Performance of the Dell PowerEdge R930 server with the Intel Xeon processor E7-8800/4800 v4 product family

This white paper illustrates the performance improvements of the Dell™ PowerEdge™ R930 with the Intel® Xeon ® processor E7-8800/4800 v4 product family

Solutions Performance Analysis
Dell | Enterprise Solutions Group
Executive summary

Introduction

The Dell PowerEdge R930 server employs the new Intel Xeon processor E7 v4 product family, code-named “Broadwell-EX”. Featuring up to 24 cores, each of improved instruction execution throughput and built upon a more energy efficient 14-nanometer process, this family promises impressive performance gains over the previous generation Xeon E7-8800/4800 v3 family, code-named “Haswell-EX”.

In order to show customers what the R930 brings to the table, Dell’s Solutions Performance Analysis team ran a series of server industry-standard benchmarks on this new processor platform and then compared the results to those from the previous 13th generation PowerEdge R930 based upon the older Intel Xeon processor E7-8800/4800 v3 product family.

Key findings

- The PowerEdge R930 performance improved **39% on the SAP SD 2-Tier benchmark**, and **69% on the SAP BW-AML benchmark**. Both are **world record 4-socket results**.

- Multithreaded integer performance, as measured by the widely-recognized SPECint_rate benchmark, **improved** a solid **37%**.

- **Linpack (HPL) performance improved 59%**, thanks to the additional core count and higher performing microarchitecture of the E7 v4 CPU family.
Methodology

To highlight the performance improvement of the PowerEdge R930 with E7 v4 CPUs over that of the R930 with E7 v3 ones, each was benchmarked in their highest available CPU/memory configuration. See Appendix A for scoring tabulation and configuration details.
Integer performance

SPEC CPU2006 integer tests

The industry standard SPEC CPU2006 benchmark is described on SPEC.org as:

CPU2006 is SPEC’s next-generation, industry-standardized, CPU-intensive 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 using workloads developed from real user 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 R930’s new E7 v4 CPUs outperforming the preceding E7 v3 ones by 37%¹ according to the SPECint_rate benchmark.

Figure 1: Performance improvement running SPECint_rate_base2006

See the Appendix B for comparative SPECint_base2006 results across the full Broadwell-EX and Haswell-EX CPU stacks.

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 Mar 22, 2017.
The SPECint_base_2006 benchmark illustrates the R930 and E7 v4 family’s per-CPU core integer performance advantage. The benchmark runs a single copy of each constituent worklet. Figure 2 shows that each individual core in the E7 v4 CPU is capable of producing nearly 9% more work than those of the E7 v3 CPU.

Figure 2: Performance improvement running SPECint_base2006

SPECint_base2006 (higher is better)

---

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 Mar 22, 2017.
Floating point performance

SPEC CPU2006 floating point tests

Floating point performance is important to those running science, simulations and HPC workloads. SPEC CPU2006 contains a suite of floating point math tests which model those real-world applications. The R930 with E7 v4 CPUs shows a 23% performance improvement over the R930 with E7 v3 CPUs.

Figure 3: Performance improvement running SPECfp_rate_base2006

---

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 as of Mar 22, 2017.
SPECfp\_base2006 runs a single copy of each floating point math workload to highlight the E7 v4 processor family architecture improvements on a core for core level. In Figure 4 we see that each Broadwell-EX CPU core produces 6.8% more work than the Haswell-EX CPU core does today.

Figure 4: Performance improvement running SPECfp\_base2006

SPECfp\_base2006 (higher is better)

6.8%

125

117

PowerEdge R930 with E7-8800/4800 v4

PowerEdge R930 with E7-8800/4800 v3

SPEC and SPECcpu are registered trademarks of Standard Performance Evaluation Corporation. The performance described is based upon results posted at [http://www.spec.org](http://www.spec.org) as of June 6, 2016.
HPC performance tests

The Linpack benchmark is an industry standard for representing a system’s floating point processing power by solving simultaneous linear equations. R930 populated with the new E7-8894 v4 processors given their additional and higher throughput Broadwell architecture cores shows an impressive 59% performance improvement over the R930 with Haswell core E7 v3 processors as shown in Figure 5.

