Performance and Energy Efficiency of the 14th Generation Dell PowerEdge Servers

This white paper details the performance improvements of Dell™ PowerEdge™ servers with the Intel® Xeon® Processor Scalable CPU family.
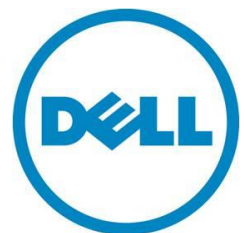
R640

R940

R740/XD

C6420/C6400

Solutions Performance Analysis

Dell | Global Solutions Engineering

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Introduction

Dell's 14th generation PowerEdge servers are now available with the Intel Xeon Processor Scalable family, code named "Skylake-SP". These new Xeon processors feature up to 28 cores, 38.5 MB of last level caching and (6) 2666 MT/s DDR4 memory channels.

In order to show customers the performance and energy efficiency uplifts possible from the new PowerEdge products, Dell's Solutions Performance Analysis team performed a series of benchmarks and compared the results to those previously obtained from PowerEdge 13G servers equipped with both the Xeon E5-2600 v4 (Broadwell-EP) and Xeon E5-2600 v3 (Haswell-EP) CPU families.

Based on these results, PowerEdge 14G servers with new Skylake-SP family processors performed up to 102% better as compared to their direct predecessor 13G servers equipped with Broadwell-EP family processors.

Key findings

Performance with Skylake-SP

- **PowerEdge 14G servers with two Xeon Platinum 8180 processors delivered up to 50% higher throughput using the comprehensive SPECcpu2006 integer suite**.

- **PowerEdge 14G servers with two Xeon Platinum 8180 processors delivered up to 64% higher throughput using the comprehensive SPECcpu2006 floating point suite**.

- **PowerEdge 14G servers with two Xeon Platinum 8180 processors produced up to 102% higher floating-point operations per second using the popular Linpack high performance computing metric**.

- **PowerEdge 14G servers with two Xeon Platinum 8180 processors and 2 DIMMS per available channel produced up to 69% higher sustainable memory bandwidth according to the STREAM benchmark.**

- **The PowerEdge 14G 4 socket server with four Xeon Platinum 8180 processors demonstrated up to 78% higher energy efficiency than its 13G 4 socket predecessor.**

- **PowerEdge 14G servers with two Xeon Platinum 8180 processors achieved up to a 44% higher score on the SAP-SD two-tier business transaction benchmark.**

Arithmetic performance

SPEC CPU2006 integer tests

The widely referenced SPEC CPU2006 benchmark is described on SPEC.org as:

> CPU2006 is SPEC's computer server industry standard benchmark suite, stressing a system's processor, memory subsystem and compiler. SPEC designed CPU2006 to provide a comparative measure of compute-intensive performance across the widest practical range of hardware based upon the aggregate score of 12 integer and 17 floating point real-world applications.

The integer portion of the benchmark is particularly good at measuring a server's ability to run general business applications. In figure 1, we see 14G's Xeon Platinum 8180 achieve a 50% improvement[1] in SPECint_rate over the best 13G result.

Figure 1 Two socket Platform Performance improvement running SPECint_rate_base2006

See the Appendix D for comparative SPECint_rate_base2006 results across the full Skylake-SP CPU stack.

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[1] SPEC and SPECcpu are registered trademarks of Standard Performance Evaluation Corporation. The performance described is based upon results posted at http://www.spec.org as of July 11, 2017.

SPEC CPU2006 floating point tests

The throughput or rate of a machine carrying out floating point arithmetic is important to those working today's biggest problems in science and engineering. In figure 2, we see 14G's Xeon Platinum 8180 achieve a 64% improvement[2] in SPECfp_rate over the best 13G result.

