

IT@Intel Brief

Intel Information Technology

Computer Manufacturing

64-Bit Computing

March 2009

Intel® Xeon® processor 5500 series has demonstrated a substantial performance multiple when compared to prior generation Intel® quad-core processors in high-performance computing applications.

— Dr. Howard Ko
Senior Vice President &
General Manager
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Improving EDA Batch Application Performance

Intel IT and Synopsys conducted a joint performance assessment of 64-bit Intel® multi-core platforms running Synopsys VCS* application for simulation and Synopsys Proteus* application for optical proximity correction (OPC). Intel® Xeon® processor 5500 series improved performance as much as 13.14x for simulation workloads and 11.39x for OPC workloads compared to 64-bit Intel® Xeon® processors with a single-core.

We administered performance tests on two-socket 64-bit servers based on Intel® Xeon® processor X5570. We then compared the results with identical previous tests of servers based on earlier generations of Intel® Xeon® processors.

Figures 1 and 2 show the test results. For both applications, the Intel Xeon processor X5570-based server delivered higher throughput and was able to run more jobs simultaneously. Our results show that one server based on new quad-core processors can replace up to 13 servers based on single-core processors for electronic design automation (EDA) simulation workloads. We could consequently decrease data center operational costs due to reduced server footprint and avoid future data center construction costs. Significantly higher throughput also enables us to accelerate design cycles within the same data center footprint to achieve faster time to market.

Profile: Intel® Xeon® Processor 5500 Series

- Up to 13.14x improved performance over single-core processors for simulation workloads
- Up to 11.39x improved performance over single-core processors for OPC workloads
- Up to 13:1 server consolidation ratio for simulation workloads and 11:1 for OPC workloads

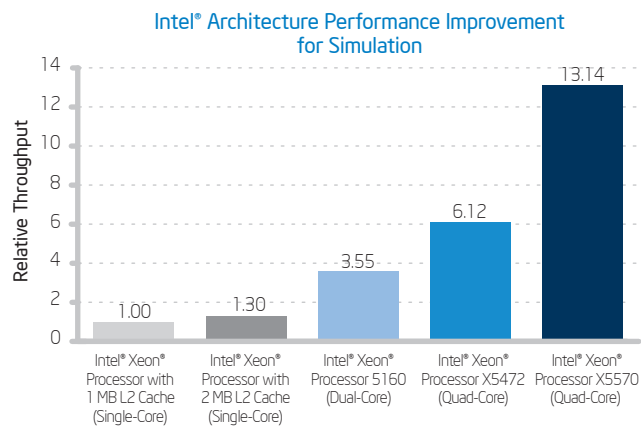


Figure 1. Servers based on Intel® Xeon® processor 5500 series improved Synopsys VCS* application performance for simulation.¹

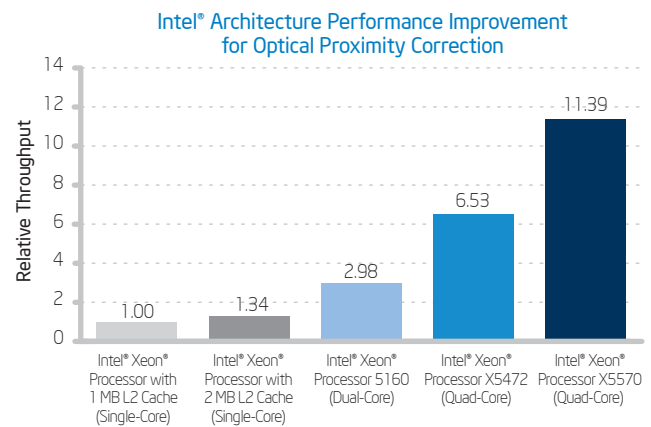


Figure 2. Servers based on Intel® Xeon® processor 5500 series improved Synopsys Proteus* application performance for optical proximity correction (OPC).¹

Design Environment Challenges

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

To support chip design, Intel IT conducts ongoing performance assessments to quantify and analyze the potential performance benefits of introducing new quad-core processors into our EDA computing environment.

While our assessments focus on EDA applications, the benefits of quad-core processor throughput could apply to other applications in high-performance computing (HPC) environments where simulation and verification are large parts of the workflow, including:

- Computational fluid dynamics (CFD) 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 our applications on two-socket servers based on Intel Xeon processor X5570 with four cores. We then compared this data with results from identical previous testing conducted on

servers based on Intel Xeon processor X5472 with four cores, Intel Xeon processor 5160 and Intel Xeon processor 5150 with two cores, and 64-bit Intel Xeon processors with a single-core. Table 1 shows test system specifications.

Test Methodology for Simulation Application

We ran Synopsys VCS application using our latest CPU design model with 136 tests. Intel® Hyper-Threading Technology (Intel® HT Technology) and Intel® Turbo Boost Technology were enabled.

