AMD EPYC 7002 Series CPU PowerEdge Server Performance

This white paper details the performance improvements of Dell EMC™ PowerEdge™ servers with the 2nd Gen EPYC CPU Family.

R6515

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Solutions Performance Analysis

Dell | Global Solutions Engineering

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Introduction

Dell PowerEdge servers are now available with AMD's second-generation EPYC 7002 Processor family. This new CPU family features up to 64 cores, 256 MB of last level caching and (8) 3200 MT/s DDR4 memory channels.

In order to show customers, the performance 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 both the AMD's previous generation EPYC 7001 family as well as to contemporary Intel Xeon Scalable Processor families.

Based on these results, PowerEdge servers with new EPYC 7002 family processors delivered 2x the performance of both AMD's previous EPYC 7001 family and Intel's contemporary Xeon-SP family processors.[1]

Key findings

Performance with EPYC 7002

- Double the integer workload compute throughput per socket of any previous PowerEdge model according to the industry standard SPECcpu2017 RATE metric.

- 81% higher floating-point workload compute throughput per socket than any previous PowerEdge model according to the industry standard SPECcpu2017 RATE metric.

- 3x the floating-point operations per second of the preceding EPYC 7001 family as well as 15% more than even the AVX512 capable Xeon-SP families according to LINPACK.

- 25% more sustained system memory bandwidth than the previous best EPYC 7001 configuration according to the STREAM benchmark.

- 93% more Java operations per second than any previous 2-socket PowerEdge model according to the SPECjbb2015 business transaction metric.

- Another SAP-SD two-tier business transaction benchmark world record with its 76% higher score than Dell's previous industry-leading result based upon Xeon Platinum 8280 CPUs.

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[1] Comparing the published SPECcpu2017 integer rate scores for the 2 x 7742 CPU configuration to the 2 x 8280, 2 x 7601 and 2 x 8180 ones (667 vs 342 vs 301 vs 296 respectively). See those publication hyperlinks in the following section

Arithmetic performance

SPEC CPU2017 integer tests

The widely referenced SPEC CPU2017 benchmark is described on SPEC.org as:

> The **SPEC CPU® 2017** benchmark package contains SPEC's next-generation, industry-standardized, CPU intensive suites for measuring and comparing compute intensive performance, stressing a system's processor, memory subsystem and code compiler. SPEC designed CPU2017 to provide a comparative measure of compute-intensive performance across the widest practical range of hardware based upon the aggregate score of 10 integer and 13 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 the EPYC 7742 configuration achieve as much as a 2.2x improvement[2] in integer throughput over the Xeon Platinum 8280, EPYC 7601 and Xeon Platinum 8180 based ones.

Figure 1 Two socket Platform Performance improvement running SPECint_rate_base2017
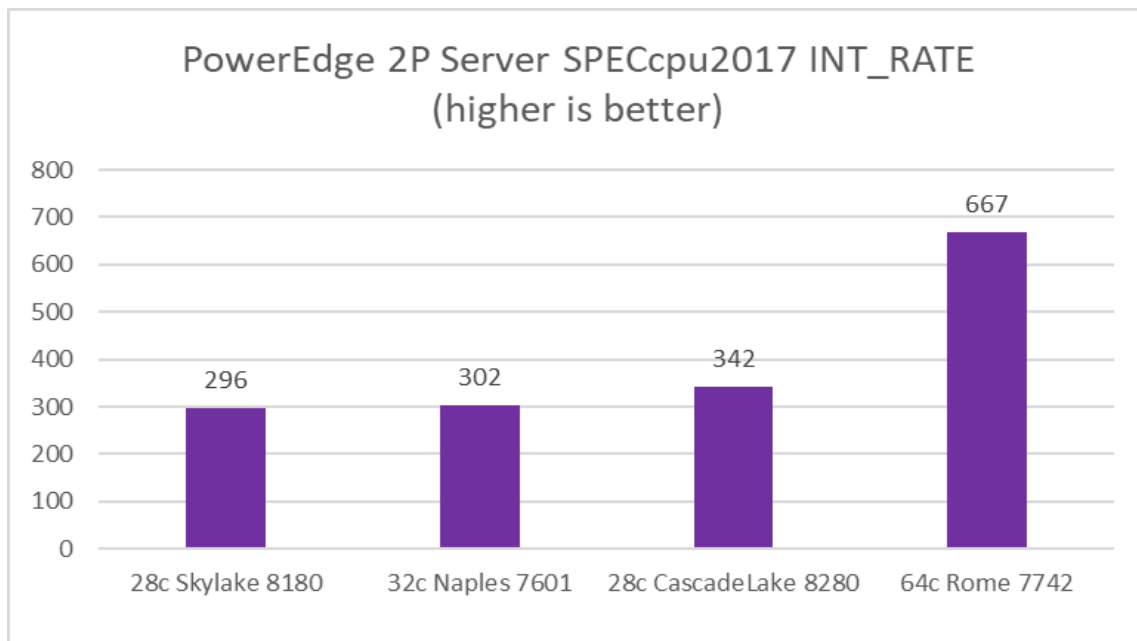
See the Appendix D for full CPU family model integer rate results.

