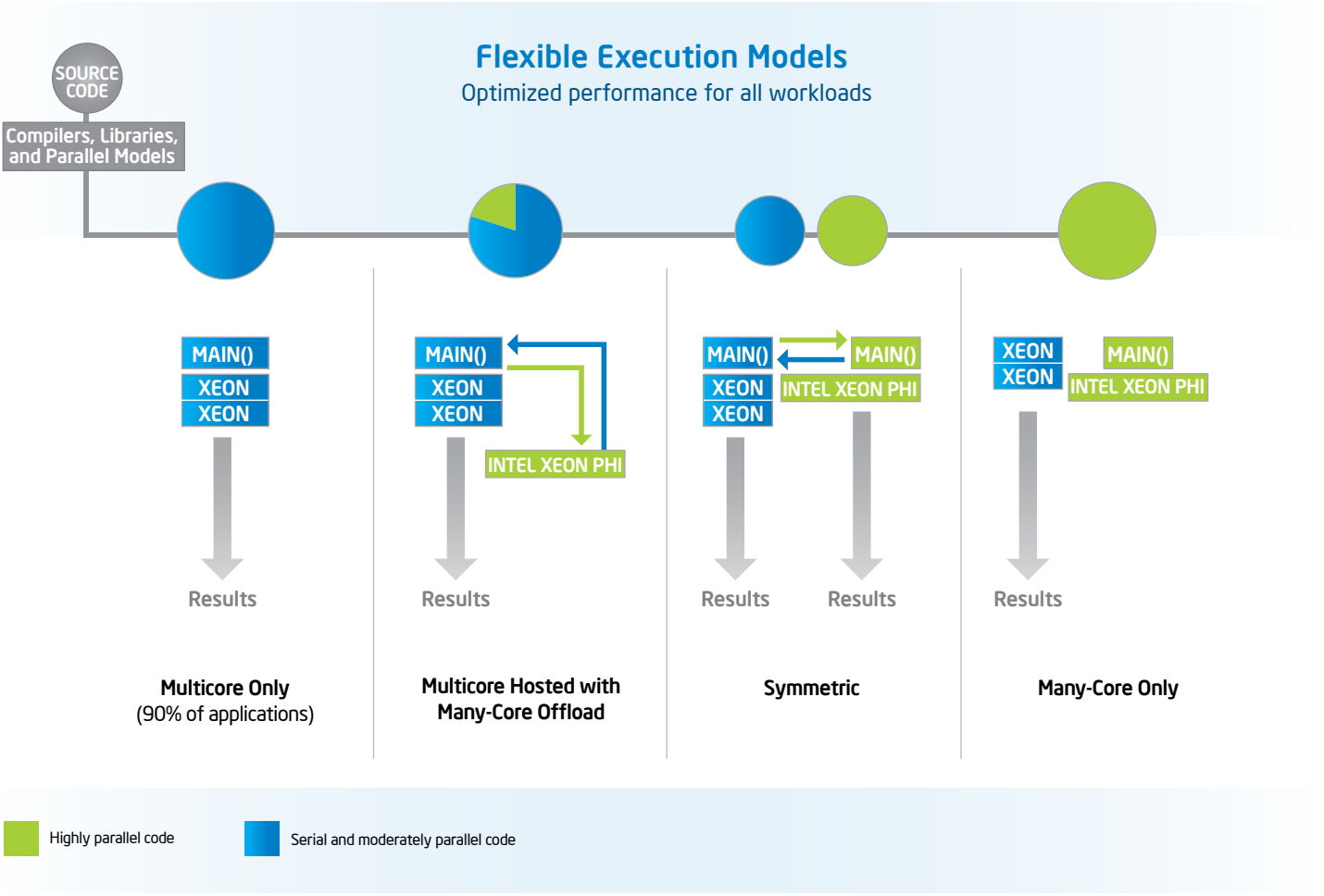


Table 1. Intel® Xeon® Processor Overview

FEATURES	BENEFITS
Intel® Xeon® Processor E5-4600/2600 High Performance for the Broadest Range of Applications and Environments	
Advanced multi-core, multi-threaded processing	▪ Up to 8 cores and 16 threads per socket ▪ Ideal for HPC clusters
Larger memory and cache configurations	▪ Up to 20 MB of last-level cache for fast access to frequently used data ▪ Up to 24 DIMMs per 2-socket server and 48 DIMMs per 4-socket server to support multiple data-hungry VMs ▪ Faster maximum memory speeds than the previous generation (1600 MHz versus 1333 MHz)
Higher performance for peak workloads	▪ Intel® Turbo Boost Technology 2.0[9] takes advantage of power and thermal headroom to increase processor frequencies for peak workloads ▪ Provides more and higher performance boosts and improved efficiency versus the previous generation
Higher performance for HPC applications	▪ Intel® Advanced Vector Extensions (Intel® AVX) accelerates vector and floating point computations by increasing maximum vector size from 128 to 256 bits ▪ Provides up to 2x performance boost[1] for floating point operations, which can significantly increase performance for high performance computing (HPC)[2] applications

Table 2. Intel® Xeon Phi™ Coprocessor Overview

FEATURES	BENEFITS
Intel® Xeon Phi™ Coprocessor 5110P Accelerated Performance for Highly-Parallel Applications	
Intel® Many Integrated Cores (MIC) architecture	▪ Up to 60 cores and 240 threads per coprocessor ▪ Ideal for highly-parallel applications and code segments
Familiar Intel architecture programming model	▪ Fully-compatible with code written for multi-core Intel Xeon processors ▪ Developers can use familiar tools and methods and maintain a common code base