Figure 2 Two socket Platform Performance improvement running SPECfp_rate_base2006
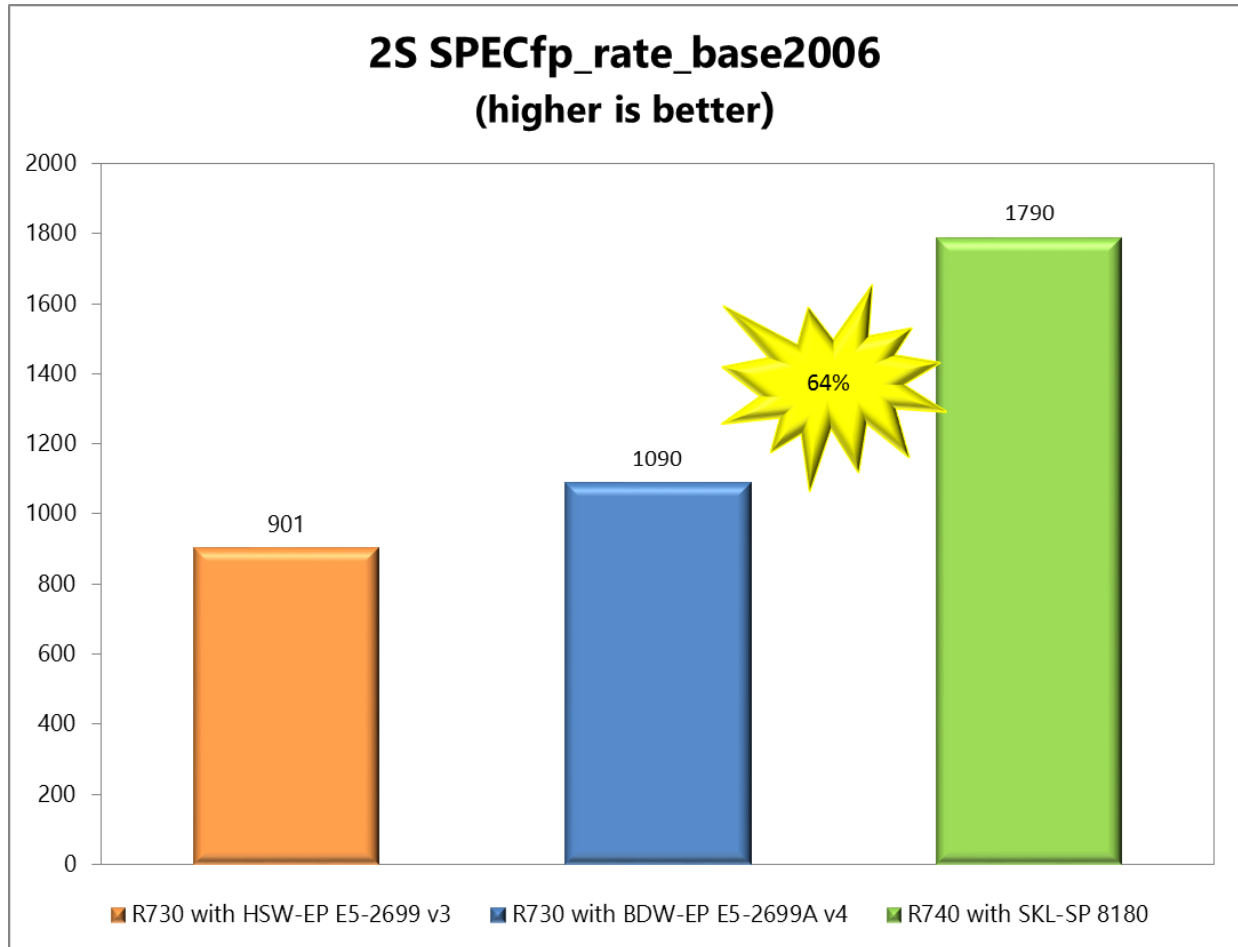

See the Appendix D for comparative SPECfp_rate_base2006 results across the full Skylake-SP CPU stack

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[2] SPEC and SPECcpu are registered trademarks of Standard Performance Evaluation Corporation. The performance described is based upon results posted at http://www.spec.org as of July 11, 2017.

High Performance Computing (HPC) performance tests

The widely-available LINPACK benchmark is the standard for illustrating a system's "heavy math" floating point processing power needed for simulating natural phenomena, analyzing structures and machine learning.

Thanks primarily to Skylake-SP's higher core count, new AVX-512 vector engines, improvements in IPC (instructions per clock cycle) and 2666 MT/s DDR4 memory support, the Xeon Platinum 8180 delivered an amazing 102% performance improvement over the Xeon E5-2699 v4, as seen in the following figure.

