IT@Intel Brief

Intel Information Technology
64-Bit Computing
March 2010

Increasing EDA Throughput with Intel® Xeon® Processor 5600 Series

- Up to 17.3x increased throughput compared with single-core Intel® Xeon® processor
- Up to 5.5x faster compared with dual-core Intel® Xeon® processor 5160

Intel's silicon design engineers need significant increases in computing capacity to deliver each new generation of silicon chips. To meet those requirements, Intel IT conducts ongoing performance tests, using the latest Intel silicon design data, to analyze the benefits of introducing compute servers based on new, more powerful processors into our electronic design automation (EDA) computing environment.

We recently tested a dual-socket server based on the latest Intel® Xeon® processor X5670, running single-threaded, multi-threaded, and distributed EDA applications operating on more than 50 Intel silicon design workloads. By utilizing all available cores, the server completed workloads up to 17.3x faster than a server based on a 64-bit Intel® Xeon® processor (3.6 GHz) with a single core, as shown in Figure 1. The server was up to 5.5x faster than a server based on Intel® Xeon® processor 5160 with two cores.

Based on our performance assessment, we plan to deploy servers based on Intel® Xeon® processor 5600 series this year, completing our replacement of older servers based on single-core Intel® Xeon® processors and beginning replacement of dual-core Intel® Xeon® processor 5100 series. By doing so, we expect to significantly increase EDA throughput while realizing savings due to avoidance of data center construction and reduced power consumption.

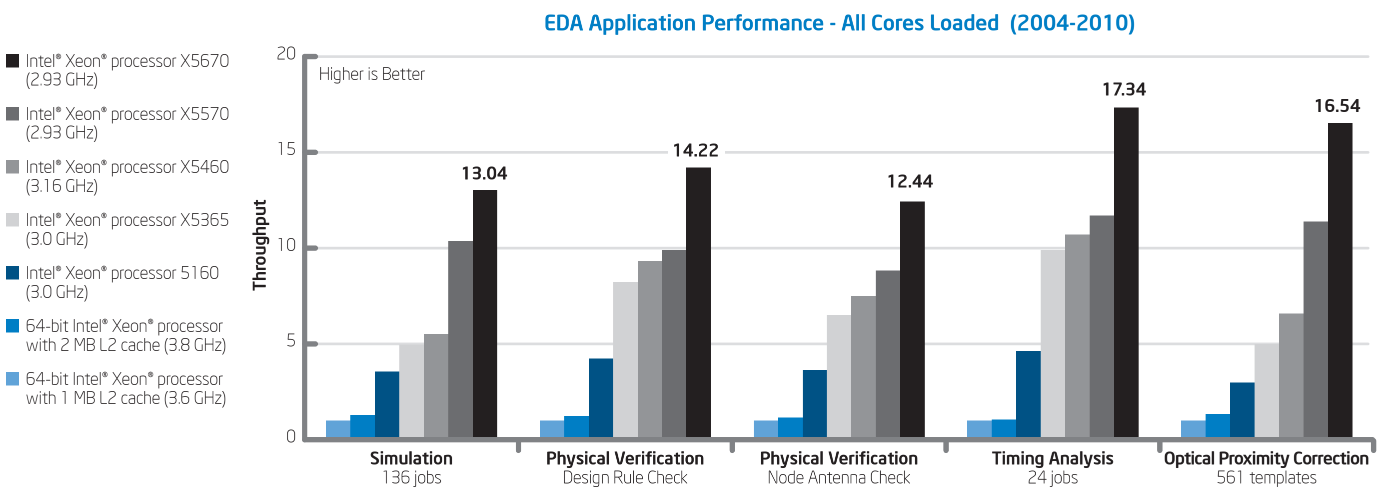
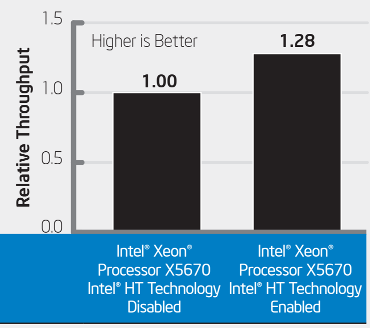


Figure 1. Summary of electronic design automation (EDA) test results, comparing relative throughput.