Figure 5: Performance improvement running Linpack

![Linpack Performance](chart.png)

Linpack Performance
(GigaFLOPS, higher is better)

3448

2161

0

500

1000

1500

2000

2500

3000

3500

59%

See the Appendix C for Linpack results across the full Broadwell E7-8800/4800 v4 CPU family
Business Functions

SPECjbb2015

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 R930 with a set of the new Xeon Broadwell family E7-8894 v4 processors provides 30% more Java operations per second than the R930 product introduced back in May 2015.5

---

5 SPEC and SPECjbb are registered trademarks of Standard Performance Evaluation Corporation.
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.

Figure 7 shows the R930/E7v4 combination can service 39% more users as compared to the R930/E7v3.

Figure 7: Performance improvement running SAP SD 2-Tier

The PowerEdge R930/E7v4 score of 43,300 benchmark users is a world record 4-socket result for this benchmark, breaking the previous record of 31,000 users set on the PowerEdge R930/E7v3.

6 Results of the Dell PowerEdge R930 on the two-tier SAP SD standard application benchmark: 43,300 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, 4 x Intel Xeon E7-8894 v4 processors (96 cores, 192 threads), 1 TB main memory. Certification number 2017001.

7 Results of the Dell PowerEdge R930 on the two-tier SAP SD standard application benchmark: 31,000 SAP SD benchmark users with the SAP enhancement package 5 for SAP ERP 6.0, Red Hat Enterprise Linux 7.1 and Sybase ASE 16, 4 x Intel Xeon E7-8890 v3 processors (72 cores, 144 threads), 1 TB main memory. Certification number 2015012.

8 For more details see http://www.sap.com/benchmark.
**SAP BW-AML**

The SAP BW Advanced Mixed Load Benchmark (BW-AML Benchmark) stresses ad-hoc, near real-time querying and reporting on large data warehouses. The key performance indicator of the benchmark is the number of ad-hoc navigation steps per hour for a given number of initial records. As Figure 8 shows, with 2,000,000,000 initial records, the R930 with a set of E7 v4 CPUs is able to perform 40,020 advanced query navigation steps per hour\(^9\), a world record 4-socket result for this benchmark and a 69% improvement over the previous 4-socket world record of 23,690 query steps per hour\(^10\) set on the R930 with E7 v3 CPUs.\(^11\)

**Figure 8: Performance improvement running SAP BW-AML**

\(\begin{align*}
40,020 & \quad 23,690 \\
\text{PowerEdge R930 with E7-8800/4800 v4} & \quad \text{PowerEdge R930 with E7-8800/4800 v3}
\end{align*}\)

---

9 Results of the Dell PowerEdge R930 on the SAP BW-AML standard application benchmark: 40,020 advanced query navigation steps per hour with SAP NetWeaver 7.50, SuSE Linux Enterprise Server 12, and SAP HANA 1.0, 4 x Intel Xeon E7-8890 v4 processors (96 cores, 192 threads), 1.5 TB main memory. Certification number 2016059.

10 Results of the Dell PowerEdge R930 on the SAP BW-AML standard application benchmark: 23,690 advanced query navigation steps per hour with SAP NetWeaver 7.50, SuSE Linux Enterprise Server 11, and SAP HANA 1.0, 4 x Intel Xeon E7-8890 v3 processors (72 cores, 144 threads), 1.5 TB main memory. Certification number 2016019.

Summary

The results of this white paper highlight the impressive increase in performance available with the PowerEdge R930 when equipped with the new Broadwell-EX CPU family.

Integer compute performance is up a solid 37% over the previous generation, and floating-point compute in Linpack is up by a substantial 59%. The system level SAP-SD 2-tier benchmark saw an impressive 39% improvement, once again a world record 4-socket result, and the SAP BW-AML benchmark result improved 69%, also a world record 4-socket result. With its capacity for 96 processor cores and 6+ TB of memory, the refreshed PowerEdge R930’s computation throughput and scalability potential make it a compelling choice for real-time, mission-critical workloads and legacy server upgrades and consolidation.