Figure 3 Performance improvement running Linpack

See the Appendix B for Linpack results across the full Skylake-SP CPU family

Memory subsystem performance

Cloud and in-memory database applications benefit from greater memory bandwidth. Dell 14G PowerEdge servers with select SKL-SP processor models support up to (48) DDR4 DIMMs running at a speed of 2666 MT/s. This is up from the 2400 MT/s limit of 13G PowerEdge and is also the case when every possible DIMM socket is populated. In figure 4, the server industry-standard STREAM benchmark illustrates a 69% improvement in total system memory bandwidth performance over the best Broadwell result thanks to Skylake's faster memory interface and the addition of two additional channels (6 total).

Figure 4 Performance improvement running STREAM

See the Appendix C for STREAM results across the full SKL-SP CPU family

Energy Efficiency

SPECpower_ssj2008 is an industry standard benchmark created by the Standard Performance Evaluation Corporation (SPEC®) to measure a server's power and performance across its full range of utilization levels from 100% to idle.

As figure 5 shows, the Dell PowerEdge R940 with four of the new Xeon-SP 8180 processors with their higher core counts and new power management features is capable of 78% higher performance per watt than was possible on the R930[3].

Figure 5 Four Socket Platform Energy Efficiency improvement running SPECpower_ssj2008

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[3] Required SPEC disclosure information: R940/8180 scores: (11,546,769 ssj_ops and 946W) @ 100% target load and 11,667 overall ssj_ops/watt vs. R930/E7-8880v3: (5,968,583 ssj_ops and 815W) @ 100% and 6,542 overall ssj_ops/watt. Comparison based on results by Dell Labs July 2017. SPEC® and the benchmark name SPECpower_ssj® are registered trademarks

Business Transaction Performance

SPECjbb2015

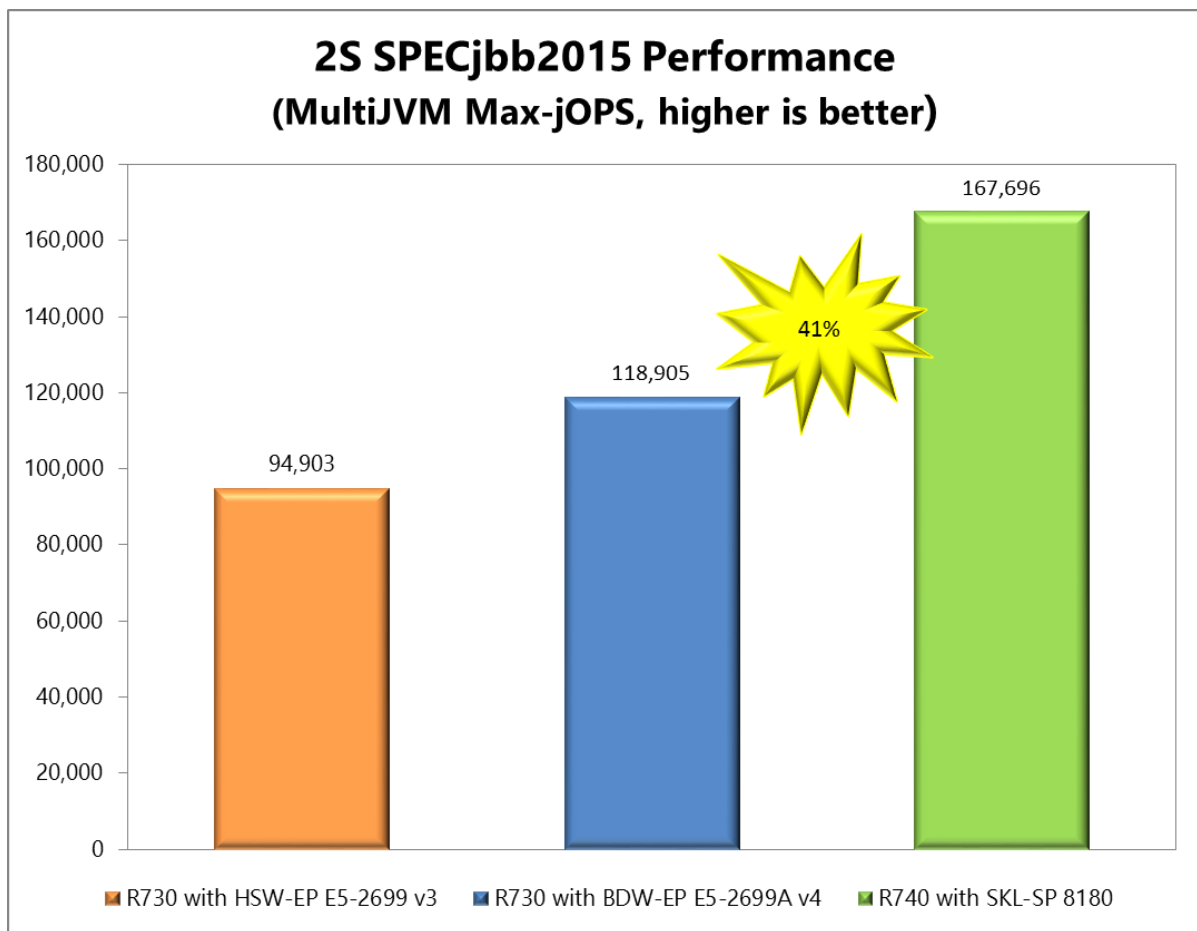According to the [SPEC website](#):