Test Methodology for OPC Application

Synopsys Proteus application is a distributed application used in semiconductor design for OPC function. We tested performance and scalability using two different datasets.

Performance Test: Dataset A

We tested throughput running dataset A, which was processed by multiple OPC application instances—one job per processing core on each server.

The two servers based on Intel Xeon processors with four cores ran eight jobs in parallel compared to four jobs on the server based on the Intel Xeon processor with two cores and two jobs on the two servers based on single-core 64-bit Intel Xeon processors.

Scalability Test: Dataset B

To determine the scalability of the performance increase, we also measured throughput running dataset B. We ran tests on one, two, and four two-socket servers based on the processors under test.

Table 1. Specifications for Two-Socket 64-Bit Test Server Platforms Running Linux*

Processor	Core	Frequency	Cache	Interconnect	System Memory		Memory Type
					OPC	Simulation	
64-bit Intel® Xeon® Processor	1	3.6 GHz	1 MB	800 MHz Shared FSB	16 GB	8 GB	DDR2-400
64-bit Intel® Xeon® Processor	1	3.8 GHz	2 MB	800 MHz Shared FSB	16 GB	8 GB	DDR2-400
Intel® Xeon® Processor 5150	2	2.66 GHz	4 MB	1333 MHz Dual Independent FSB	16 GB	16 GB	FB-DIMM/DDR2-667
Intel® Xeon® Processor 5160	2	3.0 GHz	4 MB	1333 MHz Dual Independent FSB	16 GB	16 GB	FB-DIMM/DDR2-667
Intel® Xeon® Processor X5472	4	3.0 GHz	12 MB	1600 MHz Dual Independent FSB	16 GB	32 GB	FB-DIMM/DDR2-800
Intel® Xeon® Processor X5570	4	2.93 GHz	8 MB	25.6 GB/s per Intel® Quick Path Interconnect (QPI) Link	16 GB	48 GB	DDR3-1333

DDR – double data rate; FB-DIMM – fully buffered dual in-line memory module; FSB – front side bus; OPC – optical proximity correction

Results

Performance Results for Simulation Application

Figure 1 and Table 2 show runtime performance comparisons on single two-socket servers and demonstrate that Intel Xeon processor 5500 series improves Synopsys VCS simulation throughput significantly: up to 13.14x compared to 64-bit Intel Xeon processors with a single core and up to 3.70x compared to Intel Xeon processor 5100 series with two cores.

Performance Results for OPC Application: Dataset A

The Synopsys Proteus OPC results in Figure 2 and Table 3 running dataset A show runtime performance comparisons on single two-socket servers. They demonstrate that Intel Xeon processor 5500 series improves throughput significantly: up to 11.39x compared to 64-bit Intel Xeon processors with a single core and up to 3.82x compared to Intel Xeon processor 5100 series with two cores.

Scalability Results for OPC Application: Dataset B

Our performance comparisons on multiple servers running dataset B showed that the runtime and throughput advantage for Intel Xeon processor 5500 series-based servers scales as the numbers of servers and cores increase in HPC clusters. Figure 3 shows runtime performance results across multiple servers and Figure 4 shows throughput results. Tests of Intel Xeon processor X5570 ran with Intel HT Technology turned off; we anticipate even higher gains with this feature turned on.

Table 2. Runtime Performance for Synopsys VCS* Application for Simulation

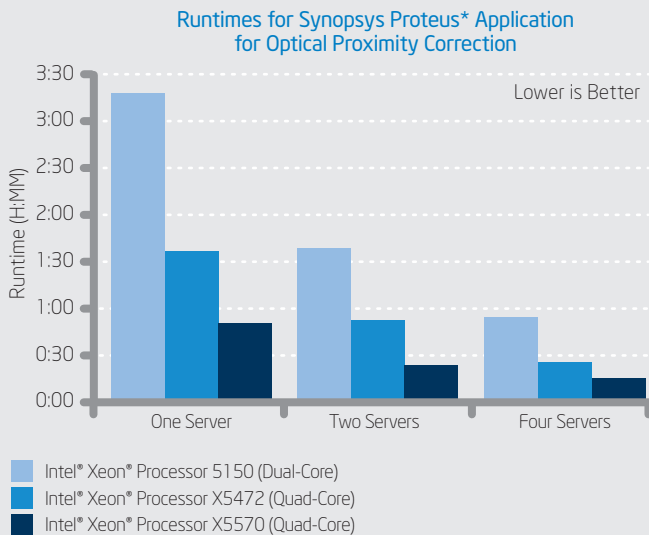
Processor	Simultaneous Simulation Jobs	Runtime (HH:MM:SS)	Relative Throughput
64-bit Intel® Xeon® Processor with 1 MB L2 Cache (3.6 GHz)	2	93:51:07	1.00
64-bit Intel® Xeon® Processor with 2 MB L2 Cache (3.8 GHz)	2	72:23:11	1.30
Intel® Xeon® Processor 5160 (3.0 GHz)	4	26:26:16	3.55
Intel® Xeon® Processor X5472 (3.0 GHz)	8	15:20:01	6.12
Intel® Xeon® Processor X5570 (2.93 GHz) ^Δ	16	07:08:36	13.14

^Δ Tests run on Intel Xeon Processor X5570 series had Intel® Hyper-Threading Technology and Intel® Turbo Boost Technology enabled.