Maximizing Throughput with Intel® Hyper-Threading Technology

Intel® Xeon® processor 5600 series with Intel® Hyper-Threading Technology (Intel® HT Technology) can support up to 24 concurrent software threads in a single two-socket platform. Intel HT Technology can help deliver higher performance throughput, as shown in the figure below. Intel HT Technology delivered up to a 1.28x benefit when completing the same number of jobs using 2x the application licenses.



Time to Complete 136 Simulation Jobs	7:11:51	5:37:17
Relative Throughput	1.00	1.28

Background

Silicon chip design engineers at Intel face ongoing challenges: integrating more features into ever-shrinking silicon chips, bringing products to market faster, and keeping design engineering and manufacturing costs low.

As design complexity increases, the requirements for compute capacity also increase, so refreshing servers and workstations with higher performing systems is cost-effective and offers a competitive advantage by enabling faster chip design.

Refreshing older servers also enables us to realize data center cost savings. By taking advantage of the performance and power-efficiency improvements in new server generations, we can increase computing capacity within the same data center footprint, avoiding expensive data center construction and achieving operational cost savings due to reduced power consumption.

Intel IT conducts ongoing performance tests, based on the latest Intel silicon design data, to analyze the potential performance and data center benefits of introducing servers based on new processors into our EDA computing environment.

While our assessments focus on EDA applications, throughput improvements may also be achieved with other applications used in high-performance computing environments where simulation and verification are large parts of the workflow, including:

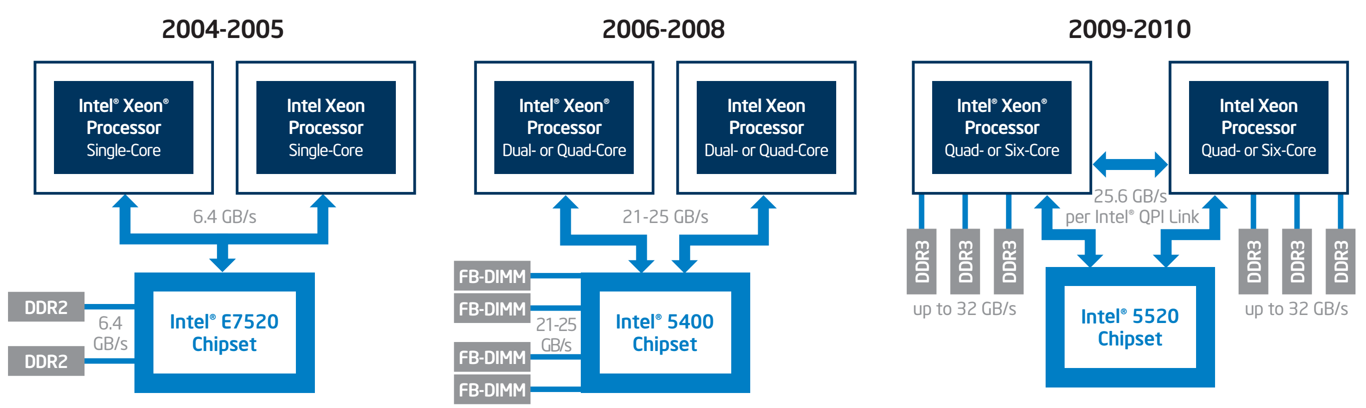
- Computational fluid dynamics and simulation in the aeronautical and automobile industries
- Synthesis and simulation applications in the life sciences
- Simulation in the oil and gas industries

Test Methodology

We ran tests on dual-socket servers based on Intel Xeon processor X5670. This processor includes new features designed to increase throughput compared with previous processor generations, including 32nm process technology, up to six cores, and up to 12 MB L3 cache. Figure 2 illustrates some of the enhancements that boost EDA application performance.

