IT@Intel Brief

Intel IT
Business Solutions
IT Efficiency and Employee Productivity
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Increasing Design Throughput with Workstations Based on New Intel® Xeon® Processor E5-2600 Product Family

- Up to 4.71x performance increase compared to the quad-core Intel® Xeon® processor 5400 series
- Enables increase in design engineer productivity
- Potential for faster time to market and quality improvements

In Intel IT tests simulating the daily workflow of a silicon design engineer, a workstation based on the new Intel® Xeon® processor E5-2600 product family completed multiple, concurrent electronic design automation (EDA) application workloads up to 4.71x faster than a workstation based on Intel Xeon processor 5400 series and up to 1.44x faster than a workstation based on Intel Xeon processor 5600 series. Performance comparisons are shown in Figure 1.

In our tests, each system completed a total of 48 jobs, using multiple front-end and back-end EDA applications operating on real Intel silicon design workloads. With a total of 16 processor cores, the workstation based on Intel Xeon processor E5-2687W provided higher throughput by running 16 jobs concurrently and completing them more quickly.

High-performance workstations based on the new Intel Xeon processor E5-2600 product family let engineers create and test designs more quickly using multiple EDA applications concurrently. This allows faster design iterations with more demanding design workloads, accelerating product time to market. It also allows more validation cycles, enabling improvements in product quality.

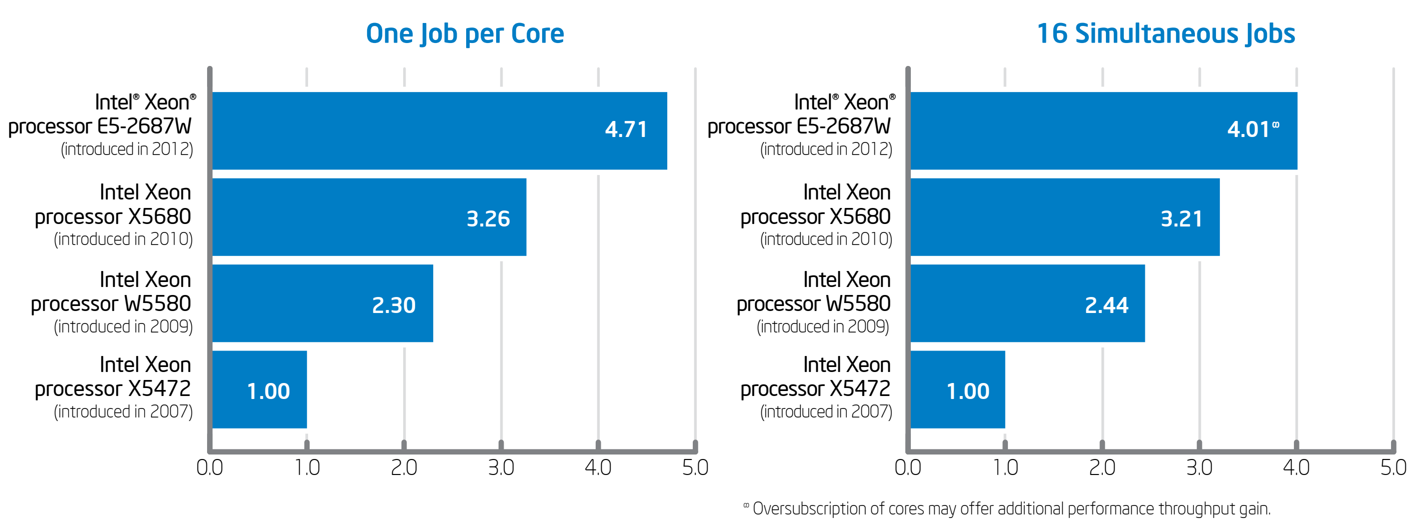

Figure 1. Relative performance of dual-socket workstations running multiple front-end and back-end electronic design automation applications. Based on Intel IT tests applying two different usage approaches: a) one job per core, and b) 16 simultaneous jobs. Intel internal measurements, January 2012.

Business Challenge

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

In a typical workday, each design engineer works simultaneously on several of the functional blocks of a silicon design. For each block, the engineer uses an iterative design method in which each front-end (logical) design stage is followed by a corresponding back-end (physical) design stage, as shown in Figure 2. Each of these design stages is supported by EDA applications that run on engineering workstations based on Intel Xeon processors. Each application workload is processor-intensive and can take from several minutes to hours to complete.

In the past, design engineers staggered design tasks due to limitations in the number of processor cores, CPU speed, and memory capacity of each workstation.

