IT@Intel Brief

Intel Information Technology

Computer Manufacturing

Server TCO

March 2009

Selecting Server Processors to Reduce Total Cost

Intel IT is standardizing on Intel® Xeon® processor X5570 (2.93 GHz) for two-socket servers for design computing and enterprise server virtualization. Our testing and analysis demonstrates that the newest high-end Intel® Xeon® processors based on Next-Generation Intel® Microarchitecture (Nehalem) can significantly enhance server performance, providing an opportunity for Intel IT to reduce total cost of ownership (TCO) by 42 percent.

Profile: Intel® Xeon® Processor 5500 Series

- High-end processors reduce server TCO by 42 percent compared to low-end processors
- High-end processors deliver up to 87 percent faster performance

With the introduction of the Intel® Xeon® processor 5500 series-based platforms, the benefits we are seeing from our IT strategy to standardize on higher-end processors for our servers purchases is even more compelling and results in a significantly lower TCO.

— Diane Bryant
Chief Information Officer
Intel Corporation

We compared the high-end Intel Xeon processor X5570 (2.93 GHz) with the low-end Intel® Xeon® processor E5504 (2.0 GHz) for two Intel IT computing environments: design and enterprise. In real-world application testing with Intel's electronic design automation (EDA) workloads, two-socket servers based on the 2.93-GHz processor delivered the same performance for an estimated 42 percent lower TCO over four years, as shown in Figure 1. For enterprise computing, analysis confirmed a similar relationship: A two-socket server based on the 2.93-GHz processor delivered 87 percent better performance for an estimated 8 percent increase in TCO.

Our analysis demonstrated to Intel IT management and purchasing groups that software acquisition and licensing costs—which represent 3x to 6x the cost of the hardware platform—are the largest components of overall TCO for servers deployed at Intel. Because of this, standardizing on high-end processors is a cost-effective way for Intel IT to maximize server return on investment (ROI).

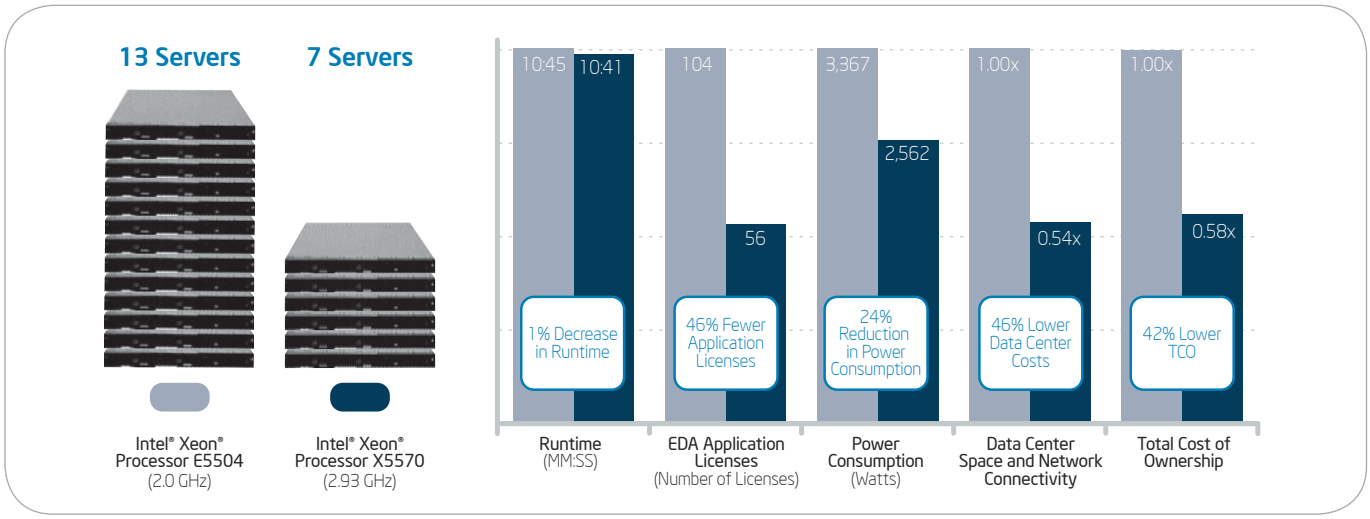

Figure 1. Electronic design automation (EDA) throughput and total cost of ownership (TCO). In tests with real Intel EDA workloads, we required fewer servers based on high-end processors to achieve the same performance. This resulted fewer EDA application licenses; reduced data center power, space, and connectivity requirements; and substantially lower estimated TCO. Intel internal measurements, February 2009.

