IT@Intel Brief
Intel IT
Computer Manufacturing
Server TCO
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Maximizing IT Value by Using High-End Server Processors

- Greater than 3x faster performance throughput for estimated 2x server cost
- Estimated 33-percent lower TCO to achieve the same performance throughput

Intel IT has standardized on Intel® Xeon® processors with a core frequency of 2.6 gigahertz (GHz) for two-socket servers to offer maximum IT value for design computing and enterprise server virtualization. Our analysis demonstrates that higher-end processors significantly enhance server performance throughput for a minimal increase in total cost of ownership (TCO).

We compared a wide range of server processor frequencies in our analysis, starting with lower-end Intel® Xeon® processor E5-2603 (four cores, 1.8 GHz) and including higher-end Intel® Xeon® processor E5-2640 (six cores, 2.5 GHz) and Intel® Xeon® processor E5-2670 (eight cores, 2.6 GHz). For Intel's electronic design automation (EDA) workloads, real-world application testing confirmed that servers based on the high-end processor delivered the same performance throughput for an estimated 33-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. We concluded that standardizing on high-end processors is a cost-effective way for Intel IT to maximize server return on investment (ROI).

Table 1. Electronic Design Automation (EDA) Performance Throughput and Total Cost of Ownership (TCO). In tests with actual Intel EDA workloads, servers based on high-end 2.6 GHz processors achieved the same performance throughput with lower TCO.

	Intel® Xeon® Processor E5-2603 (four cores, 1.8 GHz)	Intel® Xeon® Processor E5-2670 (eight cores, 2.6 GHz)
Thermal Design Power	80 watts	115 watts
Relative Performance Throughput	1.00	1.00
Number of Servers	3	1
Power Consumed	669 watts	463 watts
Application Licenses	24	16
Relative TCO	1.00	0.67

GHz - gigahertz; TCO - total cost of ownership

Background

Intel's worldwide data center environment includes more than 55,000 servers and supports more than 100,000 employees worldwide. About 80 percent of these servers are used for designing Intel products; the other 20 percent are used for enterprise and manufacturing 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 throughput and TCO, taking into account the cost of the server; the cost for software, including the OS, applications, and middleware; and data center costs including network, 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 processors or low-end processors.

Study

We compared the performance throughput and TCO of two-socket servers with varying thermal design power (TDP) and frequency levels starting from 80 watts (W) through 115 W. We evaluated processors ranging from Intel Xeon processor E5-2603 (four cores, 1.8 GHz) at the lower end through Intel Xeon processor E5-2670 (eight cores, 2.6 GHz) at the higher end.

We included the following four-year TCO elements in the analysis:

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

DESIGN COMPUTING

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

We ran a wide range of EDA application tests, which operated on an Intel silicon design data set. The tests included simulation, timing analysis, physical verification, and optical proximity correction (OPC). To obtain the overall performance throughput per server, our tests loaded all the cores in each server: all eight cores in the server based on the dual-socket Intel Xeon processor E5-2603, all 12 cores in the server based on the dual-socket Intel Xeon processor E5-2640, and all 16 cores in the server based on the dual-socket Intel Xeon processor E5-2670. We measured runtime for each application and compared relative job performance throughput. The results are shown in Figure 1.

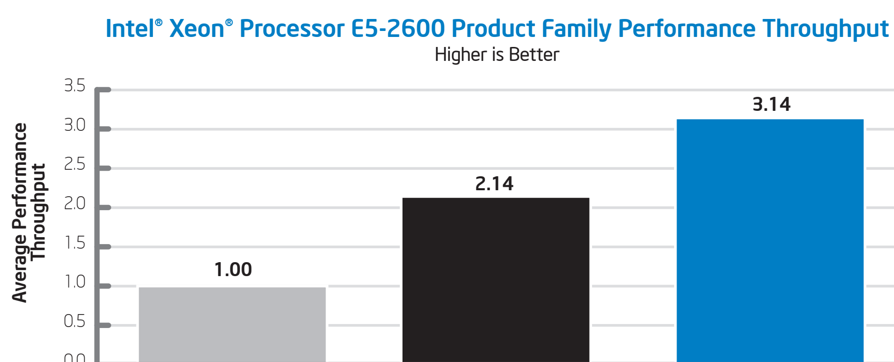

Figure 1. Electronic Design Automation (EDA) Performance Throughput Comparison. Our results indicate that the server based on the Intel® Xeon® processor E5-2670 (2.6 GHz) yields the best performance throughput of 3.14x compared to the server based on the lower-end Intel® Xeon® processor E5-2603 (1.8 GHz).