We ran several tests using industry-leading EDA single-threaded, multi-threaded, and distributed applications comprising more than 50 Intel® processor and chipset design workloads.

Our goal was to assess throughput improvement by measuring the time taken to complete a specific number of design workloads. To maximize throughput, we configured each application to utilize all available cores, resulting in one job or process per core as shown in Table 1.



	2004-2005	2006-2008	2009-2010
Process Technology	90nm	65nm and 45nm	45nm and 32nm
Cores per Socket	1	2 or 4	4 or 6
Cache	1 MB or 2 MB	4 MB or 6 MB shared between 2 cores	8 MB or 12 MB shared
DIMMs	Up to 8	Up to 16	Up to 18
Maximum Memory Capacity	16 GB (DDR2-400)	64 GB or 128 GB[1] (FB-DIMM/DDR2-667 or FB-DIMM/DDR2-800)	144 GB or 288 GB[2] (DDR3-800/1066/1333MHz)

DDR - double data rate; DIMM - dual in-line memory module; FB-DIMM - fully buffered dual in-line memory module; Intel® QPI - Intel® QuickPath Interconnect

[1] 128 GB support with Intel® 5400 Chipset introduced in 2007.

[2] 144 GB assumes 18 memory slots populated with 8-GB DIMMs; 288 GB assumes 18 memory slots populated with 16 GB DIMMs, and validated only with Intel® Xeon® processor 5600 series

Figure 2. A comparison of dual-socket servers based on Intel® Xeon® processors.

Table 1. Electronic Design Automation (EDA) Summary Test Results Showing Relative Throughput of 64-Bit Intel® Processors

Summary test results: relative throughput using 64-bit Intel® Xeon® processor with 1 MB L2 cache as baseline

	64-bit Intel® Xeon® processor with 1 MB L2 cache (3.6 GHz)	64-bit Intel® Xeon® processor with 2 MB L2 cache (3.8 GHz)	Intel® Xeon® processor 5160 (3.0 GHz)	Intel® Xeon® processor X5365 (3.0 GHz)	Intel® Xeon® processor X5460 (3.16 GHz)	Intel® Xeon® processor X5570 (2.93 GHz)	Intel® Xeon® processor X5670 (2.93 GHz)
Simulation (136 jobs)	1.00	1.30	3.55	4.97	5.52	10.38	13.04
Physical Verification (DRC)	1.00	1.23	4.24	8.22	9.32	9.89	14.22
Physical Verification (NAC)	1.00	1.16	3.64	6.50	7.50	8.84	12.44
Timing Analysis (24 jobs)	1.00	1.06	4.62	9.90	10.71	11.70	17.34
OPC (561 templates)	1.00	1.34	2.98	5.00	6.60	11.39	16.54

Summary test results: relative throughput using Intel® Xeon® processor 5160 as baseline

	Intel® Xeon® processor 5160	Intel® Xeon® processor X5365	Intel® Xeon® processor X5460	Intel® Xeon® processor X5570	Intel® Xeon® processor X5670
Simulation (136 jobs)	1.00	1.40	1.55	2.92	3.67
Physical Verification (DRC)	1.00	1.94	2.20	2.33	3.35
Physical Verification (NAC)	1.00	1.79	2.06	2.43	3.42
Timing Analysis (24 jobs)	1.00	2.14	2.32	2.53	3.75
OPC (561 templates)	1.00	1.68	2.21	3.82	5.55

DRC - design rule check; NAC - node antenna check; OPC - optical proximity correction