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Table 1. Mainstream Intel® Xeon® Processor 5500 Series Segments

	Basic	Standard	Advanced
CPU Frequency	2.0 GHz to 2.13 GHz	2.26 GHz to 2.53 GHz	2.66 GHz to 2.93 GHz
CPU Power	80 W	80 W	95 W
QPI	4.8 GT/S	5.86 GT/S	6.4 GT/S
CPU Cache Size	4 MB	8 MB	8 MB
Memory Speed	800 MHz	800/1066 MHz	800/1066/1333 MHz
Intel® Turbo Boost Technology	No	Yes	Yes
Intel® HT Technology	No	Yes	Yes

GT/S – Gigatransfers/Second; **Intel® HT** – Intel® Hyper-Threading Technology; **QPI** – Intel® QuickPath Interconnect

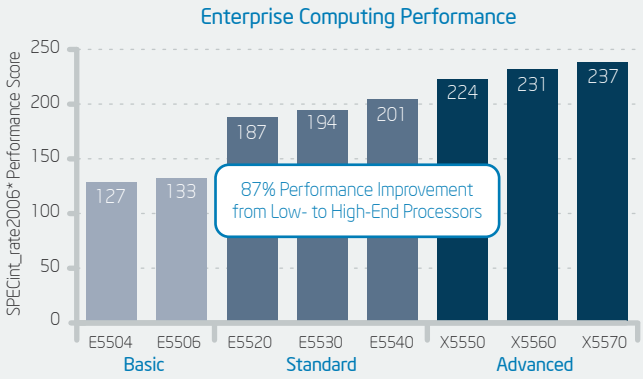

Figure 2. In our enterprise computing analysis, there was an 87 percent performance difference between the server based on low-end Intel® Xeon® processor E5504 (2 GHz) and the server based on high-end Intel® Xeon® processor X5570 (2.93 GHz). Intel internal measurements, February 2009.

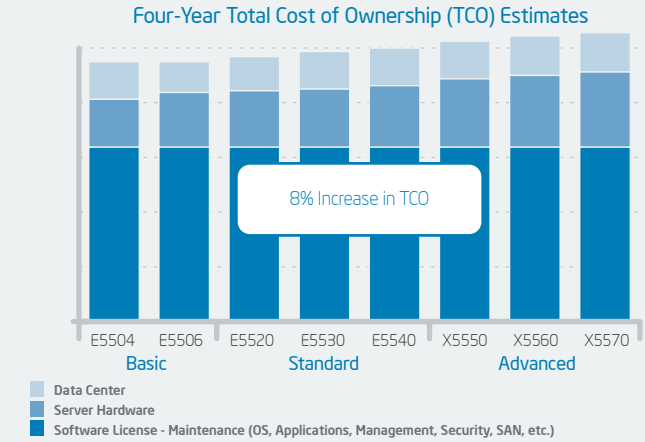

Figure 3. In our enterprise computing analysis, selecting a high-end processor increased estimated server total cost of ownership (TCO) by only eight percent. Software typically averages 3x to 6x the cost of the server hardware. Intel internal measurements, February 2009.