However, as processor performance increased, a new category of workstations has emerged, based on the new Intel Xeon processor E5-2600 product family. These act as expert workbenches, allowing engineers to more quickly create and test design ideas by running suites of multiple front-end and back-end EDA applications concurrently.

The new Intel Xeon processor E5-2600 product family is based on 32nm process technology, which provides greater performance per watt, and includes up to eight cores per processor. This product family offers several features that help to maximize performance:

- Intel® Advanced Vector Extensions accelerate floating-point intensive applications.
- Intel Turbo Boost 2.0 technology delivers more turbo upside potential.
- PCI-Express* 3.0 support gives better I/O latency and bandwidth.
- High-bandwidth, low-latency bi-direction ring interconnect allows faster access to the 20 MB multi-banked last-level L3 cache.
- Intel Hyper-Threading technology enables up to 16 computational threads.
- Integrated memory controller with 4 DDR3 memory channels and 46-bit physical addressing facilitate greater memory capacity.

Dual-socket workstations based on the new Intel Xeon processor E5-2600 product family include RAM capacity of up to 768 GB (with 32-GB DIMMS, using 24 memory slots) to support more demanding workloads and run more EDA applications simultaneously.

To evaluate the impact on design engineers' productivity, we performed tests to compare a workstation based on the new Intel Xeon processor E5-2600 product family with workstations based on previous processor generations.

Test Methodology

We compared four dual-socket workstations, each based on a different processor generation.

- **Intel Xeon processor X5472-based workstation.** This workstation included two quad-core processors, based on 45nm process technology, for a total of eight cores.
- **Intel Xeon processor W5580-based workstation.** This workstation included two quad-core processors, based on 45nm process technology, for a total of eight cores.
- **Intel Xeon processor X5680-based workstation.** This workstation included two six-core processors, based on 32nm process technology, for a total of twelve cores.
- **Intel Xeon processor E5-2687W-based workstation.** This workstation included two eight-core processors, based on 32nm process technology, for a total of sixteen cores.

Test system specifications are shown in Table 1.

We designed our tests to represent a typical workday, in which a silicon design engineer is working on multiple design tasks concurrently, using front-end and back-end design applications.

Our goal was to compare the design throughput of each workstation by measuring the time required to complete a total of 48 silicon design jobs: 24 front-end jobs and 24 back-end jobs.

Our tests used industry-leading 32-bit and 64-bit front-end (logic simulation) and back-end (design

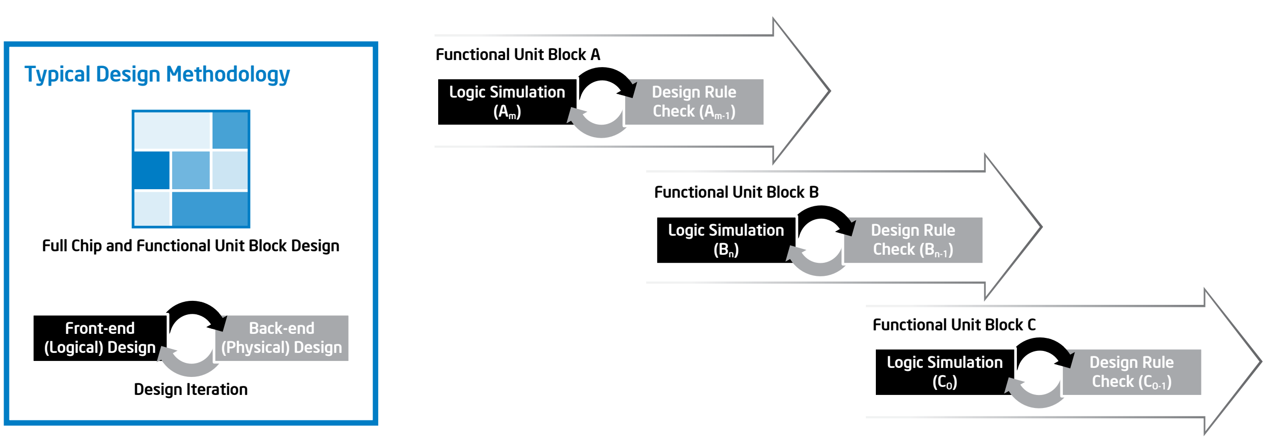

Figure 2. Day in the life of a silicon design engineer. An engineer typically works simultaneously on several of the functional blocks in each silicon design; each block is designed using an iterative process supported by front-end and back-end electronic design automation applications.

rule check) EDA applications operating on real Intel® processor and chipset design workloads.

To analyze throughput under different loads, we conducted two sets of tests on each workstation. Each set of tests represented a commonly used approach to running silicon design jobs.