The R930 with the E7 v4 CPU family lineup is available for purchase now.
## Appendix A — Test result summary

### Table 1 Benchmark scoring summary

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>R930 E7 v4 CPU model</th>
<th>BDW-EX score</th>
<th>R930 E7 v3 CPU model</th>
<th>HSW-EX score</th>
<th>R930 MLK advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPECint_rate_base2006</td>
<td>E7-8894 v4</td>
<td>3760</td>
<td>E7-8890 v3</td>
<td>2740</td>
<td>37%</td>
</tr>
<tr>
<td>SPECint_base2006</td>
<td>E7-8891 v4</td>
<td>69.5</td>
<td>E7-8891 v3</td>
<td>63.8</td>
<td>9%</td>
</tr>
<tr>
<td>SPECfp_rate_base2006</td>
<td>E7-8894 v4</td>
<td>2440</td>
<td>E7-8890 v3</td>
<td>1980</td>
<td>23%</td>
</tr>
<tr>
<td>SPECfp_base2006</td>
<td>E7-8891 v4</td>
<td>125</td>
<td>E7-8891 v3</td>
<td>117</td>
<td>7%</td>
</tr>
<tr>
<td>SPECjbb2015</td>
<td>E7-8894 v4</td>
<td>213,001</td>
<td>E7-8890 v3</td>
<td>163,751</td>
<td>30%</td>
</tr>
<tr>
<td>Linpack (GFlops)</td>
<td>E7-8894 v4</td>
<td>3448</td>
<td>E7-8890 v3</td>
<td>2170</td>
<td>59%</td>
</tr>
<tr>
<td>SAP SD 2-Tier (#SD users)</td>
<td>E7-8894 v4</td>
<td>43,300</td>
<td>E7-8890 v3</td>
<td>31,000</td>
<td>39%</td>
</tr>
<tr>
<td>SAP BW-AML 2B records (query steps per hour)</td>
<td>E7-8890 v4</td>
<td>40,020</td>
<td>E7-8890 v3</td>
<td>23,690</td>
<td>69%</td>
</tr>
</tbody>
</table>
Appendix B — 13G PowerEdge Integer Operation Throughput Rate

Figure 9 SPECcpu2006 integer rate results for the E7-8800/4800 v4 family

![Graph showing SPECcpu2006 integer rate results for E7-8800/4800 v4 family](image)
Appendix C — 13G PowerEdge Floating Point Operations per Second

Figure 10 Linpack results for the E7-8800/4800 v4 family

Intel Xeon Processor E7-8800/4800 v4 Product Family Max FLOPS

Dec 2018 SPA lab measurements using R930 with 32x16GB DR-RDIMM. BIOS 1.0.1 with settings: Home Snoop, nHT, HWPstates, AutoCstates, SLES 12 SP1 OS, MKL 2017.0.04 MP-linpack, MPI E1, N=170K, NB=192, P=2, Q=2,
*Efficiency=Rmax/Rpeak where Rpeak = #sockets x #physical cores x (machine cycle frequency) x (16 FLOPs/cycle)
Appendix D— Intel Xeon E7-8800/4800 v4 Server CPU Product Family