Table 3. Runtime Performance Using Dataset A for Synopsys Proteus* Application for Optical Proximity Correction (OPC)

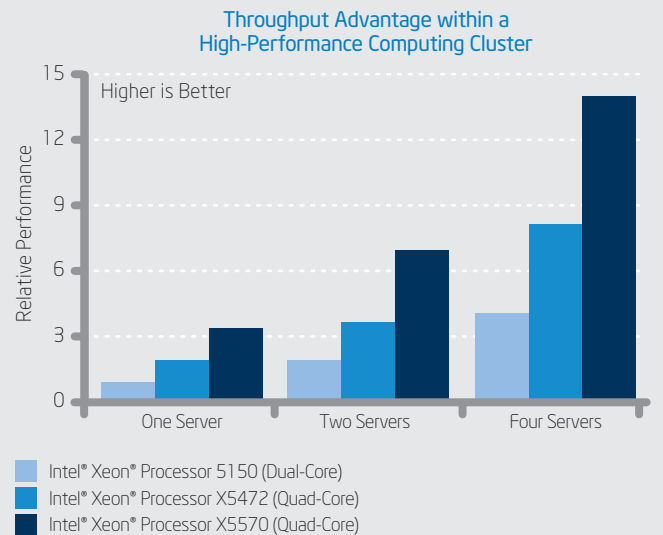
Processor	OPC Jobs [§]	Runtime (HH:MM:SS)	Relative Throughput
64-bit Intel® Xeon® Processor with 1 MB L2 Cache (3.6 GHz)	2	10:40:12	1.00
64-bit Intel® Xeon® Processor with 2 MB L2 Cache (3.8 GHz)	2	07:58:31	1.34
Intel® Xeon® Processor 5160 (3.0 GHz)	4	03:34:39	2.98
Intel® Xeon® Processor X5472 (3.0 GHz)	8	01:37:58	6.53
Intel® Xeon® Processor X5570 (2.93 GHz)	8	00:56:11	11.39

[§] One OPC job per core.



Number of Servers	Runtime (HH:MM:SS)		
	Intel® Xeon® Processor 5150 (Dual-Core)	Intel® Xeon® Processor X5472 (Quad-Core)	Intel® Xeon® Processor X5570 (Quad-Core)
One	03:18:09	01:39:11	00:53:43
Two	01:39:16	00:52:23	00:28:16
Four	00:49:55	00:25:01	00:14:08

Figure 3. Runtimes for Synopsys Proteus* application for optical proximity correction (OPC) decrease as the number of servers increase, maintaining a consistent quad-core processor advantage over dual-core processors.¹



Number of Servers	Relative Throughput		
	Intel® Xeon® Processor 5150 (Dual-Core)	Intel® Xeon® Processor X5472 (Quad-Core)	Intel® Xeon® Processor X5570 (Quad-Core)
One	1.00	2.00	3.69
Two	2.00	3.78	7.01
Four	3.97	7.92	14.02

Figure 4. The throughput advantage of Intel® Xeon® processor 5500 series scales as the total number of processors increases within a high-performance computing (HPC) cluster. Intel Xeon processor 5500 series demonstrates a consistent ability to run twice as many jobs as the dual-core processor and delivered faster runtimes, improving throughput by up to 3.5x.¹

Conclusion

Based on our performance assessment, we are beginning to deploy servers based on the new Intel Xeon processor 5500 series in our data centers to achieve greater performance and significantly increase compute capacity within the existing data center footprint. In line with our four-year refresh plan, replacing four-year-old servers based on single-core processors with servers based on Intel Xeon processor 5500 series allows us to reduce the number of EDA simulation servers by 13:1 and the number for OPC computing by 11:1, a significant value proposition for Intel.

Because increased performance allows us to use fewer systems to accomplish the same tasks, we anticipate lower overall maintenance and operation costs proportional to throughput gains. With significantly increased performance and pricing similar to single-core Intel Xeon processors, Intel Xeon processor 5500 series is the right choice for our silicon design environment and may also benefit other HPC computing applications.

Intel® Xeon® processor 5500 series-based servers are bringing us significant performance and energy-efficiency improvements for our EDA batch computing needs.

— Diane Bryant
Chief Information Officer
Intel Corporation

For more information on Intel Xeon processor 5500 series, go to:
www.intel.com/products/processor/xeon5000/index.htm

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1 Intel internal measurements May 2007, November 2007, and February 2009.

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