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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 in Dec-2019, Apr-2019, Mar-2019 and Nov-2017 respectively.
https://spec.org/cpu2017/results/res2019q4/cpu2017-20191125-20017.html
https://spec.org/cpu2017/results/res2019q2/cpu2017-20190317-11165.html
https://spec.org/cpu2017/results/res2019q1/cpu2017-20190304-11124.html
https://spec.org/cpu2017/results/res2017q4/cpu2017-20171030-00243.html

SPEC CPU2017 floating-point tests

The throughput or rate of a computer system carrying out floating-point arithmetic is important to those working today's biggest problems in science and engineering. Figure 2 shows that a 2P EPYC 7742 configuration demonstrated a 1.8x improvement[3] in floating-point application throughput over the best previous 2P PowerEdge model according to the industry standard SPECcpu2017 RATE metric.

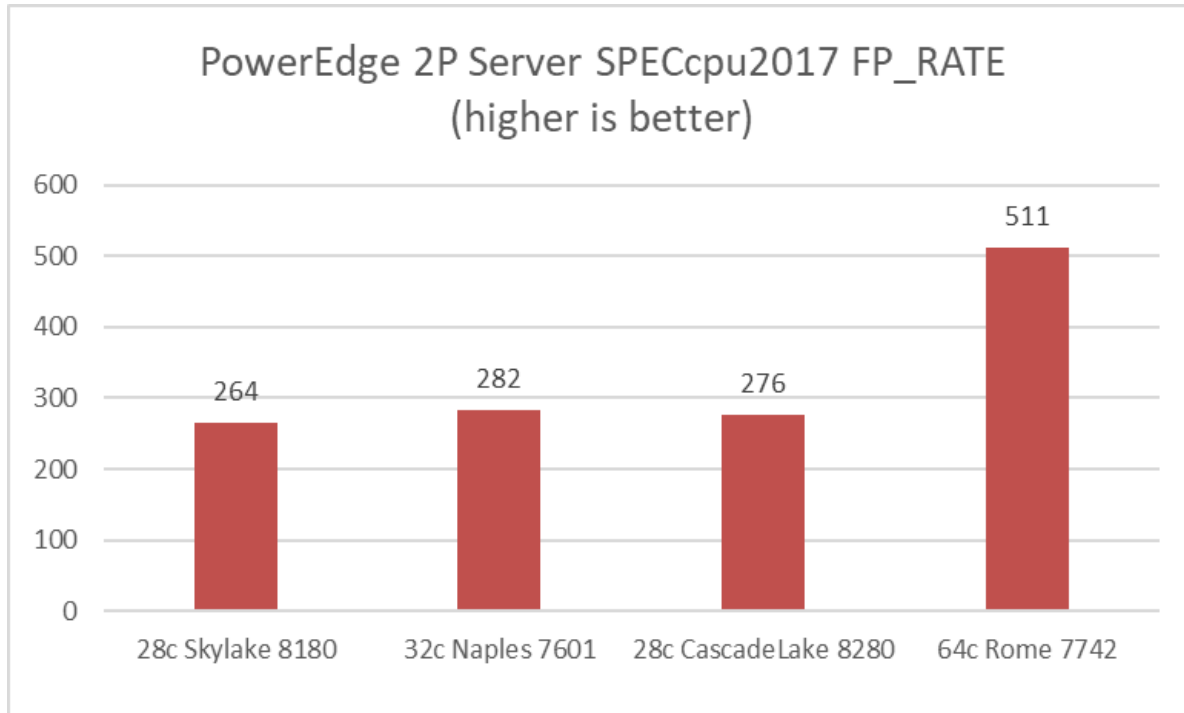[Figure 2 Two socket Platform Performance improvement running SPECfp_rate_base2017](#)

See the Appendix D for full CPU family model floating-point results.

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[3] SPEC and SPECcpu are registered trademarks of Standard Performance Evaluation Corporation. The performance described is based upon results posted at http://www.spec.org in Dec-2019, Apr-2019, Mar-2019 and Nov-2017 respectively.
https://spec.org/cpu2017/results/res2019q4/cpu2017-20191125-20016.html
http://spec.org/cpu2017/results/res2019q2/cpu2017-20190317-11166.html
http://spec.org/cpu2017/results/res2019q1/cpu2017-20190304-11125.html
http://spec.org/cpu2017/results/res2018q3/cpu2017-20180723-07901.html

High Performance Computing (HPC) performance tests

The widely-available LINPACK[4] 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.

With the addition of AVX2 vector operation support and a doubling of physical cores; EPYC 7742 provides 3.4x the FLOPS of EPYC 7601 and 15% more than even the AVX512-capable Xeon Platinum 8280 according to LINPACK.