Linux* hosting capability, IP addressable	▪ Can operate as a dependent coprocessor or an independent server node ▪ Supports standard clustering models
Up to 8 coprocessors per host server (requires one PCIe slot per coprocessor)	▪ Enables simple scaling of parallel execution resources to deliver desired performance levels

Intel Xeon Processor Family

Compared to the previous-generation Intel® Xeon® processor 5600 series, the Intel Xeon processor E5 family accelerates performance across a wide array of workloads.

UP TO **70%** PERFORMANCE BOOST[2]

Across a range of real-world technical computing applications

Achieve even higher gains with the Intel® Xeon® processor E5-4600 product family, which is available in the same server form factor.

UP TO **75%** ADDITIONAL PERFORMANCE BOOST[10]

can be realized by using 4-socket servers

A single Intel® Xeon Phi™ coprocessor 5110P provides up to 60 cores and 240 threads—for code that can run efficiently in a highly parallel execution environment.

UP TO **1 TFLOP** OF DOUBLE PRECISION PEAK PERFORMANCE[7]

for highly parallel code

Contact your OEM today to order an Intel® Xeon® processor and Intel® Xeon Phi™ coprocessor cluster solution.

To learn more, visit **www.intel.com/go/hpc**

* 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. For more information go to http://www.intel.com/performance.

[1] The Intel® Xeon® processor E5 product family supports Intel® Advanced Vector Extensions (Intel® AVX), which increases maximum vector size from 128 to 256 bits. Compared to the Intel® Xeon® processor 5600 series, Intel AVX enables up to twice the work to be accomplished per clock cycle during floating point and vector operations.