> This benchmark models a Java-based business application for a worldwide supermarket company with an IT infrastructure that handles a mix of point-of-sale requests, online purchases and data-mining operations. It exercises the latest data formats (XML), communication using compression and messaging with security in a virtualized cloud computing environment.

As figure 6 shows, a Dell PowerEdge R740 with a pair of the new Xeon-SP 8180 processors and accompanying 2666M memory provides 41% more Java operations per second than the R730 last refreshed in May 2016[4]

Figure 6 Two Socket Platform Performance improvement running SPECjbb2015

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[4] SPEC and SPECjbb are registered trademarks of Standard Performance Evaluation Corporation. The performance described is based upon results posted at http://www.spec.org as of July 11, 2017.
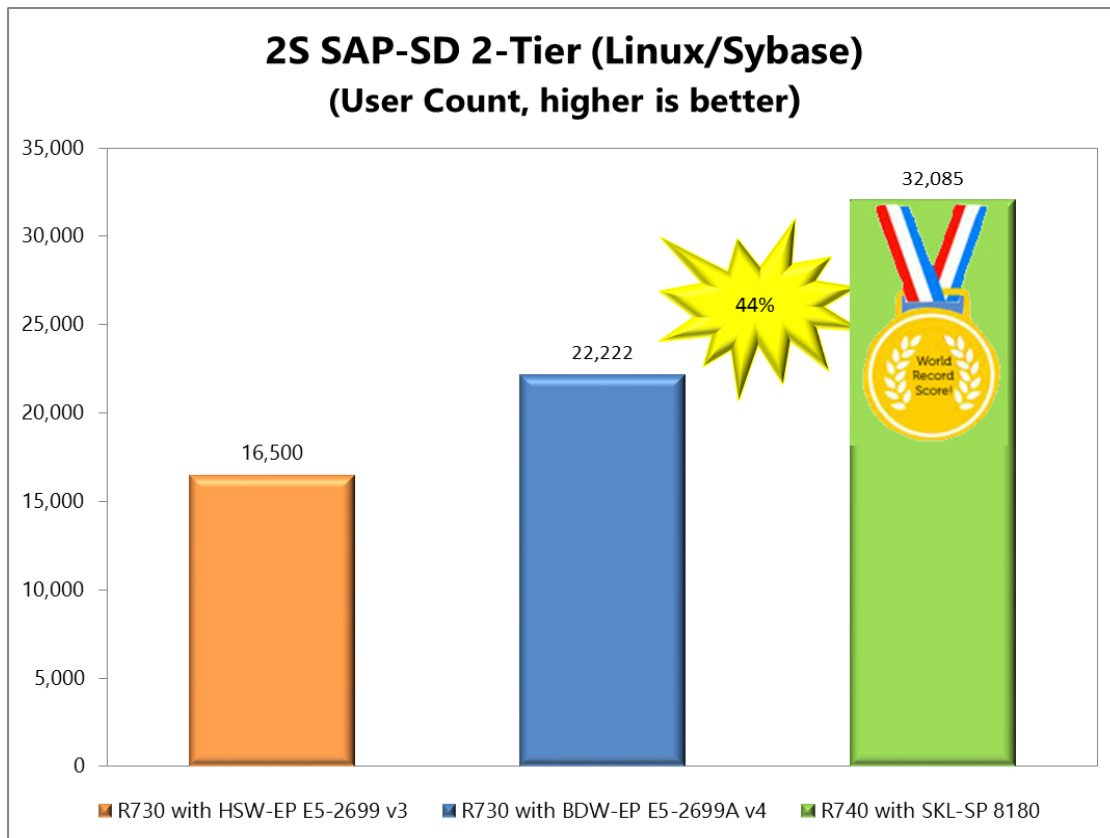
SAP-SD 2-Tier, Linux / Sybase