Figure 3 High-Performance LINPACK Results
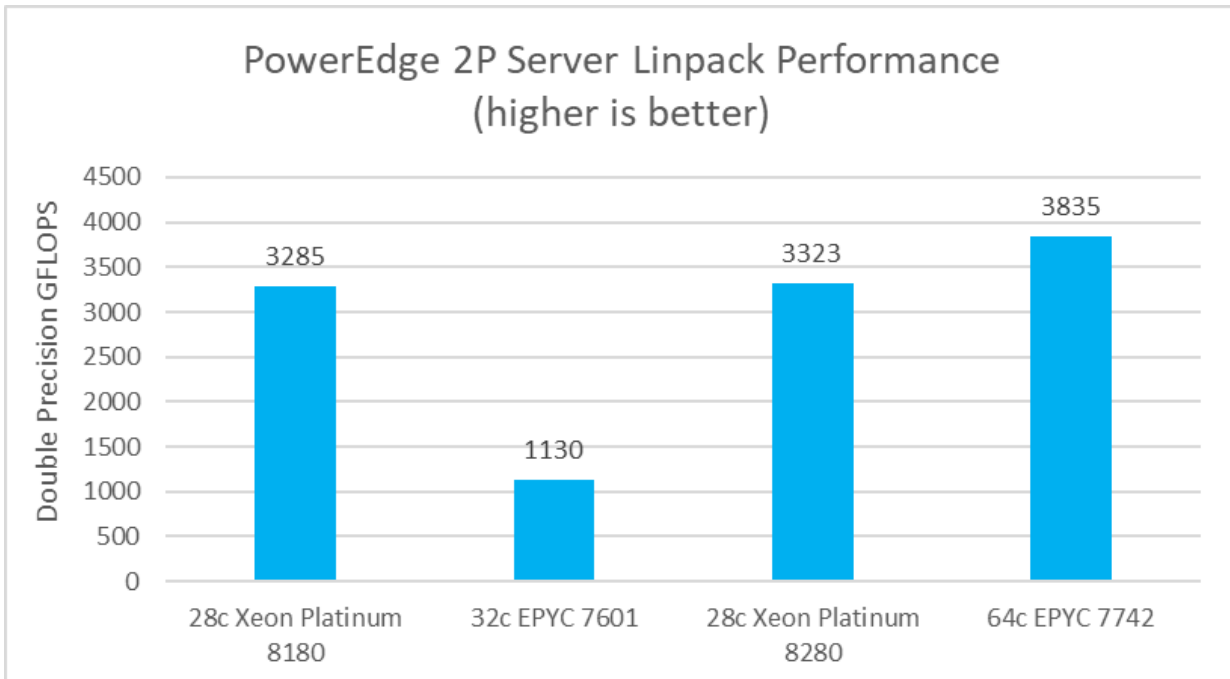
See the Appendix B for LINPACK results on all available EPYC 7002 CPU models

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[4] https://en.wikipedia.org/wiki/LINPACK_benchmarks,

Memory subsystem performance

STREAM-triad

As core counts and IPC (instructions per cycle) grows with each new CPU family, it is essential that the accompanying main memory subsystem provide correspondingly higher aggregate data transfer rates else it will constrain the solution's potential compute throughput. This is especially true for Cloud and in-memory database applications. Dell's new PowerEdge servers with EPYC 7002 processor models support 8 channels of 3200 MT/s DDR4 system memory per CPU socket. In figure 4, we see EPYC 7742 sustaining 25% more system memory bandwidth than the previous best EPYC 7601 configuration according to the STREAM benchmark[5].

Figure 4 Performance improvement running STREAM
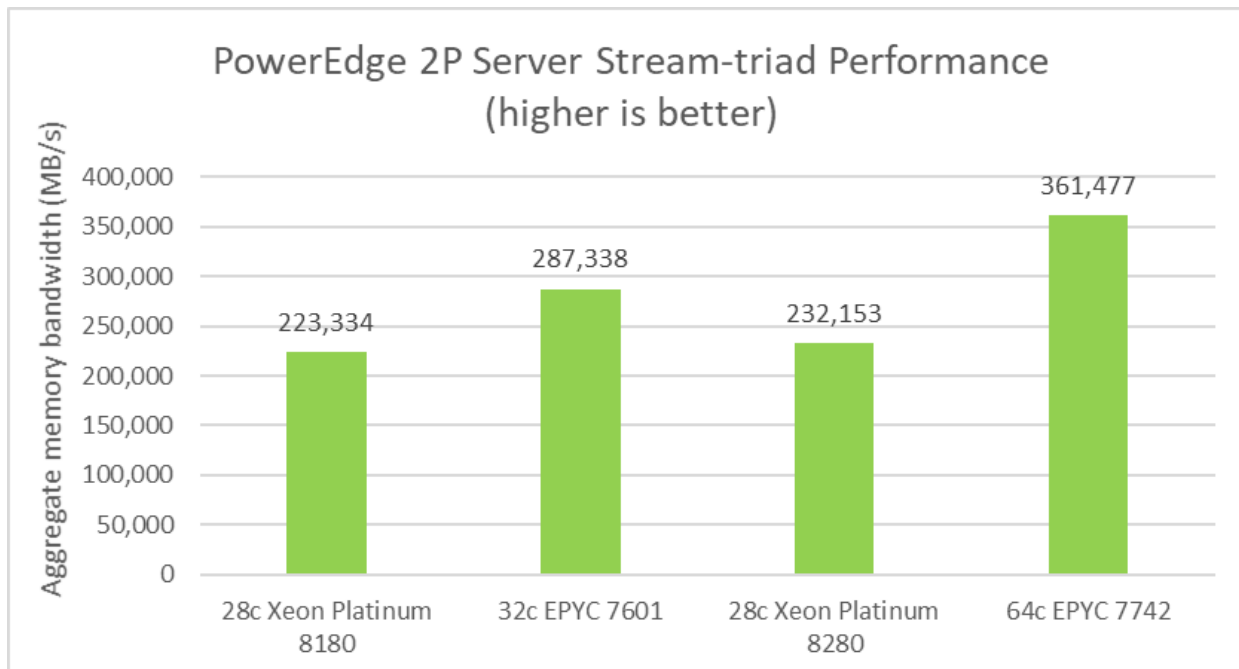
See the Appendix C for STREAM results for all EPYC 7002 CPU models and DIMM populations

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[5] https://www.cs.virginia.edu/stream/

