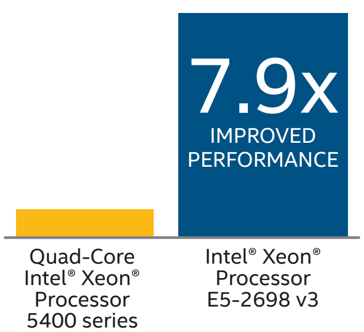
Brief
September 2014

IT@Intel

Increasing Design Throughput with Workstations Based on New Intel® Xeon® Processor E5-2600 v3 Product Family

Workload Performance Throughput



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In Intel IT tests simulating the daily workflow of a silicon design engineer, a workstation based on the new Intel® Xeon® processor E5-2600 v3 product family completed multiple, concurrent electronic design automation (EDA) application workloads up to 7.90x faster than a workstation based on Intel Xeon processor 5400 series and up to 1.30x faster than a workstation based on previous-generation Intel Xeon processor E5-2600 v2 series.

In our tests, each system completed a total of 96 jobs, using multiple front-end and back-end EDA applications operating on actual Intel silicon design workloads. With a total of 32 processor cores, the workstation based on Intel® Xeon® processor E5-2698 v3 provided higher throughput by running 32 jobs concurrently and completing them more quickly.

High-performance workstations based on the new Intel Xeon processor E5-2600 v3 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 a product's time to market. It also allows more validation cycles, enabling improvements in product quality.

Contents

Acronyms

EDA electronic design automation

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 1. 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 throughput increased, a new category of workstations has emerged, based on the new Intel Xeon processor E5-2600 v3 product family. These processors 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 E5-2698 v3 is based on 22nm process technology, which provides greater performance per watt, and includes 16 cores per processor.

Day in the Life of a Silicon Design Engineer

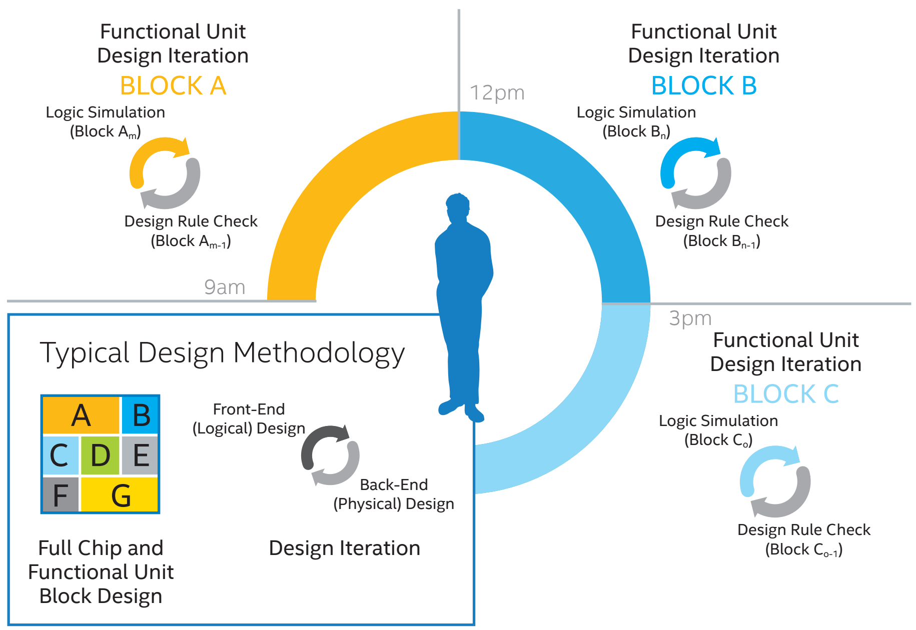

Figure 1. Day in the life of a silicon design engineer. An engineer typically works simultaneously on several of the functional blocks in each silicon design; each block is designed using an iterative process supported by front-end and back-end electronic design automation (EDA) applications.

Intel® Xeon® Processor E5-2698 v3 Features

- Intel® Advanced Vector Extensions 2.0 accelerates integer and floating-point intensive applications.
- Intel® Turbo Boost Technology 2.0 delivers more performance 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 40-MB multi-banked last-level L3 cache.
- Intel® Hyper-Threading Technology enables up to 32 computational threads per socket.
- Integrated memory controller with four DDR4 memory channels and 46-bit physical addressing facilitates greater memory capacity.

