IT@Intel Brief

Intel Information Technology
Computer Manufacturing
Server TCO

October 2008

Maximizing IT Value by Using High-End Server Processors

Intel IT has standardized on Intel® Xeon® processors with a core frequency of 3 GHz for two-socket servers for design computing and enterprise server virtualization. Our analysis demonstrates that higher-end processors significantly enhance server performance for a minimal increase in total cost of ownership (TCO).

Profile: High-End Server Processors

- 23 to 29 percent faster performance for estimated 5 to 7 percent increase in TCO
- Estimated 18 to 19 percent lower TCO to achieve same performance

We compared high-end Quad-Core Intel Xeon processor E5450 (3 GHz) with low-end Quad-Core Intel Xeon processor E5405 (2 GHz) for Intel IT enterprise and technical computing environments. For enterprise computing, analysis showed that a two-socket server based on the 3 GHz processor delivered 29 percent better performance for less than a 5 percent estimated increase in TCO over four years. For Intel's electronic design automation (EDA) workloads, real-world application testing confirmed a similar relationship: Servers based on the high-end processor delivered the same performance for an estimated 18 percent lower TCO, as shown in Table 1.

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 drivers 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).

With servers based on higher-end Intel® Xeon® processors, we see significant IT OpEx and CapEx advantages through reduced data center space, reduced power, and lower application licenses for our given design performance/ throughput needs.

— Diane Bryant
Chief Information Officer
Intel Corporation

Table 1. Electronic Design Automation (EDA) Throughput and Total Cost of Ownership (TCO)

	Quad-Core Intel® Xeon® Processor E5405 (2 GHz)	Quad-Core Intel Xeon Processor E5450 (3 GHz)
Relative Performance	1.00	1.01
Number of Servers	13	10
Power Consumed	3,601 w	3,200 w
Application Licenses	104	80
Relative TCO	1.00	0.82

In tests with real Intel EDA workloads, servers based on high-end processors achieved the same performance with substantially lower TCO.

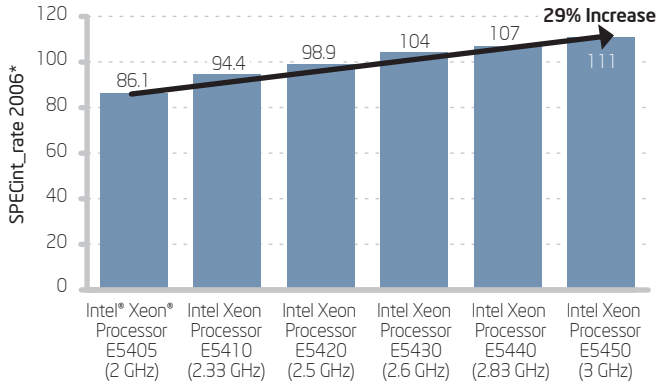

Figure 1. In our enterprise computing analysis, there was a 29 percent performance difference between the server based on low-end Quad-Core Intel® Xeon® processor E5405 (2 GHz) and the server based on higher-end Quad-Core Intel Xeon processor E5450 (3 GHz).

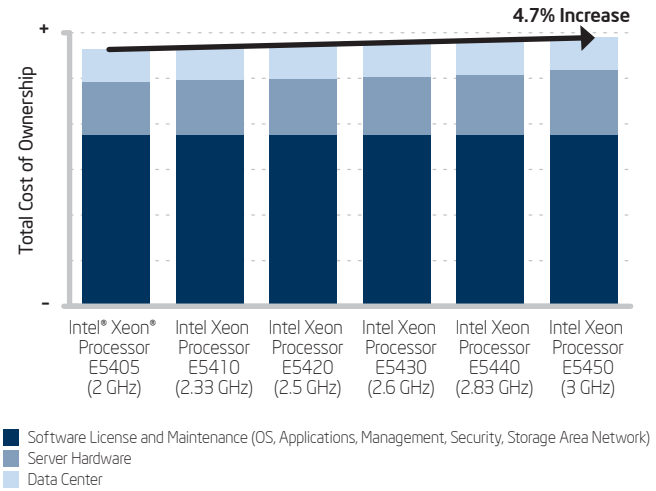

Figure 2. In our enterprise computing analysis, selecting a high-end processor increased server total cost of ownership (TCO) by less than five percent. Software typically averages 3x to 6x the cost of the server hardware.

Background

Intel's worldwide computing environment includes more than 80,000 servers and supports more than 80,000 employees worldwide. About 80 percent of these servers are used for designing Intel products; the other 20 percent are 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 our servers.

We performed an evaluation focused exclusively on processor selection. Our goal was to determine which delivers better value: high-end or low-end processors.

Study

We compared performance and TCO of two-socket servers based on the mainstream 80-watt Quad-Core Intel Xeon processor 5400 series. We evaluated processors ranging from Quad-Core Intel Xeon processor E5405 (2 GHz) at the low end to Quad-Core Intel Xeon processor E5450 (3 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, hosting, and connectivity costs.

Enterprise Computing

Our enterprise computing analysis was based on list prices and published industry-standard performance benchmark test results.

Intel IT uses a diverse set of enterprise applications including enterprise resource planning (ERP), financial, collaboration, and productivity software. Rather than test performance of all these applications, we selected publicly available SPECint 2006* benchmark results as a reasonable proxy.