Table 2. Test System Configurations for Dual-Socket Servers

Processor	Cores	Frequency	Cache	Interconnect	RAM	Memory Type
64-bit Intel® Xeon® Processor	1	3.6 GHz	1 MB	800 MHz Shared FSB	16 GB	DDR2-400
64-bit Intel® Xeon® Processor	1	3.8 GHz	2 MB	800 MHz Shared FSB	16 GB	DDR2-400
Intel® Xeon® Processor 5160	2	3.0 GHz	4 MB	1333 MHz Dual Independent FSB	16 GB	FB-DIMM/DDR2-667
Intel® Xeon® Processor X5365	4	3.0 GHz	8 MB	1333 MHz Dual Independent FSB	32 GB	FB-DIMM/DDR2-667
Intel® Xeon® Processor X5460	4	3.16 GHz	12 MB	1333 MHz Dual Independent FSB	32 GB	FB-DIMM/DDR2-667
Intel® Xeon® Processor X5570	4	2.93 GHz	8 MB	25.6 GB/s per Intel® QuickPath Interconnect (Intel® QPI) Link	48 GB	DDR3-1333
Intel® Xeon® Processor X5670	6	2.93 GHz	12 MB	25.6 GB/s per Intel® QPI Link	48 GB	DDR3-1333

DDR - double data rate; FB-DIMM - fully buffered dual in-line memory module; FSB - front side bus

We then compared our results with previous tests conducted using the same approach on servers based on the following processors:

- Intel® Xeon® processor X5570, introduced in 2009
- Intel® Xeon® processor X5460, introduced in 2007
- Intel® Xeon® processor X5365, introduced in 2007
- Intel Xeon processor 5160, introduced in 2006
- Single-core 64-bit Intel Xeon processor with 2 MB L2 cache (3.8 GHz), introduced in 2005
- Single-core 64-bit Intel Xeon processor with 1 MB L2 cache (3.6 GHz), introduced in 2004

Test system configurations are shown in Table 2.

Results

Results are shown in Figure 1 and Tables 1 and 3. The Intel Xeon processor X5670-based server completed the tests up to 17.3x faster than a server based on the single-core 64-bit Intel Xeon processor, and up to 5.5x faster than a server based on Intel Xeon processor 5160.

Conclusion

The Intel Xeon processor 5600 series delivers significant throughput improvements for Intel design workloads across a range of EDA applications. Using a weighted performance measure of end-to-end EDA applications based on Intel® silicon design tests, we found that the effective refresh ratio to replace our existing Intel Xeon processors with 1 MB L2 cache-based servers with Intel Xeon processor X5670 is 15:1.

Based on our performance assessment and our refresh cycle, we plan to deploy servers based on the new Intel Xeon processor 5600 series this year, completing our replacement of older servers based on single-core Intel Xeon processors and beginning replacement of dual-core Intel Xeon processor 5100 series. By doing so, we expect to achieve greater throughput while realizing operational benefits such as data center construction cost avoidance and reduced power consumption.

AUTHORS

Shesha Krishnapura
Senior Principal Engineer, Intel IT

Vipul Lal
Principal Engineer, Intel IT

Shaji Achuthan
Systems Programmer, Intel IT

Murty Ayyalasomayajula
Systems Programmer, Intel IT

Ty Tang
Principal Engineer, Intel IT

For more straight talk on current topics from Intel's IT leaders, visit www.intel.com/it.

Table 3. Electronic Design Automation (EDA) Test Results Showing Runtimes and Workload Configurations

Simulation (136 CPU Model Tests)

	64-bit Intel® Xeon® processor with 1 MB L2 cache (3.6 GHz)	64-bit Intel® Xeon® processor with 2 MB L2 cache (3.8 GHz)	Intel® Xeon® processor 5160 (3.0 GHz)	Intel® Xeon® processor X5365 (3.0 GHz)	Intel® Xeon® processor X5460 (3.16 GHz)	Intel® Xeon® processor X5570 (2.93 GHz)	Intel® Xeon® processor X5670 (2.93 GHz)
Number of Simultaneous Jobs	2	2	4	8	8	8	12
Total Runtime (hh:mm:ss)	93:51:07	72:23:11	26:26:16	18:54:01	17:00:58	9:02:21	7:11:51
Relative Throughput	1.00	1.30	3.55	4.97	5.52	10.38	13.04