Dual-socket workstations based on the new Intel Xeon processor E5-2600 v3 product family include RAM capacity of up to 1536 GB (with 64-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 v3 product family with workstations based on previous processor generations.

Test Methodology

We compared six dual-socket workstations, each based on a different processor generation. Test system specifications are shown in Table 1.

- **Intel® Xeon® processor X5472-based workstation.** This workstation included two quad-core processors, based on 45nm process technology.
- **Intel® Xeon® processor W5580-based workstation.** This workstation included two quad-core processors, based on 45nm process technology.
- **Intel® Xeon® processor X5680-based workstation.** This workstation included two six-core processors, based on 32nm process technology.
- **Intel® Xeon® processor E5-2687W-based workstation.** This workstation included two eight-core processors, based on 32nm process technology.
- **Intel® Xeon® processor E5-2697 v2-based workstation.** This workstation included two 12-core processors, based on 22nm process technology.
- **Intel® Xeon® processor E5-2698 v3-based workstation.** This workstation included two 16-core processors, based on 22nm process technology.

Table 1. Test System Specifications

	Intel® Xeon® Processor 5400 Series	Intel® Xeon® Processor 5500 Series	Intel® Xeon® Processor 5600 Series	Intel® Xeon® Processor E5-2600 Product Family	Intel® Xeon® Processor E5-2600 v2 Product Family	Intel® Xeon® Processor E5-2600 v3 Product Family
Launched	2007	2009	2010	2012	2013	2014
Processor	2 x Intel® Xeon® Processor X5472	2 x Intel® Xeon® Processor W5580	2 x Intel® Xeon® Processor X5680	2 x Intel® Xeon® Processor E5-2687W	2 x Intel® Xeon® Processor E5-2697 v2	2 x Intel® Xeon® Processor E5-2698 v3
Cores per Processor	4 (8 total)	4 (8 total)	6 (12 total)	8 (16 total)	12 (24 total)	16 (32 total)
Speed	3.0 GHz	3.2 GHz	3.33 GHz	3.10 GHz	2.7 GHz	2.3 GHz
Intel® Turbo Boost Technology	—	Enabled	Enabled	Enabled	Enabled	Enabled
Intel® HT Technology	—	Disabled	Disabled	Disabled	Disabled	Disabled
Intel® Chipset	5400	5520	5520	C600	C600	C610
Interconnects	1600 MHz Front-Side Bus	6.4 GT/s Intel® QPI	6.4 GT/s Intel® QPI	Dual 8.0 GT/s Intel® QPI	Dual 8.0 GT/s Intel® QPI	Dual 9.6 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)	128 GB (16 x 8 GB)	256 GB (16 x 16 GB)
RAM Type	DDR2-667 MHz Fully Buffered DIMM	DDR3-1333 MHz (operating at 1066 MHz)	DDR3-1333 MHz	DDR3-1333 MHz	DDR3-1600 MHz	DDR4-2133 MHz (operating at 1866 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	1 TB, 7200 RPM SATA, 6.0 Gb/s	1 TB, 7200 RPM SATA, 6.0 Gb/s
OS	64-bit Linux*	64-bit Linux	64-bit Linux	64-bit Linux	64-bit Linux	64-bit Linux

Intel® QPI – Intel® QuickPath Interconnect; Intel® HT Technology – Intel® Hyper-Threading Technology; DDR – double data rate; DIMM – dual in-line memory module; GB – gigabytes; Gb/s – gigabits per second; MHz – megahertz; RPM – revolutions per minute; SATA – serial advanced technology attachment; TB – terabyte

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 96 silicon design jobs: 48 front-end jobs and 48 back-end jobs.

Our tests used industry-leading 32-bit and 64-bit front-end (logic simulation) and back-end (design rule check) EDA applications operating on actual Intel® Xeon® processor and chipset design workloads.

We ran one concurrent job or application process per physical core. An engineer might use this approach in order to maximize the raw performance throughput of individual applications. In our tests, this resulted in sets of eight to 32 concurrent jobs, depending on the number of cores. When each set had completed, we submitted the next set of eight to 32 jobs. We continued this process until the workstation had completed all 96 jobs (see Table 2).

Table 2. Concurrent Jobs per Set and Number of Steps

Intel® Xeon® Processor Numbers	Jobs per Set	Steps
X5472	8	12
W5580	8	12
X5680	12	8
E5-2687W	16	6
E5-2697 v2	24	4
E5-2698 v3	32	3

Results

In the tests, the Intel Xeon processor E5-2698 v3-based workstation completed the 96 jobs 7.90x faster than the workstation based on Intel Xeon processor X5472 and 1.30x faster than the workstation based on Intel Xeon processor E5-2697 v2, as shown in Table 3 and Figure 2.