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.
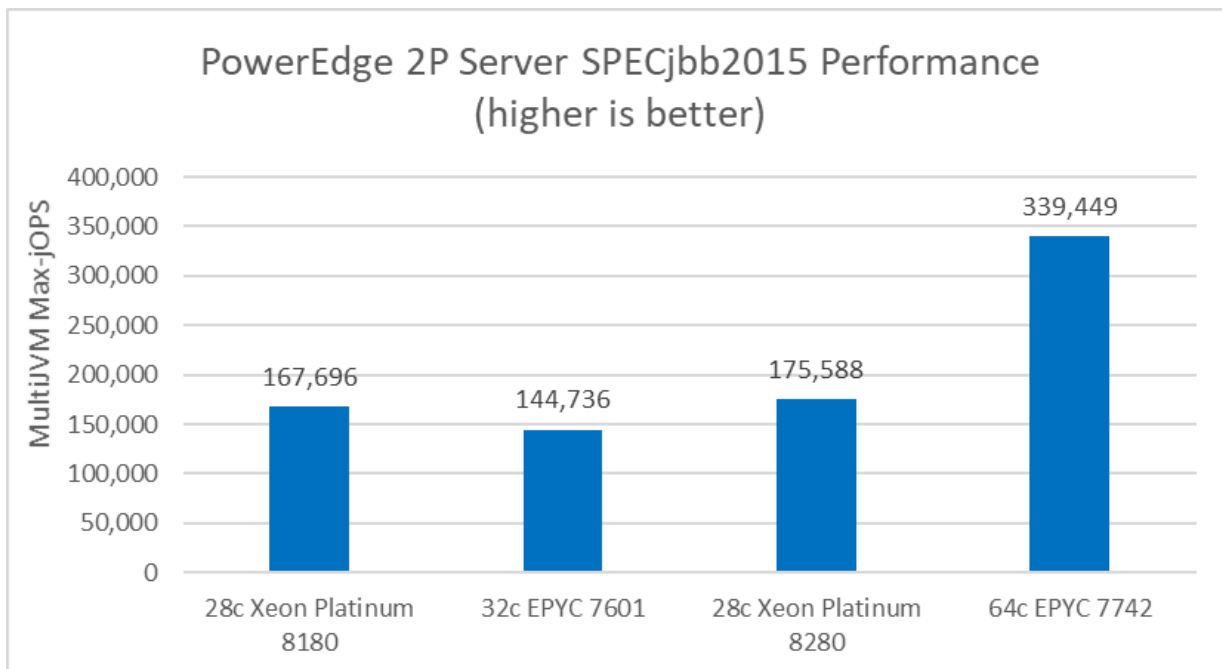
As figure 6 shows, Dell PowerEdge R6525 with a pair of the new EPYC 7742 processors and accompanying 3200M memory provides 93% more Java operations per second than any previous 2P PowerEdge server according to the SPECjbb2015 business transaction metric[6]

[Figure 6 Two Socket Platform Performance improvement running SPECjbb2015](#)

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[6] SPEC and SPECjbb are registered trademarks of Standard Performance Evaluation Corporation. **The performance described is based upon results posted at** http://www.spec.org in Nov-2019, Apr-2019, Mar-2019 and Nov-2017 respectively.
https://spec.org/jbb2015/results/res2019q4/jbb2015-20191120-00507.html
https://spec.org/jbb2015/results/res2019q2/jbb2015-20190313-00363.html
https://spec.org/jbb2015/results/res2018q1/jbb2015-20171107-00270.html
https://spec.org/jbb2015/results/res2017q3/jbb2015-20170620-00160.html

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 that receive adequate quality of service query response. As figure 7 shows, the PowerEdge R6525 with a pair of EPYC 7742 achieved yet another server OEM world record with a 76% higher[7] result than the previous PowerEdge R740 Xeon Platinum 8280 one[8]

[Figure 7 Performance improvement running SAP SD 2-Tier, Linux / Sybase](#)

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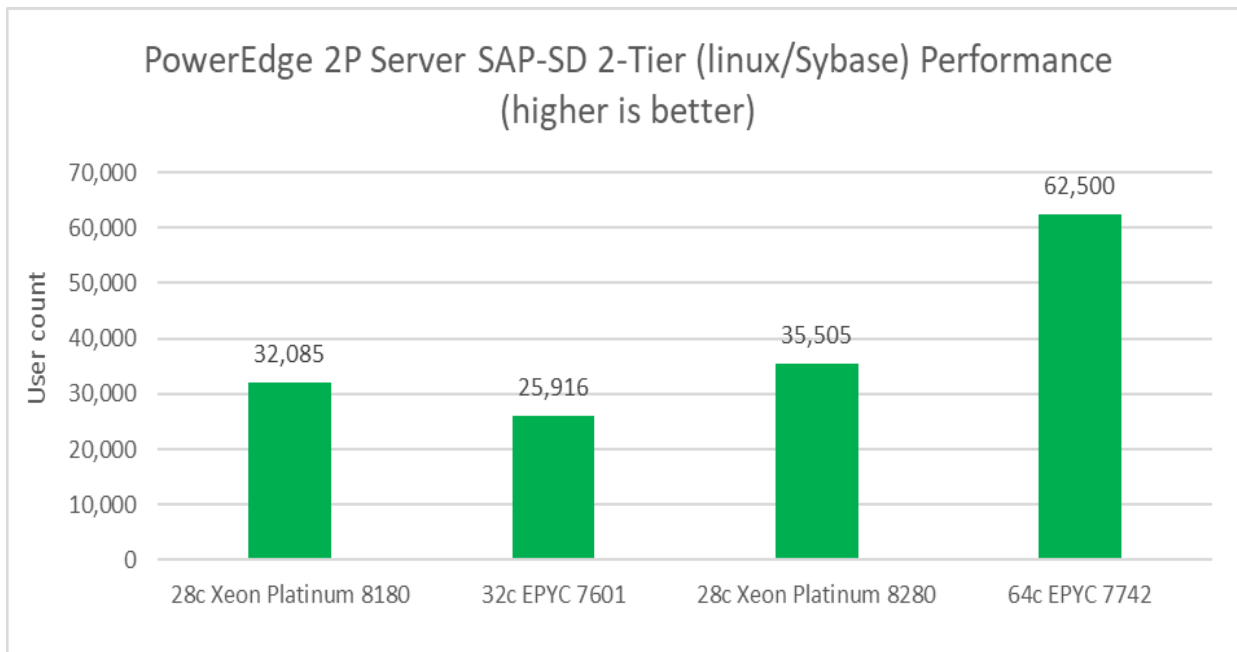
[7] Results of the Dell PowerEdge R6525 on the two-tier SAP SD standard application benchmark: 62,500 SAP SD benchmark users with the SAP enhancement package 5 for SAP ERP 6.0, SUSE Linux Enterprise Server 15, and Sybase ASE 16.0.03.03, 2 x AMD EPYC 7742 processors (128 cores, 256 threads), 1 TB main memory. Certification number 2019047
https://www.sap.com/dmc/exp/2018-benchmark-directory/#/sd?id=bf1ff01d-8c5c-43bd-82ea-6c79f0bf6d95