Performance varied substantially over the range of processors we examined, as shown in Figure 1. Core processor frequency was primarily responsible for this variation, since processor cache size—12 MB—and front-side bus (FSB) speed—1333 MHz—remained constant over the processors evaluated.

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 E5430 (2.6 GHz).

In our TCO analysis, we used published hardware list prices, 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 the estimated four-year server TCO varies very little with processor selection, as shown in Figure 2.

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. Our tests compared performance of a cluster based on Quad-Core Intel Xeon processor E5405 (2 GHz) with a cluster based on Quad-Core Intel Xeon processor E5450 (3 GHz). We measured runtime for each cluster and compared relative job throughput.

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

In our first test, each cluster contained 10 servers. Results are shown in Table 2. The servers based on the Quad-Core Intel Xeon processor E5450 completed the job 23 percent faster for approximately 7 percent estimated TCO increase, driven by slightly higher power consumption and hardware costs. They also provided 6 percent better performance per watt.

In our second test, we normalized throughput. We used fewer servers based on the high-end Intel Xeon processor E5450 to achieve the same throughput as a larger number of servers based on the low-end Intel Xeon processor E5405.

Results are shown in Table 3. We needed 30 percent more servers based on the low-end Intel Xeon processor E5405 to obtain the same throughput, with a 30 percent increase in the number of software licenses, a 30 percent increase in data center connectivity and hosting costs, and a 13 percent increase in power consumption.

Table 2. Electronic Design Automation (EDA) Throughput and Total Cost of Ownership (TCO) in a Ten-Server Cluster

	Quad-Core Intel® Xeon® Processor E5405 (2 GHz)	Quad-Core Intel Xeon Processor E5450 (3 GHz)
Number of Servers	10	10
Memory per Server	32 GB	32 GB
EDA Application Licenses	80	80
Runtime (minutes:seconds)	14:14	11:36
Relative Throughput	1.00	1.23
Power Consumed	2,770 w	3,200 w
Relative Power Consumed	1.00	1.16
Relative TCO	1.00	1.07

In tests with real Intel EDA workloads on a ten-server cluster, servers based on high-end processors achieved 23 percent higher performance for an estimated 7 percent higher TCO.

Table 3. Electronic Design Automation (EDA) Normalized Throughput and Total Cost of Ownership (TCO)

	Quad-Core Intel® Xeon® Processor E5405 (2 GHz)	Quad-Core Intel Xeon Processor E5450 (3 GHz)
Number of Servers	13	10
Memory per Server	32 GB	32 GB
EDA Application Licenses	104	80
Runtime (minutes:seconds)	11:44	11:36
Relative Throughput	1.00	1.01
Power Consumed	3,601 w	3,200 w
Relative Power Consumed	1.13	1.00
Relative TCO	1.00	0.82

In tests with real Intel EDA workloads, servers based on high-end processors achieved the same performance for an estimated 18 percent lower TCO.

Conclusion

Our analysis demonstrated that higher-end processors deliver the maximum value to Intel IT.

The 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 hosting, 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 3. 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 to Intel IT.

Further analysis of our enterprise computing data confirmed that high-end processors can deliver 23 percent faster performance than low-end processors for the same estimated TCO, or the same performance for an estimated 19 percent lower TCO, as shown in Figure 4.

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

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

Based on these performance and TCO advantages, for two-socket servers, Intel IT has standardized on Intel Xeon processors with a core frequency of 3 GHz for design computing and enterprise server virtualization.

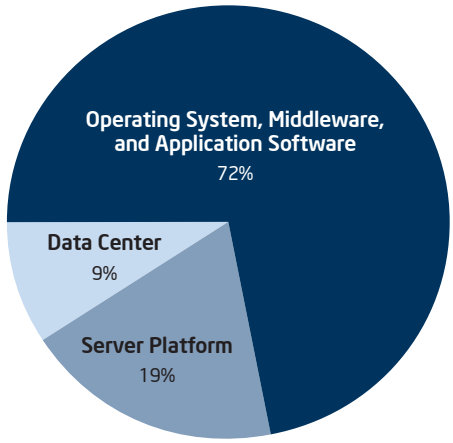

Figure 3. The hardware platform accounts for a small proportion of server total cost of ownership (TCO). Based on Quad-Core Intel® Xeon® processor E5450 (3 GHz).

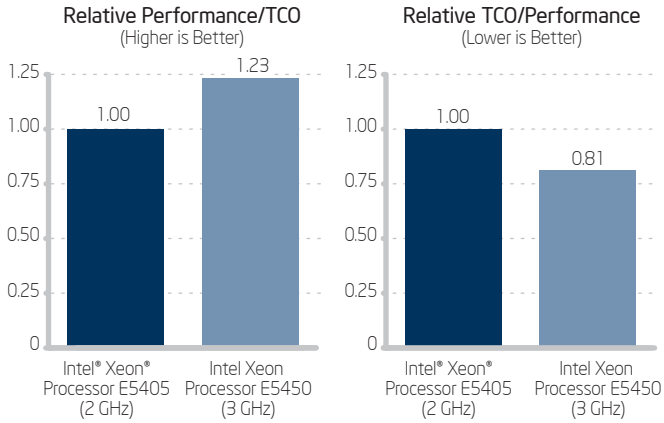

Figure 4. Higher-end processors deliver higher performance for the same total cost of ownership (TCO), on the left, or the same performance for lower TCO, on the right.

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