The (Sales and Distribution) benchmark is described on the SAP web site as:

> The Sales and Distribution (SD) Benchmark covers a sell-from-stock scenario, which includes the creation of a customer order with five line items and the corresponding delivery with subsequent goods movement and invoicing.

The SAP-SD Two-Tier benchmark's primary metric is the Number of Benchmark Users. As figure 7 shows, the PowerEdge R740 with Xeon Platinum 8180 achieved an acknowledged world record result being 44% higher[5] than from the PowerEdge R730 with Xeon E5-2699A v4, itself a world record[6]

Figure 7 Performance improvement running SAP SD 2-Tier, Linux / Sybase

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[5] Results of the Dell PowerEdge R740 on the two-tier SAP SD standard application benchmark: 32,085 SAP SD benchmark users with the SAP enhancement package 5 for SAP ERP 6.0, Red Hat Enterprise Linux 7.3, and Sybase ASE 16.0, 2 x Intel Xeon Platinum 8180 processors (56 cores, 112 threads), 768 GB main memory. Certification number 2017017. http://www.sap.com/benchmark

[6] Results of the Dell PowerEdge R730 on the two-tier SAP SD standard application benchmark: 22,222 SAP SD benchmark users with the SAP enhancement package 5 for SAP ERP 6.0, Red Hat Enterprise Linux 7.2, and Sybase ASE 16, 2 x Intel Xeon E5-2699A v4 processors (44 cores, 88 threads), 512 GB main memory. Certification number 2016050.

Summary

PowerEdge 14G servers with the new Skylake-SP processor models, can provide even more performance from all representative scientific and business transaction workloads. Thanks to both the CPU family's additional compute resources and Dell's Energy Smart implementation; this additional performance comes with the same or even less electricity required or waste heat generated making possible capacity growth, infrastructure reduction and lower total cost of ownership over the life of the product.

The Xeon Processor Scalable family is available for purchase on all PowerEdge 14G servers. The enhanced performance of the 14G server lineup continues the PowerEdge tradition of delivering the maximum performance today's datacenter administrators' demand.
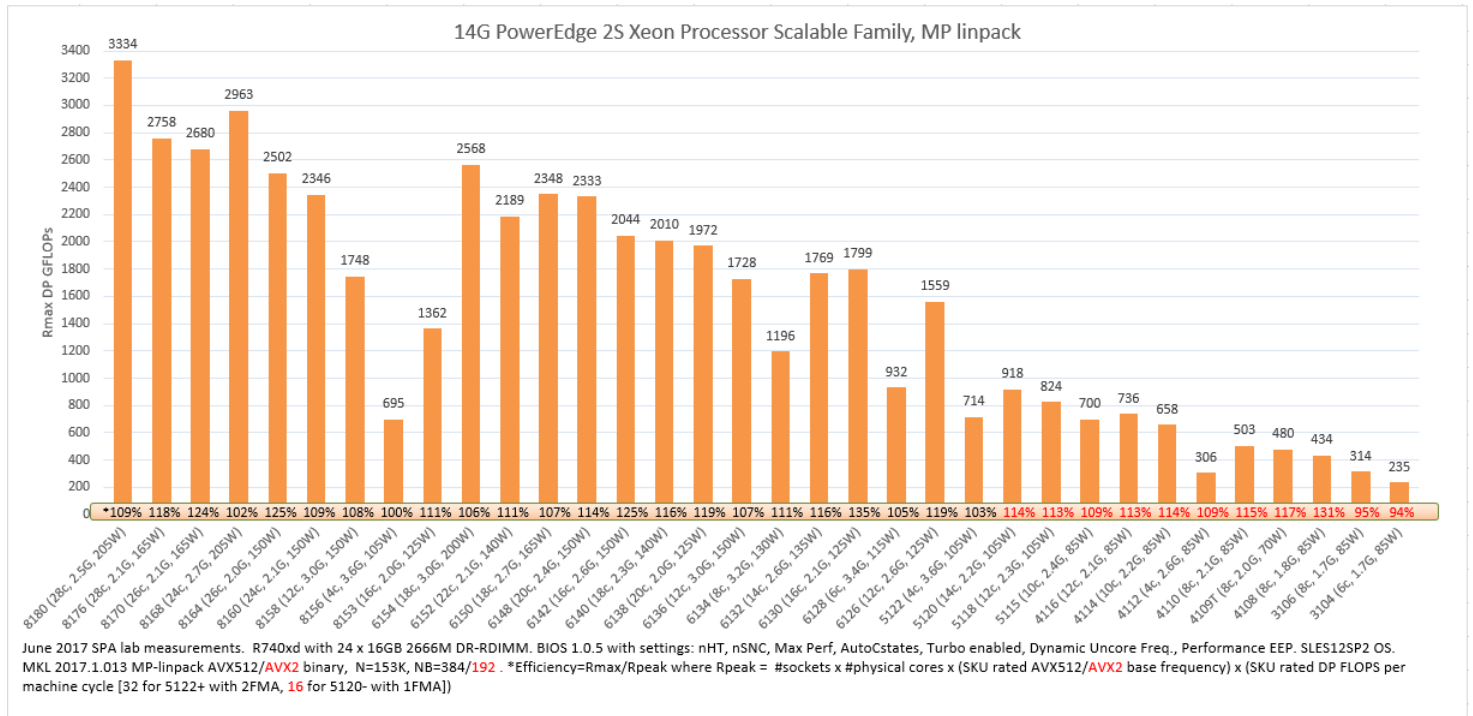
Appendix A — Test configurations