[8] Results of the Dell PowerEdge R740 on the two-tier SAP SD standard application benchmark: 35,505 SAP SD benchmark users with the SAP enhancement package 5 for SAP ERP 6.0, SUSE Linux Enterprise Server 15, and Sybase ASE 16.0.03.03, 2 x Intel Xeon Platinum 8280 processors (56 cores, 112 threads), 768 GB main memory. Certification number 2019026.
https://www.sap.com/dmc/exp/2018-benchmark-directory/#/sd?id=837fab42-0806-45c3-831b-430e054b354b

Summary

Dell's PowerEdge servers based upon the AMD EPYC 7002 CPU family provides double the compute throughput per socket of any previous model on all scientific analysis and business transaction workloads. Thanks to that CPU's state-of-the-art 7nm semiconductor process fabrication; this additional performance comes with >25% higher energy efficiency (work throughput per watt of input power consumption) making possible capacity growth, infrastructure reduction and lower total cost of ownership.

The EPYC 7002 processor family is available for purchase now on select PowerEdge servers.

Appendix A — Test configurations

Table 1 Benchmark configurations

Benchmark	Processor quantity	EPYC 7002 family processor	DIMM quantity	DIMM specifications
SPECint_rate_base2017	2	EPYC 7742	16	32 GB dual rank 3200 MT/s registered DIMMs
SPECfp_rate_base2017	2	EPYC 7742	16	32 GB dual rank 3200 MT/s registered DIMMs
High Performance LINPACK	2	EPYC 7742	16	32 GB dual rank 3200 MT/s registered DIMMs
STREAM	2	EPYC 7742	16	32 GB dual rank 3200 MT/s registered DIMMs
SPECjbb2015	2	EPYC 7742	32	32 GB dual rank 3200 MT/s registered DIMMs running at 2933 MT/s
SAP SD Two-Tier, Linux	2	EPYC 7742	32	32 GB dual rank 3200 MT/s registered DIMMs running at 2933 MT/s