ONE JOB PER CORE

We ran one concurrent job or application process per physical core. An engineer may use this approach in order to maximize the raw performance of individual applications. In our tests, this resulted in sets of eight to 16 concurrent jobs, depending on the number of cores. When each set had completed, we submitted the next set of eight to 16 jobs. We continued this process until the workstation had completed all 48 jobs.

16 CONCURRENT JOBS

An engineer may not be aware of the number of physical cores in a given workstation and may submit all front-end or back-end jobs at the same time. To represent this usage model, we first ran 16 simultaneous front-end jobs on each workstation. When all 16 front-end jobs had completed, we submitted the 16 back-end design jobs.

Results

The Intel Xeon processor E5-2687W-based workstation completed tests up to 4.71x faster than a workstation based on the Intel Xeon processor X5472 and up to 1.44x faster than a workstation based on Intel Xeon processor X5680.

ONE JOB PER CORE

In the tests with one job per core, the Intel Xeon processor E5-2687W-based workstation completed the 48 jobs 4.71x faster than the workstation based on Intel Xeon processor X5472 and 1.44x faster than the workstation based on Intel Xeon processor X5680, as shown in Table 2.

With a total of 16 cores, the Intel Xeon processor E5-2687-based workstation was able to run 16 jobs concurrently with good performance, and therefore completed the 48 jobs in fewer steps than the other workstations. This resulted in a faster overall completion time.

Table 1. Test System Specifications

	Intel® Xeon® Processor 5400 Series	Intel Xeon Processor 5500 Series	Intel Xeon Processor 5600 Series	New Intel Xeon Processor E5-2600 Product Family
Processor	2x Intel Xeon processor X5472	2x Intel Xeon processor W5580	2x Intel Xeon processor X5680	2x Intel Xeon processor E5-2687W
Cores per Processor	4	4	6	8
Speed	3.0 GHz	3.2 GHz	3.33 GHz	3.10 GHz
Intel® Turbo Boost Technology	Not Applicable (NA)	Enabled	Enabled	Enabled
Intel Hyper-Threading Technology	NA	Disabled	Disabled	Disabled
Chipset	Intel 5400 Chipset	Intel 5520 Chipset	Intel 5520 Chipset	Intel C600 Chipset
Interconnects	1600 MHz Front-side Bus	6.4 GT/s Intel® QuickPath Interconnect (Intel® QPI)	6.4 GT/s Intel® QPI	Dual 8.0 GT/s Intel® QPI
RAM	64 GB (8 x 8 GB)	96 GB (12 x 8 GB)	96 GB (12 x 8 GB)	128 GB (16 x 8 GB)
RAM Type	DDR2-667/Fully Buffered DIMM	DDR3-1333 MHz (operating at 1066 MHz)	DDR3-1333 MHz	DDR3-1333 MHz
Hard Drive	500 GB, 7200 RPM SATA, 3.0 Gb/s	500 GB, 7200 RPM SATA, 3.0 Gb/s	500 GB, 7200 RPM SATA, 3.0 Gb/s	1 TB, 7200 RPM SATA, 6.0 Gb/s
OS	64-bit Linux*	64-bit Linux	64-bit Linux	64-bit Linux

DDR - double data rate; **DIMM** - dual in-line memory module; **GB** - gigabytes; **Gb/s** - gigabits per second; **GHz** - gigahertz; **GT/s** - gigatransfers per second; **MHz** - megahertz; **RPM** - revolutions per minute; **SATA** - serial advanced technology attachment; **TB** - terabyte