[2] Up to 3.8x better density at rack level claim based on 1U or 2U servers in a given rack with double the number of sockets moving from the choice of Intel Xeon processor 5600 series or E5-2600 product family to the E5-4600 product family, all at the 130W TDP processor specification. Performance Details as of 21 March 2012 (all servers tested using Red Hat* Enterprise LINUX 6.1 using best known BIOS settings and tunings): Life Sciences vertical (based on the geometric mean of three ISV code molecular dynamics and bioinformatic workloads). Source: Intel SSG TR#1218. Baseline 1.0 – 2-socket server based on Intel Xeon processors X5690 (12M cache, 3.46GHz, 6.4GT/s Intel® QPI), 48GB memory (12x 4GB DDR3-1333). Score: 1260.3. Next generation 2-socket server based on Intel Xeon processors E5-2680 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 32GB memory (8x 4GB DDR3-1600). Score: 1929.6. New 4-socket server based on Intel Xeon processor E5-4650 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 64GB memory (16x 4GB DDR3-1600). Score: 3108.9. Computer-Aided Engineering (CAE) vertical (based on the geometric mean of five ISV code crash simulation and fluid dynamic workloads). Source: Intel SSG TR#1218. Baseline 1.0 – 2-socket server based on Intel Xeon processors X5690 (12M cache, 3.46GHz, 6.4GT/s Intel® QPI), 48GB memory (12x 4GB DDR3-1333). Score: 146.4. Next generation 2-socket server based on Intel Xeon processors E5-2680 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 32GB memory (8x 4GB DDR3-1600). Score: 228.1. New 4-socket server based on Intel Xeon processor E5-4650 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 64GB memory (16x 4GB DDR3-1600). Score: 393.3. Energy vertical (based on the geometric mean of three ISV code reservoir and seismic workloads). Source: Intel SSG TR#1218. Baseline 1.0 – 2-socket server based on Intel Xeon processors X5690 (12M cache, 3.46GHz, 6.4GT/s Intel® QPI), 48GB memory (12x 4GB DDR3-1333). Score: 1260.3. Next generation 2-socket server based on Intel Xeon processors E5-2680 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 32GB memory (8x 4GB DDR3-1600). Score: 1929.6. New 4-socket server based on Intel Xeon processor E5-4650 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 64GB memory (16x 4GB DDR3-1600). Score:3108.9. Financial Sciences vertical (based on the geometric mean of four ISV code Monte Carlo, Black Scholes, and binomial workloads). Source: Intel SSG TR#1218. Baseline 1.0 – 2-socket server based on Intel Xeon processors X5690 (12M cache, 3.46GHz, 6.4GT/s Intel® QPI), 48GB memory (12x 4GB DDR3-1333). Score: 1994.9. Next generation 2-socket server based on Intel Xeon processors E5-2680 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 32GB memory (8x 4GB DDR3-1600). Score: 3229.8. New 4-socket server based on Intel Xeon processor E5-4650 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 64GB memory (16x 4GB DDR3-1600). Score: 5914.2. Floating-Point Throughput (based on the SPECfp*_rate_base2006 benchmark baseline score) Baseline 1.0 – 2-socket server based on Intel Xeon processors X5690 (12M cache, 3.46GHz, 6.4GT/s Intel® QPI), 96GB memory (12x 8GB DDR3-1333). SPECfp*_rate_base2006 score: 270. Source: http://www.spec.org/cpu2006/results/res2012q1/cpu2006-20120213-19463.html. Next generation 2-socket server based on Intel Xeon processors E5-2680 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 32GB memory (8x 4GB DDR3-1600). SPECfp*_rate_base2006 est. score: 466. Source: Intel SSG TR#1147. New 4-socket server based on Intel Xeon processor E5-4650 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 64GB memory (16x 4GB DDR3-1600). SPECfp*_rate_base2006 est. score: 825. Source: Intel SSG TR#1265. Numerical Weather vertical (based on the geometric mean of five ISV code geophysical, ocean, and circulation simulation and forecasting workloads). Source: Intel SSG TR#1218. Baseline 1.0 – 2-socket server based on Intel Xeon processors X5690 (12M cache, 3.46GHz, 6.4GT/s Intel® QPI), 48GB memory (12x 4GB DDR3-1333). Score: 2220.1. Next generation 2-socket server based on Intel Xeon processors E5-2680 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 32GB memory (8x 4GB DDR3-1600). Score: 3849.7. New 4-socket server based on Intel Xeon processor E5-4650 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 64GB memory (16x 4GB DDR3-1600). Score: 6951.0. Quantum Physics vertical (based on the MILC quantum chromo-dynamics model workload completion time). Source: Intel SSG TR#1218. Baseline 1.0 – 2-socket server based on Intel Xeon processors X5690 (12M cache, 3.46GHz, 6.4GT/s Intel® QPI), 48GB memory (12x 4GB DDR3-1333). Score: 1260.3. Next generation 2-socket server based on Intel Xeon processors E5-2680 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 32GB memory (8x 4GB DDR3-1600). Score: 1929.6. New 4-socket server based on Intel Xeon processor E5-4650 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 64GB memory (16x 4GB DDR3-1600). Score: 3108.9. Matrix Multiplication (based on the LINPACK MP Intel MKL benchmark) Baseline 1.0 – 2-socket server based on Intel Xeon processors X5690 (12M cache, 3.46GHz, 6.4GT/s Intel® QPI), 48GB memory (12x 4GB DDR3-1333). Score: 159.4 GFLOPS. Source: Intel SSG TR#1236. Next generation 2-socket server based on Intel Xeon processors E5-2680 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 32GB memory (8x 4GB DDR3-1600). Score: 342.6 GFLOPS. Source: Intel SSG TR#1236 New 4-socket server based on Intel Xeon processor E5-4650 (20M cache, 2.7GHz, 8.0GT/s Intel QPI), 64GB memory (16x 4GB DDR3-1600). Score: 602 GFLOPS. Source: Intel SSG TR#1264.