Processor	CPU	Memory Speed	QPI	Cache
Intel® Xeon® Processor E5504	2.00 GHz	800 MHz	4.8 GT/s	4 MB
Intel® Xeon® Processor E5506	2.13 GHz	800 MHz	4.8 GT/s	4 MB
Intel® Xeon® Processor E5520	2.26 GHz	1060 MHz	5.86 GT/s	8 MB
Intel® Xeon® Processor E5530	2.40 GHz	1060 MHz	5.86 GT/s	8 MB
Intel® Xeon® Processor E5540	2.53 GHz	1060 MHz	5.86 GT/s	8 MB
Intel® Xeon® Processor X5550	2.66 GHz	1333 MHz	6.40 GT/s	8 MB
Intel® Xeon® Processor X5560	2.80 GHz	1333 MHz	6.40 GT/s	8 MB
Intel® Xeon® Processor X5570	2.93 GHz	1333 MHz	6.40 GT/s	8 MB

GT/s – Gigatransfers/Second; **QPI** – Intel® QuickPath Interconnect

Intel Computing Environment Overview

Intel's worldwide computing environment includes more than 90,000 servers and supports more than 80,000 employees worldwide. About 70 percent of these servers are used for designing Intel® products, with the remaining 30 percent used for enterprise computing.

We refresh thousands of servers each year based on a four-year refresh cycle, with a focus on maximizing ROI and business value from each technology investment. To determine the optimum servers for our needs, we analyze both performance and TCO—taking into account platform cost; software including OS, applications, and middleware; and data center costs including power and cooling—over the expected life of the servers.

Assessing Processors for TCO Impacts

We performed an evaluation focused exclusively on processor selection within the new Intel Xeon processor 5500 series to determine which offers the greatest opportunity to reduce TCO: high-end or low-end processors.

We compared performance and TCO of two-socket servers based on mainstream 80-watt and 95-watt Intel Xeon processor 5500 series. Within this series, there are three segments—basic, standard, and advanced—with different levels of features that increase performance, as shown in Table 1. We evaluated processors ranging from Intel Xeon processor E5504 (basic, 2 GHz) at the low end to Intel Xeon processor X5570 (advanced, 2.93 GHz) at the high end.

We performed separate comparisons for design and for enterprise computing. Both included four-year TCO elements:

- **Hardware platforms.** We based our analysis on mainstream two-socket rack-mounted servers from major manufacturers.
- **Software.** We included license and maintenance cost of software including OS, applications, middleware, security products, backup and restore, storage area network (SAN) connectivity, and manageability (monitoring, alerting, compliance, patching, and provisioning).
- **Data center.** We included data center power, cooling, and network connectivity costs.

Enterprise Computing

For our enterprise computing analysis, we used published Intel CPU pricing, estimates of system pricing, and publicly available industry-standard performance benchmark tests.

Intel IT uses a diverse set of enterprise applications for enterprise resource planning (ERP), finance, collaboration, productivity, and more. Rather than test the performance of each application, we selected published results of SPECint_rate2006* benchmark tests conducted by Intel as a reasonable proxy.

Performance varied substantially over the range of processors we examined, as shown in Figure 2. There was a significant step in performance at the transition from basic to standard segments, and another significant step at the transition from standard to advanced.

Enterprise computing TCO analysis

We reviewed Intel IT software license and maintenance costs for our main enterprise applications and infrastructure services. We determined that, overall, Intel IT spends 3x to 6x more on software than on server hardware. To simplify our analysis, we conservatively assumed an average of 3x the cost of a fully configured server based on mid-range Intel® Xeon® processor E5530 (2.4 GHz).

In our TCO analysis, we used estimates of system pricing based on Intel published CPU prices, prior server list prices, and anticipated trends for illustration purposes. We estimated software cost using our 3x ratio. We included estimates of typical data center costs based on our experience. Our estimates included data center depreciation, power and cooling, and LAN and SAN port costs over four years. Our analysis showed that estimated four-year server TCO varies relatively little with processor selection, as shown in Figure 3.

Design Computing

To validate our analysis, we conducted performance testing using real Intel silicon design workloads.

In our tests, we ran a distributed EDA application on a server cluster. The application operated on an Intel silicon design dataset. We compared performance of clusters based on four different processors in the Intel Xeon processor 5500 series:

- Low-end Intel Xeon processor E5504 (2 GHz)
- Intel® Xeon® processor E5520 (2.26 GHz)
- Intel® Xeon® processor X5550 (2.66 GHz)
- High-end Intel Xeon processor X5570 (2.93 GHz)

We measured runtime for each cluster and compared relative job throughput.