Table 1 Benchmark configurations

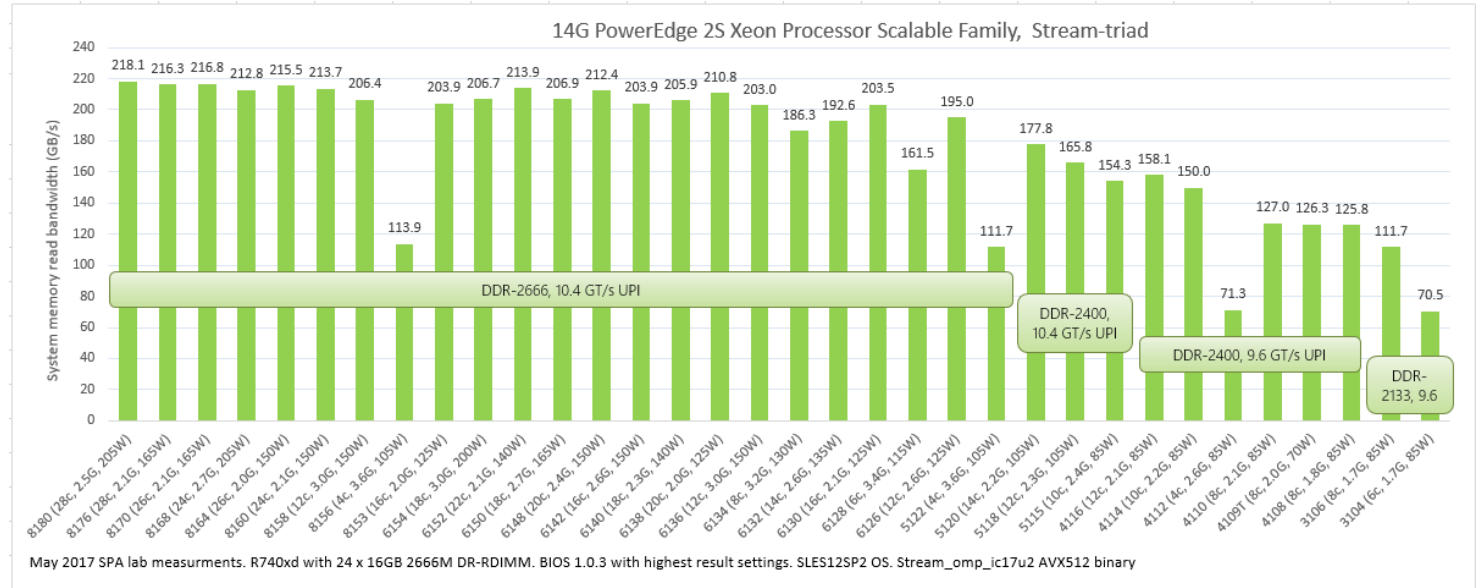| Benchmark	Processor quantity	Skylake-SP4 family processor	DIMM quantity	DIMM specifications
SPECint_rate_base2006	2	Xeon Platinum 8180	24	16 GB dual rank 2666 MT/s registered DIMMs
SPECfp_rate_base2006	2	Xeon Platinum 8180	24	16 GB dual rank 2666 MT/s registered DIMMs
Linpack	2	Xeon Platinum 8180	24	16 GB dual rank 2666 MT/s registered DIMMs
STREAM	2	Xeon Platinum 8180	24	16 GB dual rank 2666 MT/s registered DIMMs
SPECpower_ssj2008	4	Xeon Platinum 8180	24	16 GB dual rank 2666 MT/s registered DIMMs
SPECjbb2015	2	Xeon Platinum 8180	24	16 GB dual rank 2666 MT/s registered DIMMs
SAP SD Two-Tier, Linux	2	Xeon Platinum 8180	24	32 GB dual rank 2666 MT/s registered DIMMs