[3] Intel Optimized SMP LINPACK 10.3.5 on Linux x86_64 Intel® Xeon® processor X5690 platform Intel® Xeon® 5600 platform with two Intel® Xeon® Processor X5690 (6-Core, 3.46GHz, 12MB L3 cache, 6.4GT/s, B1-stepping), EIST Enabled, Turbo Boost enabled, Hyper-Threading Disabled, 48GB memory (12x 4GB DDR3-1333 REG ECC), 160GB SATA 7200RPM HDD, Red Hat* Enterprise Linux Server 6.1 with kernel 2.6.32-131.0.15.el6.x86_64 . Source: Intel internal testing as of Nov 2011. Score: 159.36 Gflops. (TR#1236) Intel® Xeon® processor E5-2690 platform Intel® Xeon® E5-2600 Qual platform with two Intel® Xeon® Processor E5-2690 (8-core 2.9GHz, 20M L3 cache, 8.0GT/s, 135W, C1-stepping), EIST Enabled, Turbo Boost enabled, Hyper-Threading Disabled, 64GB memory (8x 8GB DDR3-1600 REG ECC), 160GB SATA 7200RPM HDD, Red Hat* Enterprise Linux Server 6.1 with kernel 2.6.32-131.0.15.el6.x86_64. Source: Intel internal testing as of Nov 2011. Score: 347.69 Gflops. (TR#1236).

[4] Intel measurements of average time for an I/O device read to local system memory under idle conditions. Improvement compares Xeon processor E5-2600 product family (230 ns) vs. Xeon processor 5500 series (340 ns). Baseline Configuration: Green City system with two Intel® Xeon processor E5520 (2.26GHz, 4C), 12GB memory @ 1333, C-States Disabled, Turbo Disabled, SMT Disabled, Rubicon* PCIe* 2.0 x8. New Configuration: Meridian system with two Intel® Xeon processor E5-2665 (C0 stepping, 2.4GHz, 8C), 32GB memory @1600 MHz, C-States Enabled, Turbo Enabled. The measurements were taken with a LeCroy* PCIe* protocol analyzer using Intel internal Rubicon (PCIe* 2.0) and Florin (PCIe* 3.0) test cards running under Windows* 2008 R2 w/SP1.

[5] Intel® AES-NI requires a computer system with an AES-NI enabled processor, as well as non-Intel software to execute the instructions in the correct sequence. AES-NI is available on select Intel® processors. For availability, consult your reseller or system manufacturer. For more information, see Intel® Advanced Encryption Standard Instructions (AES-NI) http://software.intel.com/en-us/articles/intel-advanced-encryption-standard-instructions-aes-ni/.