Appendix B —PowerEdge Server Floating-Point Operations per Second

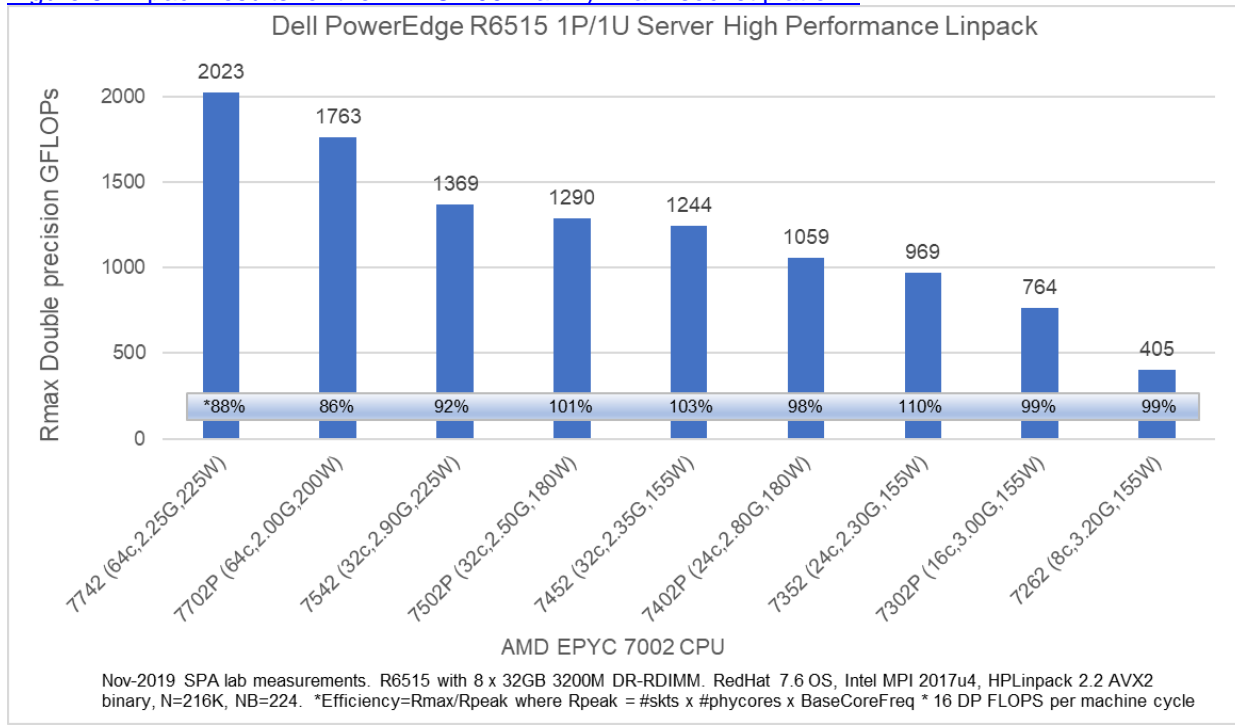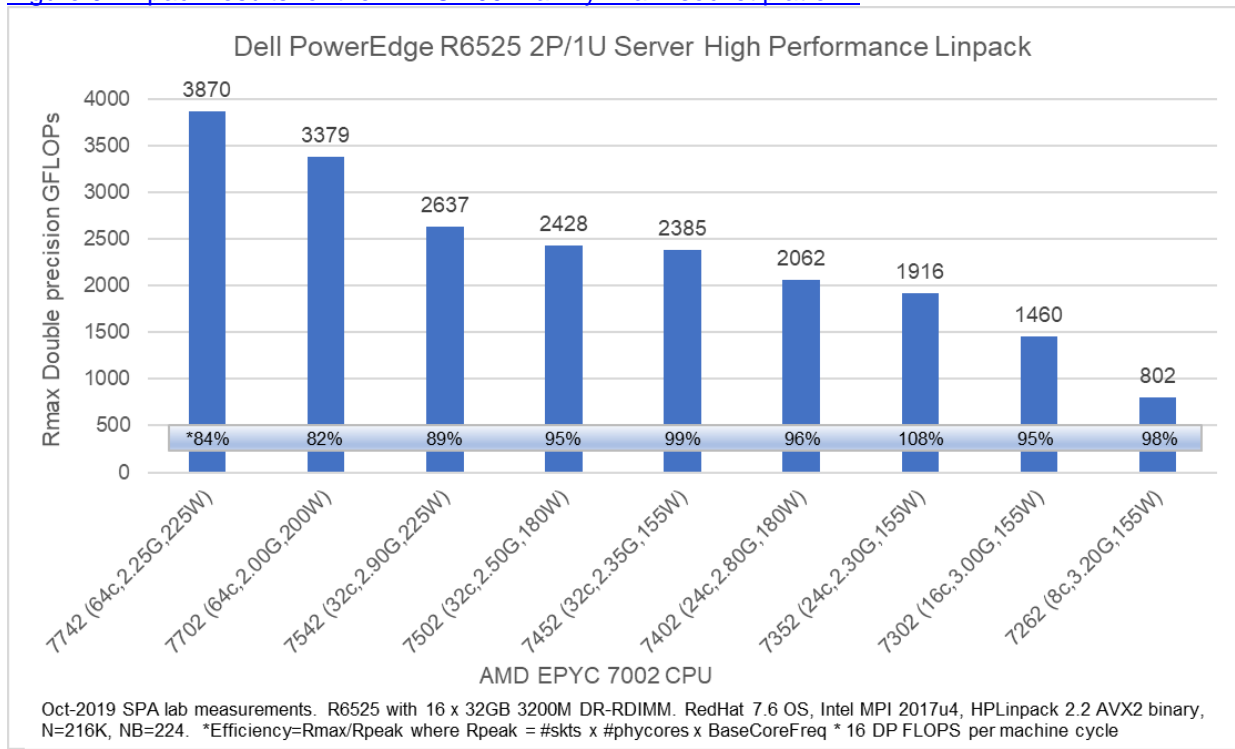Figure 8 Linpack results for the EPYC 7002 family in a 1-socket platform