	Intel® Xeon® Processor E5-2603 1.8 GHz; 8 GB/core RAM; Four Cores Per Socket	**Intel® Xeon® Processor E5-2640** 2.5 GHz; 8 GB/core RAM; Six Cores Per Socket	**Intel® Xeon® Processor E5-2670** 2.6 GHz; 8 GB/core RAM; Eight Cores Per Socket
Simulation (113 jobs)	1.00	2.01	3.15
Timing Analysis (48 jobs)	1.00	2.32	3.30
Physical Verification (DRC) (48 Jobs)	1.00	2.20	2.92
Physical Verification (NAC) (48 Jobs)	1.00	2.28	3.31
OPC (561 Templates)	1.00	1.87	3.03
Average Performance Throughput	**1.00**	**2.14**	**3.14**

DRC - design rule check; GB - gigabyte; GHz - gigahertz; NAC - node antenna check; OPC - optical proximity correction

TCO Analysis

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

Results are shown in Table 2. We needed 3x more servers based on the low-end Intel Xeon processor E5-2603 to obtain similar throughput of the server based on the Intel Xeon processor E5-2670 (2.6 GHz). With the low-end server, we had a 50-percent increase in the number of software licenses, an 82-percent increase in data center connectivity and hosting costs, and a 44-percent increase in power requirements.

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 server platform. The costs for data center hosting, connectivity, and power and cooling are also significant factors. The server and, hence, the processor accounts for only a small percentage of overall cost, as shown in Figure 2. High-end processors substantially increase performance throughput and deliver better value to Intel IT.

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

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

Based on these performance throughput and TCO advantages, for two-socket servers, Intel IT has standardized on Intel Xeon processors with a core frequency of 2.6 GHz for design computing and enterprise server virtualization needs.

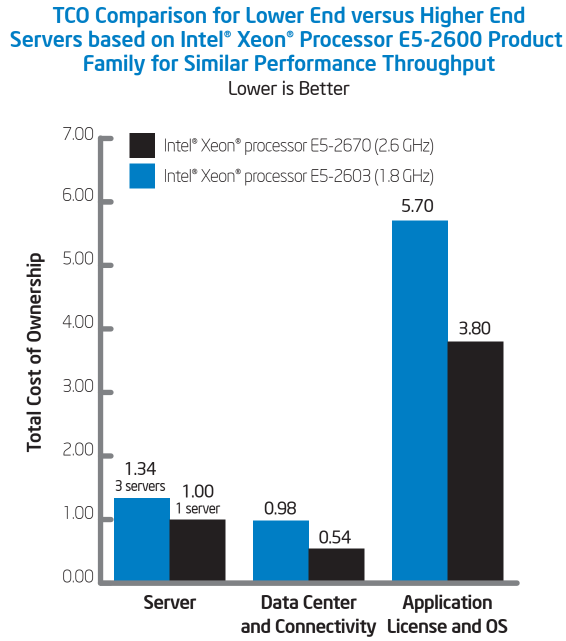

Figure 2. The hardware platform accounts for a small proportion of server total cost of ownership (TCO).

Table 2. Electronic Design Automation (EDA) Performance Throughput and Total Cost of Ownership (TCO) Comparing Higher-end Intel® Xeon® Processors and Lower-end Intel Xeon Processors. In tests with actual Intel EDA workloads, the servers based on high-end processors achieved the same performance throughput for an estimated 33-percent lower TCO.

	Intel® Xeon® Processor E5-2603 (Four Cores, 1.8 GHz)	Intel® Xeon® Processor E5-2670 (Eight Cores, 2.6 GHz)
Thermal Design Power (W)	80	115
Number of Servers	3	1
Memory	8 GB per core	8 GB per core
EDA Application Licenses	24	16
Relative Performance Throughput	1.00	3.14
Power Consumed (W)	669	463
Relative Power Consumed	1.44	1.00
Relative TCO	1.00	0.67

GHz - gigahertz; TCO - total cost of ownership; W - watts

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