[6] Intel internal measurements showing 62 percent, 78 percent, and 94 percent higher performance for the Intel Xeon processor E5 product family versus the Intel Xeon processor 5600 series on the SPECfp*rate2006, STREAM, and Linpack benchmarks, respectively. Configurations: Benchmark: SPECfp*_rate2006 Intel Xeon processor E5 product family-based server: Intel® C606 Chipset-based CRB system with two Intel® Xeon® Sandy Bridge EP B-0 Stepping Processors (8-Core, 2.7GHz, 20MB L3 cache, 8.0 GT/s), 8 x 4GB 1333 RDIMMs, Turbo Disabled, HT Disabled, Red Hat Enterprise Linux 5.5, Kernel 2.6.35. Intel Xeon processor 5600 series-based server: Cisco B200-M1 system with two Intel® Xeon® X5690 Processors (6-Core, 3.46 GHz, 12MB L3 cache, 6.4 GT/s), 6 x 4GB 1333 RDIMMs, Turbo Enabled, HT Enabled, SuSe Linux Enterprise Server 11 (x86_64), Kernel 2.6.27-15-2-default RC4. Benchmark: Stream* Triad (Windows*) Intel Xeon processor E5 product family-based server: Intel® C606 Chipset-based CRB system with two Intel® Xeon® Sandy Bridge EP B-0 Stepping Processors (8-Core, 2.7GHz, 20MB L3 cache, 8.0 GT/s), 8 x 8GB dual-rank 1600 RDIMMs (1 DPC), Turbo Enabled, HT Enabled, Microsoft Windows Server 2008 R2,* Intel internal Windows StreamMP. Source: Intel internal testing as of January 2011. Score (Normalized relative to X5670 baseline): NTWs: 1.78, RFOs: 2.05. Intel Xeon processor 5600 series-based server: Intel® 5520 Chipset-based CRB system with two Intel® Xeon® X5670 Processors (6-Core, 2.93GHz, 12MB L3 cache, 6.4 GT/s), 6 x 4GB dual-rank 1333 RDIMMs (1 DPC), Turbo Enabled, HT Enabled, Microsoft Windows Server 2008 R2*, Intel internal Windows StreamMP. Source: Intel internal testing as of January 2011. Score (Normalized relative to X5670 baseline): NTWs: 1.0, RFOs: 1.0. Benchmark: Linpack* Intel Xeon processor E5 product family-based server: Intel® C606 Chipset-based CRB system with two Intel® Xeon® Sandy Bridge EP B-0 Stepping Processors (8-Core, 2.7GHz, 20MB L3 cache, 8.0 GT/s), 8 x 4GB 1333 RDIMMs, Turbo Disabled, HT Disabled, Red Hat Enterprise Linux 5.5, Kernel 2.6.35. Intel Xeon processor 5600 series-based server: Cisco B200-M1 system with two Intel® Xeon® X5690 Processors (6-Core, 3.46 GHz, 12MB L3 cache, 6.4 GT/s), 6 x 4 GB 1333 RDIMMs, Turbo Enabled/Disabled, HT Enabled/Disabled, SuSe Linux Enterprise Server 11 (x86_64), Kernel 2.6.27-15-2-default RC4.6.

[7] Claim based on calculated theoretical peak double precision performance capability for a single coprocessor. 16 DP flops/clock/core * 60 cores * 1.053 GHz = 1.01088 Tflops.

[8] Source: www.top500.org

[9] 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.

[10] Additional performance gain up to 75% claim based on performance comparisons using best measured 2- and 4-socket server results on the SPECjbb*2005 benchmark as of 1 March 2012. Server-side Java* - SPECjbb*2005 (Source: TR#1228) Baseline 2-socket populated Intel® C606 Chipset-based customer reference server using two Intel® Xeon® processors E5-2690 (8C, 20M Cache, 2.9GHz, 8.0GT/s Intel QPI), 32GB memory (8x 4GB DDR3-1600 DIMMs), Micro- soft Windows Server* 2008R2 Enterprise Edition, Oracle HotSpot* 64-bit Server VM build 20,0-v11 using Java* SE RE 1.6.0 Update 25. Score: 1,520,408 bops. New 4-socket populated Intel® C606 Chipset-based customer reference server with four Intel® Xeon® processors E5-4650 (8C, 20M Cache, 2.7GHz, 8.0GT/s Intel QPI), 128GB memory (16x 8GB DDR3-1600 DIMMs), Microsoft Windows Server* 2008R2 Enterprise Edition, Oracle HotSpot* 64-bit Server VM build 20,0-v11 using Java* SE RE 1.6.0 Update 25. Score: 2,663,768 bops.

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