Appendix B — 14G PowerEdge Floating Point Operations per Second

Figure 8 Linpack results for the Skylake-SP family in a 2 socket platform

14G PowerEdge 2S Xeon Processor Scalable Family, MP linpack

June 2017 SPA lab measurements. R740xd with 24 x 16GB 2666M DR-RDIMM. BIOS 1.0.5 with settings: nHT, nSNC, Max Perf, AutoCstates, Turbo enabled, Dynamic Uncore Freq., Performance EEP. SLES12SP2 OS. MKL 2017.1.013 MP-linpack AVX512/AVX2 binary, N=153K, NB=384/192 . *Efficiency=Rmax/Rpeak where Rpeak = #sockets x #physical cores x (SKU rated AVX512/AVX2 base frequency) x (SKU rated DP FLOPS per machine cycle [32 for 5122+ with 2FMA, 16 for 5120- with 1FMA])

Appendix C — 14G PowerEdge System Memory Bandwidth

Figure 9 Stream results for the Skylake-SP family in a 2 socket platform

Appendix D- SPEC CPU 2006 throughput metric results across Xeon Processor Scalable Family[7]
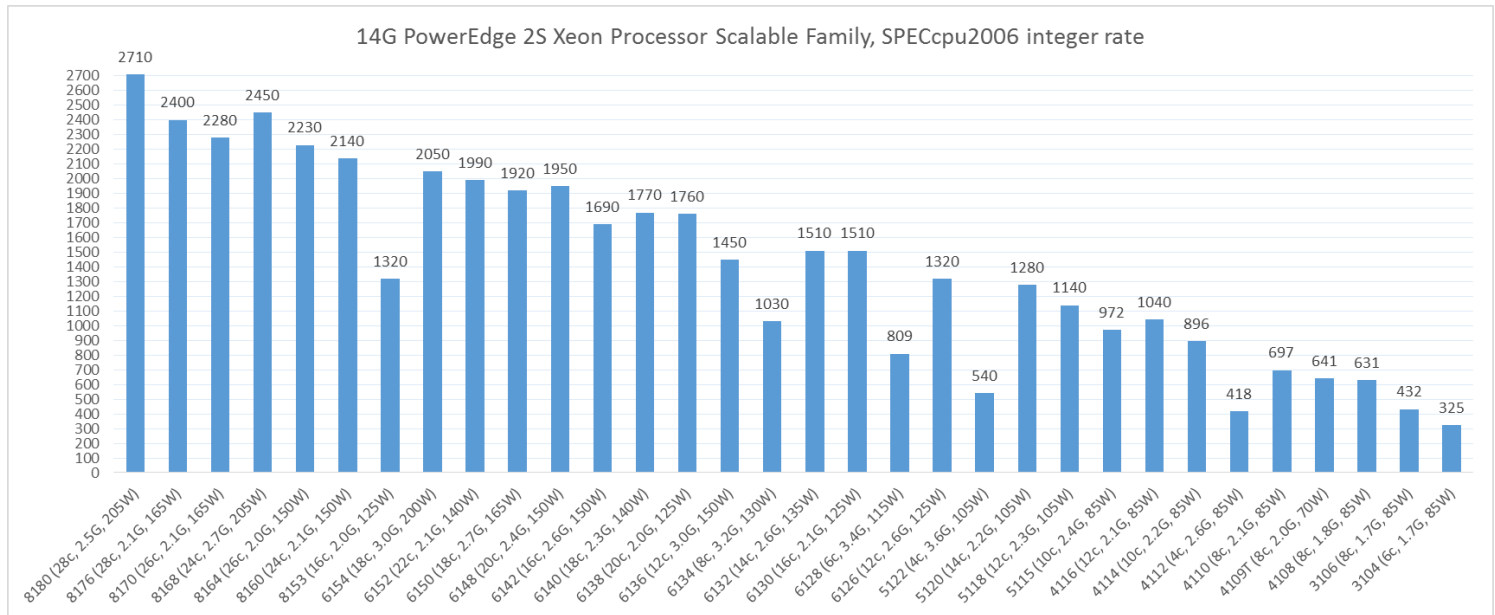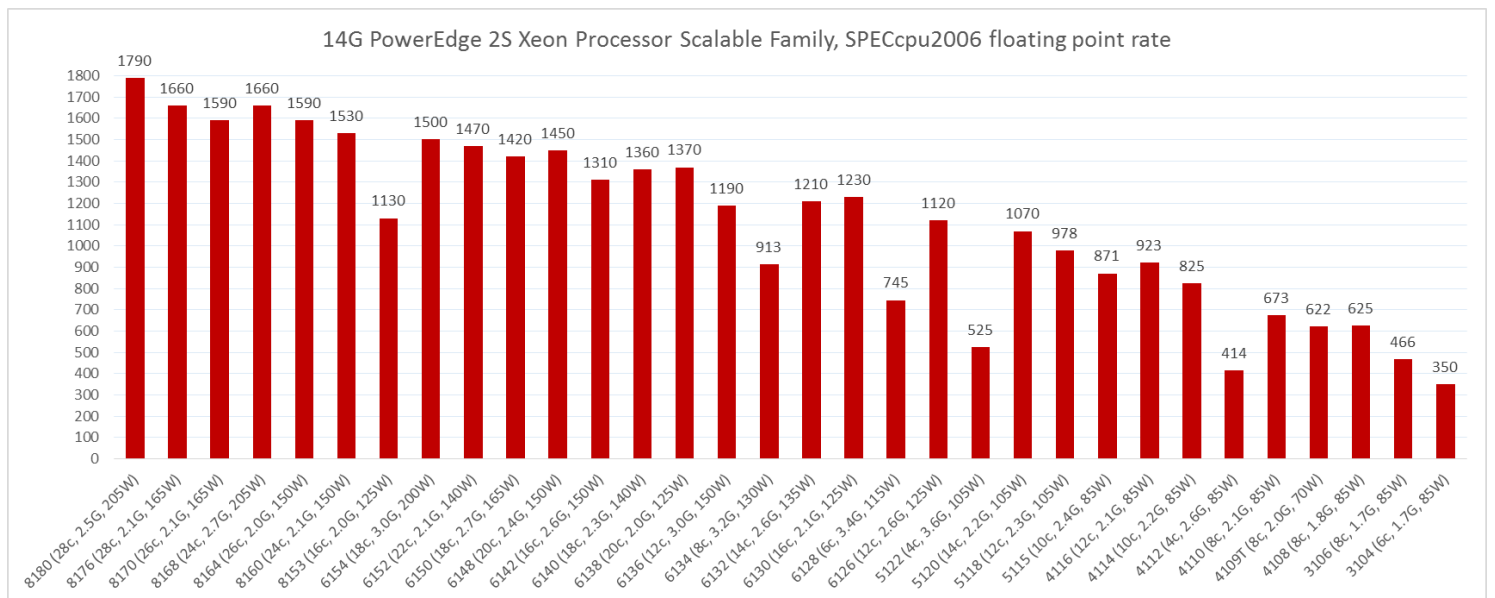
Figure 10 Integer Workloads

Figure 11 Floating Point Workloads