Figure 9 Linpack results for the EPYC 7002 family in a 2-socket platform

Appendix C — PowerEdge Server Total Memory Bandwidth

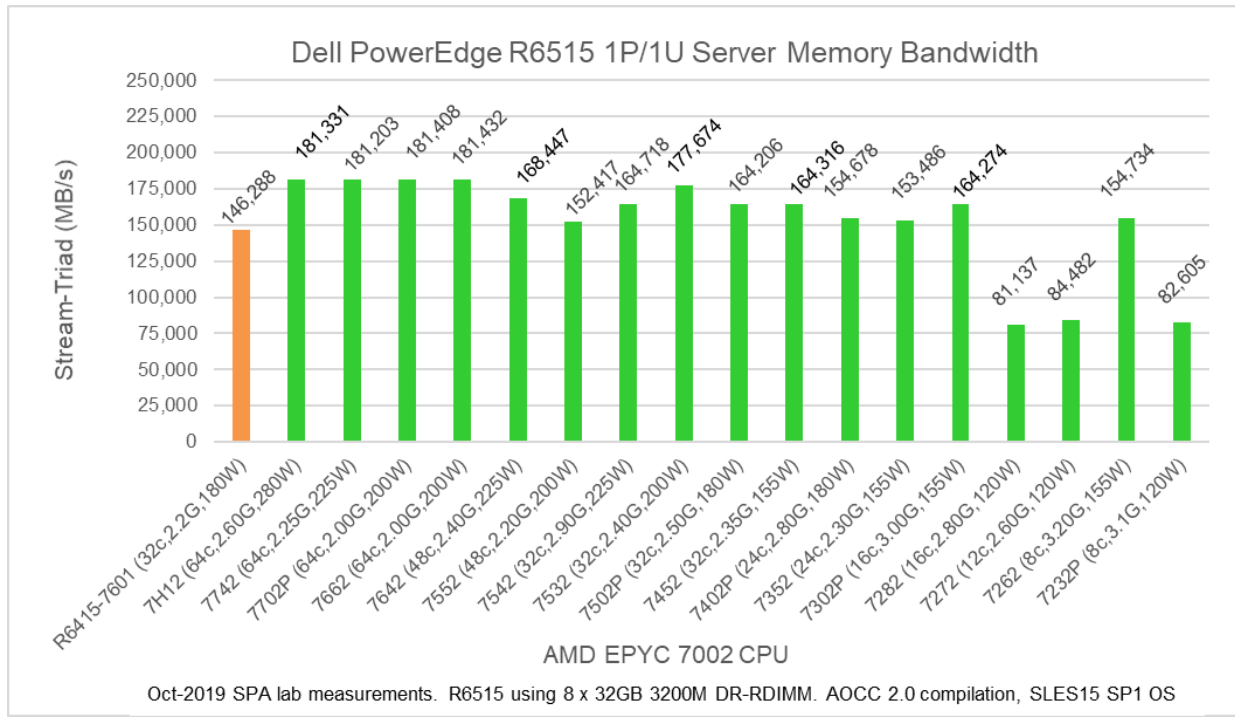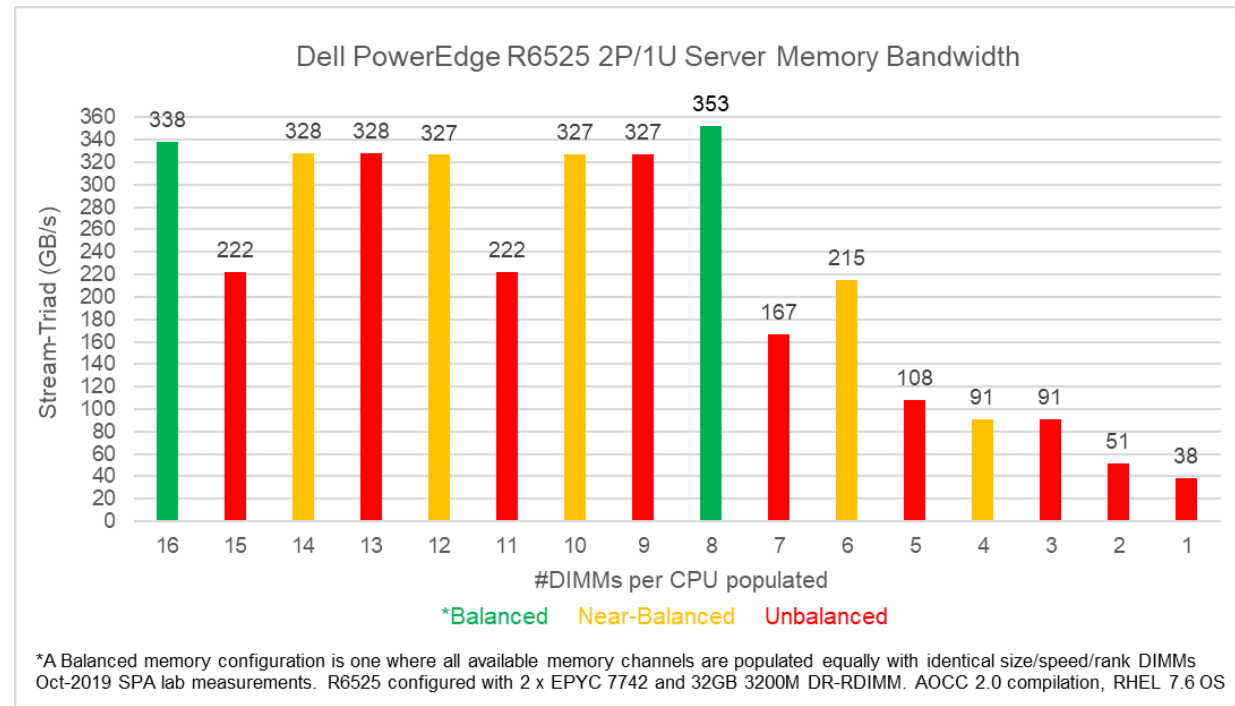Figure 10 Stream results for the EPYC 7002 family in a 1-socket platform

Dell PowerEdge R6515 1P/1U Server Memory Bandwidth

Oct-2019 SPA lab measurements. R6515 using 8 x 32GB 3200M DR-RDIMM. AOCC 2.0 compilation, SLES15 SP1 OS

Figure 11 Stream results across 2-socket platform DIMM populations

Dell PowerEdge R6525 2P/1U Server Memory Bandwidth

*Balanced Near-Balanced Unbalanced

*A Balanced memory configuration is one where all available memory channels are populated equally with identical size/speed/rank DIMMs
Oct-2019 SPA lab measurements. R6525 configured with 2 x EPYC 7742 and 32GB 3200M DR-RDIMM. AOCC 2.0 compilation, RHEL 7.6 OS