In our tests, we normalized throughput. When testing each cluster, we used as many servers as we needed to complete our workload in approximately the same specified runtime. This meant that we included more servers in the cluster based on low-end processors compared with the clusters using higher-end processors.

Design computing TCO analysis

Our analysis of four-year TCO compared Intel IT hardware, software, and data center cost ratios. For the high-end platform, the total cost of all software, including maintenance, averaged approximately 3.8x the hardware platform cost. Our data center costs included network connectivity and power and cooling for four years.

Results are shown in Figure 4. Compared with the low-end Intel Xeon processor E5504, we needed 46 percent fewer servers based on the high-end Intel Xeon processor X5570 to obtain the same throughput, with a 46 percent decrease in the number of software licenses, a 46 percent decrease in data center space and network connectivity requirements, and a 24 percent decrease in power consumption.

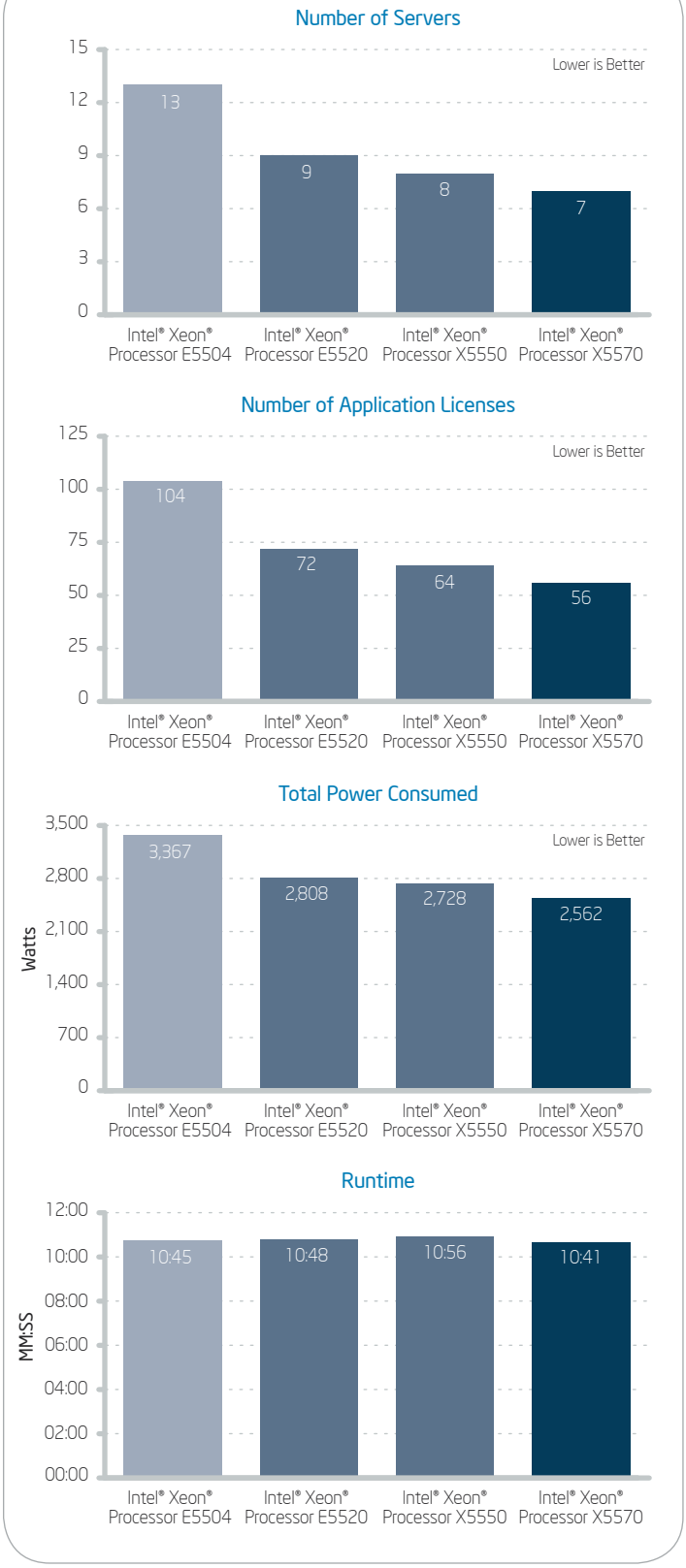

Figure 4. Results of electronic design automation (EDA) normalized throughput tests. Intel internal measurements, February 2009.

Conclusion

Selecting higher-end processors delivers the maximum value to Intel IT. Our analysis showed that four-year server TCO is dominated by software costs, which typically range from 3x to 6x the cost of the hardware platform. Data center connectivity and power and cooling costs also are a significant factor. The server, and hence the