Figure 11 R930 Broadwell-EX SKU line-up

<table>
<thead>
<tr>
<th>Description</th>
<th>Dell PN</th>
<th>Stepping/QDF</th>
<th>TDP base frequency (MHz)</th>
<th>AVX base frequency (MHz)</th>
<th># Cores</th>
<th>TDP Wattage (W)</th>
<th>HT (2=Yes, 1=No)</th>
<th>L3 Cache (MB)</th>
<th>Max Memory Freq (MHz)</th>
<th>QPI (GT/sec)</th>
<th>All Cores non-AVX Turbo Freq (MHz)</th>
<th>All Cores AVX Turbo Freq (MHz)</th>
<th>Max non-AVX Turbo Freq (MHz)</th>
<th>Max AVX Turbo Freq (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E7-8894 v4</td>
<td>D7G0J</td>
<td>B-D/QM03</td>
<td>2400</td>
<td>1900</td>
<td>24</td>
<td>165</td>
<td>2</td>
<td>60</td>
<td>1600, 1866L</td>
<td>9.6</td>
<td>2900</td>
<td>2700</td>
<td>3400</td>
<td>3400</td>
</tr>
<tr>
<td>E7-8891 v4</td>
<td>Z9R0D</td>
<td>B-D/QK1T1</td>
<td>2800</td>
<td>2400</td>
<td>10</td>
<td>165</td>
<td>2</td>
<td>25</td>
<td>1600, 1866L</td>
<td>9.6</td>
<td>3300</td>
<td>3200</td>
<td>3500</td>
<td>3500</td>
</tr>
<tr>
<td>E7-8893 v4</td>
<td>Y91CN</td>
<td>B-D/QK3F2</td>
<td>3200</td>
<td>2600</td>
<td>4</td>
<td>140</td>
<td>2</td>
<td>10</td>
<td>1600, 1866L</td>
<td>9.6</td>
<td>3400</td>
<td>3200</td>
<td>3500</td>
<td>3500</td>
</tr>
<tr>
<td>E7-8890 v4</td>
<td>V9CR3</td>
<td>B-D/QK3T3</td>
<td>2200</td>
<td>1800</td>
<td>24</td>
<td>165</td>
<td>2</td>
<td>60</td>
<td>1600, 1866L</td>
<td>9.6</td>
<td>2600</td>
<td>2600</td>
<td>3400</td>
<td>3400</td>
</tr>
<tr>
<td>E7-8881 v4</td>
<td>6MW6B</td>
<td>B-D/QK5M</td>
<td>2200</td>
<td>1800</td>
<td>23</td>
<td>150</td>
<td>2</td>
<td>55</td>
<td>1600, 1866L</td>
<td>9.6</td>
<td>2600</td>
<td>2600</td>
<td>3300</td>
<td>3300</td>
</tr>
<tr>
<td>E7-8870 v4</td>
<td>R941F</td>
<td>B-D/QK5F</td>
<td>2100</td>
<td>1700</td>
<td>20</td>
<td>140</td>
<td>2</td>
<td>50</td>
<td>1600, 1866L</td>
<td>9.6</td>
<td>2600</td>
<td>2600</td>
<td>3000</td>
<td>3000</td>
</tr>
<tr>
<td>E7-8867 v4</td>
<td>C9R6D</td>
<td>B-D/QK5L</td>
<td>2400</td>
<td>2100</td>
<td>18</td>
<td>165</td>
<td>2</td>
<td>45</td>
<td>1600, 1866L</td>
<td>9.6</td>
<td>2800</td>
<td>2800</td>
<td>3300</td>
<td>3300</td>
</tr>
<tr>
<td>E7-8860 v4</td>
<td>8GW6W</td>
<td>B-D/QK5N</td>
<td>2200</td>
<td>1900</td>
<td>18</td>
<td>140</td>
<td>2</td>
<td>45</td>
<td>1600, 1866L</td>
<td>9.6</td>
<td>2700</td>
<td>2700</td>
<td>3200</td>
<td>3200</td>
</tr>
<tr>
<td>E7-8855 v4</td>
<td>XWWVT</td>
<td>B-D/QK5P</td>
<td>2100</td>
<td>1700</td>
<td>14</td>
<td>140</td>
<td>2</td>
<td>35</td>
<td>1333, 1866L</td>
<td>8.0</td>
<td>2400</td>
<td>2400</td>
<td>2800</td>
<td>2800</td>
</tr>
<tr>
<td>E7-4850 v4</td>
<td>9K39X</td>
<td>B-D/QK5G</td>
<td>2100</td>
<td>1700</td>
<td>16</td>
<td>115</td>
<td>2</td>
<td>40</td>
<td>1333, 1866L</td>
<td>8.0</td>
<td>2400</td>
<td>2400</td>
<td>2800</td>
<td>2800</td>
</tr>
<tr>
<td>E7-4830 v4</td>
<td>F0XCHD</td>
<td>B-D/QK5H</td>
<td>2000</td>
<td>1600</td>
<td>14</td>
<td>115</td>
<td>2</td>
<td>35</td>
<td>1333, 1866L</td>
<td>8.0</td>
<td>2200</td>
<td>2200</td>
<td>2800</td>
<td>2800</td>
</tr>
<tr>
<td>E7-4820 v4</td>
<td>GPT6V</td>
<td>B-D/QK3J</td>
<td>2000</td>
<td>1600</td>
<td>10</td>
<td>115</td>
<td>2</td>
<td>25</td>
<td>1333, 1866L</td>
<td>6.4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>E7-4809 v4</td>
<td>R77KF</td>
<td>B-D/QK5K</td>
<td>2100</td>
<td>1800</td>
<td>8</td>
<td>115</td>
<td>2</td>
<td>20</td>
<td>1333, 1866L</td>
<td>6.4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>