Appendix D- SPECcpu2017 RATE results across the EPYC 7002 CPU family[9]

Figure 12 Integer Workload Suite

Dell PowerEdge R6515 1P/1U Server SPECint_rate_base2017

Oct-2019 SPA lab measurements. R6515 with 8 x 32GB 3200M RDIMM. SPECcpu2017 v1.1.0. AMD C1 binaries. SLES15 SP1 OS
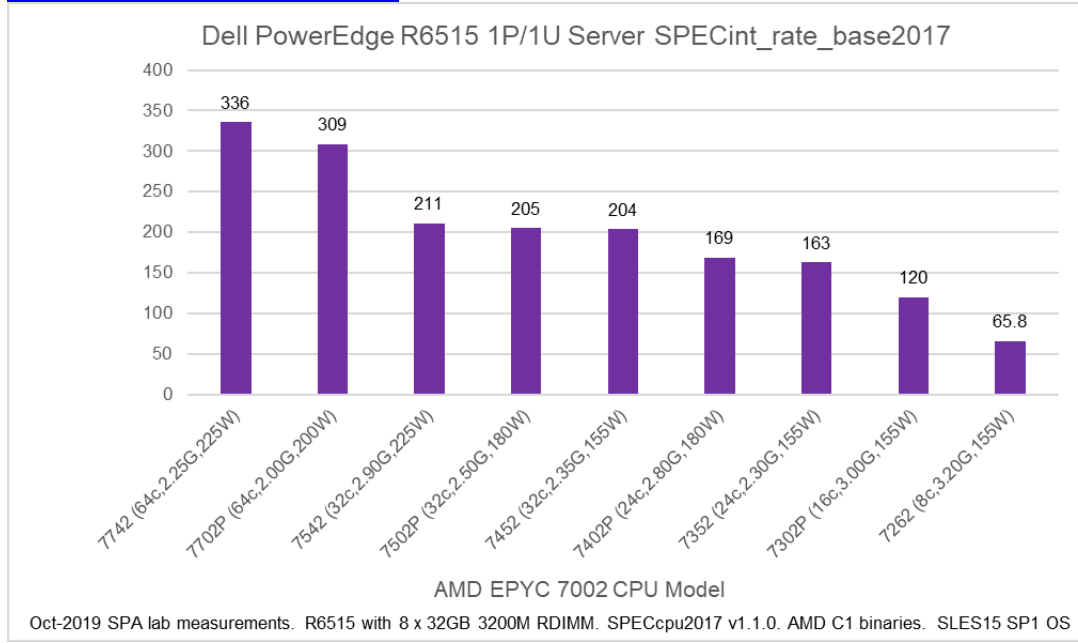
Figure 13 Floating-Point Workload Suite

R6515 SPECfp_rate_base2017

Oct-2019 SPA lab measurements. R6515 with 8 x 32GB 3200M RDIMM. SPECcpu2017 v1.1.0. AMD C1 binaries. SLES15 SP1 OS

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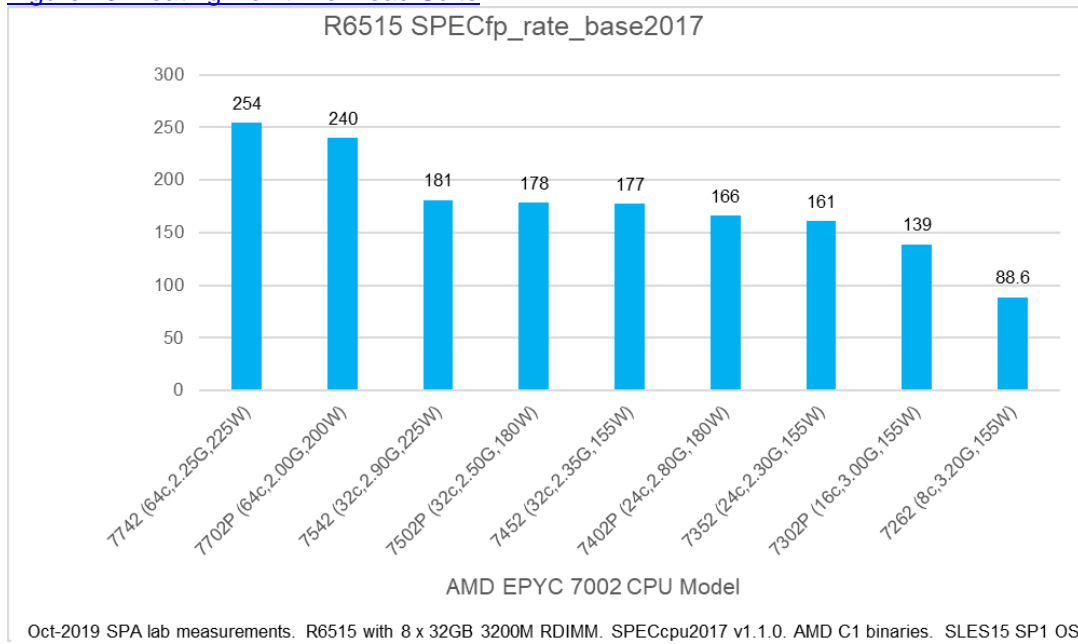
[9] SPEC and SPECcpu are registered trademarks of Standard Performance Evaluation Corporation. The performance described is based upon published results as of Dec 3, 2019.
https://spec.org/cgi-bin/osgresults?conf=cpu2017&op=fetch&field=SYSTEM&pattern=r6515