Physical Verification (Design Rule Check)

	64-bit Intel® Xeon® processor with 1 MB L2 cache (3.6 GHz)	64-bit Intel® Xeon® processor with 2 MB L2 cache (3.8 GHz)	Intel® Xeon® processor 5160 (3.0 GHz)	Intel® Xeon® processor X5365 (3.0 GHz)	Intel® Xeon® processor X5460 (3.16 GHz)	Intel® Xeon® processor X5570 (2.93 GHz)	Intel® Xeon® processor X5670 (2.93 GHz)
Simultaneous 2-Threaded Jobs	1	1	2	4	4	4	6
Total Number of Iterations	12	12	6	3	3	3	2
Total Number of Jobs	12	12	12	12	12	12	12
Total Runtime (hh:mm:ss)	77:59:24	63:35:12	18:22:42	9:29:30	8:22:06	7:53:00	5:28:58
Relative Throughput	1.00	1.23	4.24	8.22	9.32	9.89	14.22

Physical Verification (Node Antenna Check)

	64-bit Intel® Xeon® processor with 1 MB L2 cache (3.6 GHz)	64-bit Intel® Xeon® processor with 2 MB L2 cache (3.8 GHz)	Intel® Xeon® processor 5160 (3.0 GHz)	Intel® Xeon® processor X5365 (3.0 GHz)	Intel® Xeon® processor X5460 (3.16 GHz)	Intel® Xeon® processor X5570 (2.93 GHz)	Intel® Xeon® processor X5670 (2.93 GHz)
Simultaneous 2-Threaded Jobs	1	1	2	4	4	4	6
Total Number of Iterations	12	12	6	3	3	3	2
Total Number of Jobs	12	12	12	12	12	12	12
Total Runtime (hh:mm:ss)	21:17:12	18:21:12	5:50:42	3:16:24	2:50:21	2:24:27	1:42:38
Relative Throughput	1.00	1.16	3.64	6.50	7.50	8.84	12.44

Timing Analysis

	64-bit Intel® Xeon® processor with 1 MB L2 cache (3.6 GHz)	64-bit Intel® Xeon® processor with 2 MB L2 cache (3.8 GHz)	Intel® Xeon® processor 5160 (3.0 GHz)	Intel® Xeon® processor X5365 (3.0 GHz)	Intel® Xeon® processor X5460 (3.16 GHz)	Intel® Xeon® processor X5570 (2.93 GHz)	Intel® Xeon® processor X5670 (2.93 GHz)
Number of Simultaneous Jobs	2	2	4	8	8	8	12
Total Number of Iterations	12	12	6	3	3	3	2
Total Number of Jobs	24	24	24	24	24	24	24
Total Runtime (hh:mm:ss)	22:31:12	21:12:00	4:52:24	2:16:33	2:06:09	1:55:30	1:17:56
Relative Throughput	1.00	1.06	4.62	9.90	10.71	11.70	17.34

Optical Proximity Correction (561 Templates Processing)

	64-bit Intel® Xeon® processor with 1 MB L2 cache (3.6 GHz)	64-bit Intel® Xeon® processor with 2 MB L2 cache (3.8 GHz)	Intel® Xeon® processor 5160 (3.0 GHz)	Intel® Xeon® processor X5365 (3.0 GHz)	Intel® Xeon® processor X5460 (3.16 GHz)	Intel® Xeon® processor X5570 (2.93 GHz)	Intel® Xeon® processor X5670 (2.93 GHz)
Number of Simultaneous Jobs	2	2	4	8	8	8	12
Total Runtime (hh:mm:ss)	10:40:12	7:58:31	3:34:39	2:08:04	1:37:03	0:56:11	0:38:42
Relative Throughput	1.00	1.34	2.98	5.00	6.60	11.39	16.54

Printed in USA
0310/KAR/KC/PDF

Please Recycle
322969-001US