Table 2. Relative Performance and Runtimes when Running One Job per Core

<table>
<tr><th>Workload</th><th>Peak Memory Used</th><th>Intel® Xeon® Processor X5472
8 Jobs per Set, 6 Steps</th><th>Intel Xeon Processor W5580
8 Jobs per Set, 6 Steps</th><th>Intel Xeon Processor X5680
12 Jobs per Set, 4 Steps</th><th>Intel Xeon Processor E5-2687W
16 Jobs per Set, 3 Steps</th></tr>
<tr><td>Logic Simulation - Tool B (4 Jobs)</td><td>12 GB</td><td rowspan="2">0:57:08</td><td rowspan="2">0:28:44</td><td rowspan="3">0:29:16</td><td rowspan="4">0:25:02</td></tr>
<tr><td>Logic Simulation - Tool B (4 Jobs)</td><td>12 GB</td></tr>
<tr><td>Logic Simulation - Tool B (4 Jobs)</td><td>12 GB</td><td rowspan="2">1:00:44</td><td rowspan="2">0:24:45</td></tr>
<tr><td>Logic Simulation - Tool B (4 Jobs)</td><td>12 GB</td><td rowspan="3">0:30:56</td></tr>
<tr><td>Logic Simulation - Tool B (4 Jobs)</td><td>12 GB</td><td rowspan="2">1:06:19</td><td rowspan="2">0:28:35</td><td rowspan="4">0:35:10</td></tr>
<tr><td>Logic Simulation - Tool B (4 Jobs)</td><td>12 GB</td></tr>
<tr><td>Design Rule Check - Tool B
2 Distributed Processes x 2 Threads</td><td>1.8 GB</td><td rowspan="2">1:29:13</td><td rowspan="2">0:36:36</td><td rowspan="3">0:39:14</td></tr>
<tr><td>Design Rule Check - Tool C
4 Threads</td><td>2.7 GB</td></tr>
<tr><td>Design Rule Check - Tool B
2 Distributed Processes x 2 Threads</td><td>1.5 GB</td><td rowspan="2">1:24:29</td><td rowspan="2">0:38:41</td><td rowspan="4">0:35:55</td></tr>
<tr><td>Design Rule Check - Tool C
4 Threads</td><td>2.7 GB</td><td rowspan="3">0:39:14</td></tr>
<tr><td>Design Rule Check - Tool B
2 Distributed Processes x 2 Threads</td><td>1.8 GB</td><td rowspan="2">1:34:45</td><td rowspan="2">0:39:43</td></tr>
<tr><td>Design Rule Check - Tool B
2 Distributed Processes x 2 Threads</td><td>1.5 GB</td></tr>
<tr><td>Total Run Time</td><td></td><td>7:32:38</td><td>3:17:04</td><td>2:18:40</td><td>1:36:07</td></tr>
<tr><td>Relative Performance</td><td></td><td>1.00</td><td>2.30</td><td>3.26</td><td>4.71</td></tr>
</table>

GB - gigabytes

Note: The reported times (hh:mm:ss) are the maximum job runtimes observed within each step.

Table 3. Relative Performance and Runtimes when Running 16 Simultaneous Jobs (48 total jobs)

Workload	Peak Memory Used	Intel® Xeon® Processor X5472 16 Jobs per Set	Intel Xeon Processor W5580 16 Jobs per Set	Intel Xeon Processor X5680 16 Jobs per Set	Intel Xeon Processor E5-2687W 16 Jobs per Set[a]
Logic Simulation Tool B - Set 1	48 GB	1:56:52	0:49:49	0:34:02	0:25:02
Logic Simulation Tool B and Design Rule Check - Tool B, C - Set 2	36.5 GB	2:22:34	0:57:55	0:44:04	0:35:10
Design Rule Check - Tool B, C - Set 3	7.5 GB	2:05:46	0:49:58	0:41:54	0:35:55
Total Run Time		**6:25:12**	**2:37:42**	**2:00:00**	**1:36:07**
Relative Performance		**1.00**	**2.44**	**3.21**	**4.01[a]**

GB - gigabytes
Note: The reported times (hh:mm:ss) are the maximum job runtimes observed within each step.
[a]Oversubscription of cores may offer additional performance throughput gain.

16 CONCURRENT JOBS

In the tests with 16 concurrent jobs on each system, the Intel Xeon processor E5-2687W-based workstation completed the 48 jobs 4.01x faster than the workstation based on Intel Xeon processor X5472 and 1.25x faster than the workstation based on Intel Xeon processor X5680, as shown in Table 3.

On the Intel Xeon processor E5-2687W-based workstation, this test procedure resulted in one job per core. However, on the other three workstations, the cores were oversubscribed—with 16 concurrent jobs, there were 1.33 to 2x as many jobs as cores. This resulted in slower completion times, even on the Intel Xeon processor X5680-based workstation, which had twelve cores.

Conclusion

The availability of workstations based on the new Intel Xeon processor E5-2600 product family has broad implications for silicon design. In the past, design engineers staggered design tasks due to limitations in processing power and the number of cores available. Now, design engineers can run more jobs concurrently with good performance. In addition, each processing core offers faster performance, reducing total design time.

This allows engineers to analyze the results of each design stage sooner, make necessary design changes, and quickly run the next design iteration—resulting in increased design engineer productivity and faster semiconductor product design. Engineers can also run more validation cycles, identifying problems earlier in product development to improve quality.

Our results suggest that other technical applications with large memory requirements, such as simulation and verification applications in the auto, aeronautical, oil and gas, and life sciences industries, could see similar improvements.

Based on our test results, we are establishing workstations based on the new Intel Xeon processor E5-2600 product family as our standard for Intel IT internal workstation deployments, including refreshes of older systems.

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