CPU, accounts for only a small percentage of overall cost, as shown in Figure 5. As a result, the cost difference between platforms with low-end and high-end CPUs has little impact on overall server TCO. Because high-end processors substantially increase performance, they deliver better value.

Further analysis of our enterprise computing data confirmed that high-end processors can deliver 73 percent faster performance than low-end processors for the same estimated TCO, or the same performance for an estimated 42 percent lower TCO, as shown in Figure 6.

Based on our analysis, using higher-end processors results in one of the following benefits:

- Lower TCO to achieve the same performance or throughput
- Higher performance for a given TCO
- Substantial performance increase for a modest increase in TCO

Based on these performance and TCO advantages, for two-socket servers, Intel IT is standardizing on Intel Xeon processor X5570 (2.93 GHz) for design computing and enterprise server virtualization.

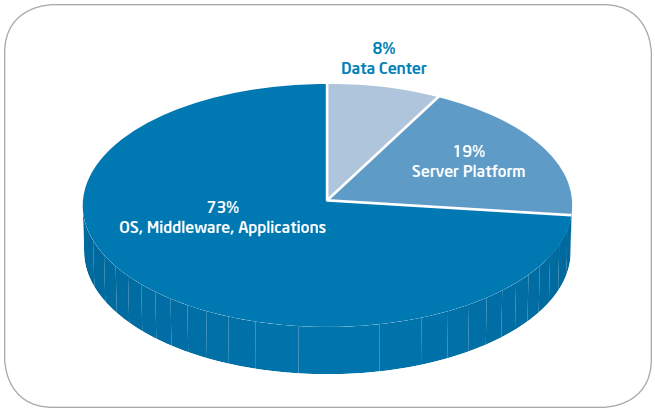

Figure 5. The hardware platform accounts for a small proportion of server total cost of ownership (TCO). TCO calculations based on Intel® Xeon® processor X5570 (2.93 GHz).

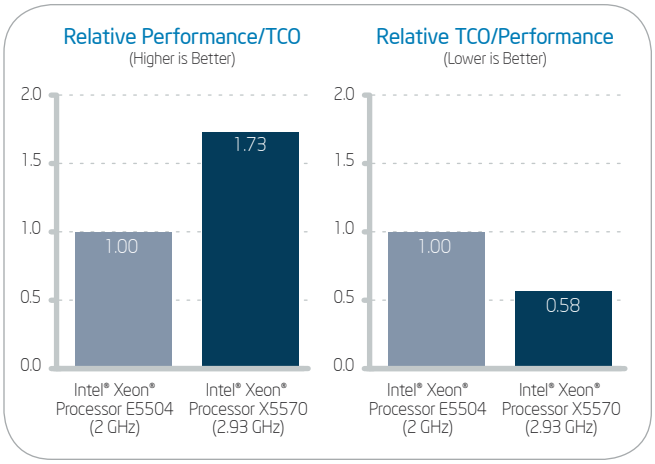

Figure 6. Higher-end processors deliver higher performance for the same total cost of ownership (TCO), on the left, or the same performance for lower TCO, on the right. Intel internal measurements, February 2009.

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

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