Table 3. Relative Performance Throughput and Runtimes

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

<table>
<tr><th>Workload</th><th>Intel® Xeon® Processor X5472</th><th>Intel® Xeon® Processor W5580</th><th>Intel® Xeon® Processor X5680</th><th>Intel® Xeon® Processor E5-2687W</th><th>Intel® Xeon® Processor E5-2697 v2</th><th>Intel® Xeon® Processor E5-2698 v3</th></tr>
<tr><td>Logic Simulation - Tool B (4 Jobs)</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><td rowspan="6">0:36:02</td><td rowspan="8">0:37:12</td></tr>
<tr><td>Logic Simulation - Tool B (4 Jobs)</td></tr>
<tr><td>Logic Simulation - Tool B (4 Jobs)</td><td rowspan="2">1:00:44</td><td rowspan="2">0:24:45</td></tr>
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<tr><td>Logic Simulation - Tool B (4 Jobs)</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></tr>
<tr><td>Design Rule Check - Tool B (2 Distributed Processes x 2 Threads)</td><td rowspan="2">1:29:13</td><td rowspan="2">0:36:36</td><td rowspan="3">0:39:14</td><td rowspan="6">0:38:14</td></tr>
<tr><td>Design Rule Check - Tool C (4 Threads)</td></tr>
<tr><td>Design Rule Check - Tool B (2 Distributed Processes x 2 Threads)</td><td rowspan="2">1:24:29</td><td rowspan="2">0:38:41</td><td rowspan="4">0:35:55</td><td rowspan="8">0:38:40</td></tr>
<tr><td>Design Rule Check - Tool C (4 Threads)</td><td rowspan="3">0:39:14</td></tr>
<tr><td>Design Rule Check - Tool B (2 Distributed Processes x 2 Threads)</td><td rowspan="2">1:34:45</td><td rowspan="2">0:39:43</td></tr>
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<tr><td>Design Rule Check - Tool B (2 Distributed Processes x 2 Threads)</td></tr>
<tr><td>Total Runtime</td><td>15:05:16</td><td>6:34:08</td><td>4:37:20</td><td>3:12:14</td><td>2:28:32</td><td>1:54:36</td></tr>
<tr><td>Relative Throughput</td><td>1.00</td><td>2.30</td><td>3.26</td><td>4.71</td><td>6.09</td><td>7.90</td></tr>
</table>

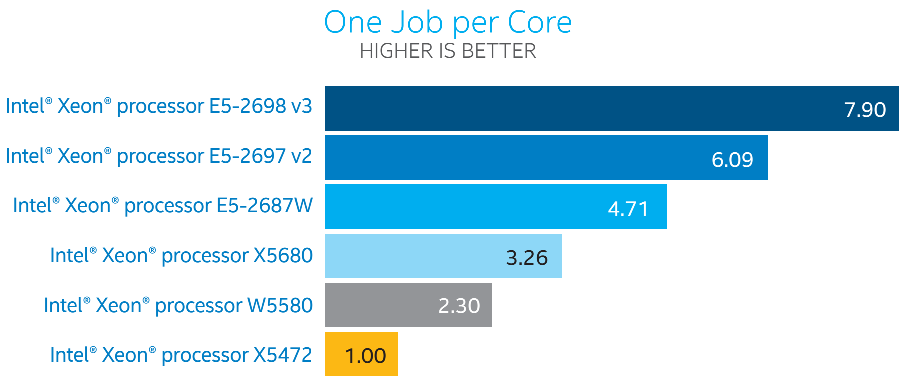

Figure 2. Relative performance throughput of dual-socket workstations running multiple front-end and back-end electronic design automation (EDA) applications. Intel internal measurements; August 2014.

With a total of 32 cores, the Intel Xeon processor E5-2698 v3-based workstation was able to run 32 jobs concurrently, and therefore completed the 96 jobs in fewer steps than the other workstations. This resulted in a faster overall completion time.

Conclusion

The availability of workstations based on the new Intel Xeon processor E5-2600 v3 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, 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 Intel Xeon processor E5-2600 v3 product family as our standard for Intel IT internal workstation deployments, including refreshes of older systems.

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