Performance Brief
Intel® Xeon® processor
E5-2600 v3 Product Family
Java* SE Development Kit (JDK) 8

Data Center Foundations for Accelerated Java*

Co-engineering by Oracle and Intel drives up server-side Java* performance, with the highly optimized combination of JDK 8 and the Intel® Xeon® processor E5-2600 v3 product family.

The introduction of Java* SE Development Kit (JDK) 8 in March 2014 is regarded as the most significant set of changes to the Java platform since the initial Java 1.0 release in 1995.[1] Through co-engineering and joint innovation by Oracle and Intel, JDK 8 is highly tuned for performance on Intel® Xeon® processors.

As the heart of the agile, efficient data center, the Intel® Xeon® processor E5-2600 v3 product family is the ideal engine to power Java server applications, at any scale. Premiering a new architecture on industry-leading 22nm process technology, the Intel Xeon processor E5-2600 v3 product family dramatically accelerates Java workloads while also delivering energy-efficiency improvements.

Together, these hardware and software building blocks support growing data stores, complex computations, and large user bases, while decreasing server count and energy demands, helping produce both CAPEX and OPEX benefits.

An Engine for Java* Innovation: The Intel® Xeon® Processor E5-2600 v3 Product Family

The Intel Xeon processor E5-2600 v3 product family is designed to meet the compute, storage, and network needs of data centers, from corporate environments to cloud service providers and telecommunications carriers. Improvements across the execution, memory, and I/O subsystems directly benefit Java workloads, as shown in Table 1.

TABLE 1. GENERATION-OVER-GENERATION PROCESSOR IMPROVEMENTS.

	INTEL® XEON® PROCESSOR E5-2600 V2 PRODUCT FAMILY	INTEL® XEON® PROCESSOR E5-2600 V3 PRODUCT FAMILY
Execution Resources (max)	• 12 cores (24 threads) • 30 MB last-level cache • Intel® AVX[2]	• 18 cores (36 threads) • 45 MB last-level cache • Intel® AVX and Intel® AVX2[2]
Memory Support per Socket (max)	• 384 GB • DDR3-1866	• 768 GB • DDR4-2133
I/O Resources	• 8.0 GT/s (CPU-to-CPU) • 10GbE (network)	• 9.6 GT/s (CPU-to-CPU) • 40GbE (network)

Beyond metrics such as core count and memory capacity, several advances in the Intel Xeon processor E5-2600 v3 product family are particularly noteworthy, in terms of increasing performance and reducing operating cost.

- **Intel® Advanced Vector Extensions 2** (Intel® AVX2)[2,3] accelerates and improves accuracy for many types of calculations, increasing performance for a broad range of tasks, including encryption and compression.
- **DDR4 memory** offers up to 44% higher memory bandwidth, with significantly lower power consumption than DDR3.[3,4]
- **Per-core P-states** enable each processor core to run at an individual frequency and voltage (independent of other cores), greatly increasing power efficiency by optimizing workload processing.[3,5]

Building on a History of Co-Engineering

Oracle and Intel are well into the second decade of their continuous, deep collaboration. This commitment focuses on maximizing the performance, agility, and efficiency of solutions based on combinations of the two companies' products. The scope of co-engineering between Oracle and Intel ranges from enablement for low-level hardware features, all the way up to system-level optimization of large-scale engineered systems, such as the Oracle Exadata* Database Machine.

Innovations for Java demonstrate the value to end customers of ongoing joint enablement by Oracle and Intel. Oracle is the main corporate driver behind Java, and Intel has been a key contributor to the Java open-source community since its inception. Both companies offer extraordinary leadership in both hardware and software, and together, they put cutting-edge capabilities within reach of the entire Java ecosystem.

- **Advances in Java software**. Each new generation of Java offers performance improvements in areas such as data handling and memory management. Because these developments are integrated into the Java managed runtime, they are automatically available to Java applications.
- **Advances in Intel® platforms**. Intel's **tick-tock cadence**[6] of innovation introduces new features and capabilities in each generation of Intel® processors. The increasing native performance and new hardware features provide a regular succession of opportunities for improved software performance.
- **Optimizations through co-engineering**. Established relationships between Oracle and Intel—and personal ones among engineers at the two companies—create a spirit of continuous invention, where long-term work over many years produces an ongoing succession of breakthroughs.

Refresh Opportunities for Java in the Data Center

Typical refresh of a server after four years offers hardware advances that are far greater than the single-generation improvements shown in Table 1. The Intel Xeon processor E5-2600 v3 product family offers significant performance improvements for Java applications compared to its predecessors from a few years ago.[3]

Likewise, JDK 8 introduces significant advances relative to JDK 7 that help increase application performance. These capabilities range in scope from improved memory handling and garbage collection to more efficient utilization of multi-core hardware.

While upgrading Java stack hardware or software each offers benefits on its own, refreshing both together provides even more dramatic performance gains, as illustrated in Figure 1.[3,7]

- **Upgrading the hardware alone can deliver up to a 3.5x performance improvement.**[3,7] Refreshing a typical four-year-old platform offers dramatic enhancements to processing and memory resources, including a 3x increase in core count as well as reduced network and storage bottlenecks with up to 2x more read/write bandwidth from integrated PCI Express* 3.0.[3,8]
- **Upgrading both hardware and software can deliver up to an 8.7x performance improvement.**[3,7] Refreshing the JDK helps enable Java applications to take full advantage of the latest Intel Xeon processors, with hardware optimizations in areas such as data handling, memory management, and multi-core utilization.

JDK 8 Optimizations for the Intel® Xeon® Processor E5-2600 v3 Product Family

Co-engineering by Oracle and Intel has baked performance optimizations into the solution stack that benefit Java applications without additional effort by organizations that deploy JDK 8 on servers based on the Intel Xeon processor E5-2600 v3 product family. The two companies began working together in the early development stages of both products to take full advantage of the performance gains from software and hardware advances. That tuning helps drive up the value of architectural synergies, some of which are shown in Table 2.

TABLE 2. ENABLEMENT FOR ORACLE JAVA* SE DEVELOPMENT KIT 8 ON THE INTEL® XEON® PROCESSOR E5-2600 V3 PRODUCT FAMILY.

HARDWARE FEATURES	SOFTWARE OPTIMIZATIONS
Increased number of processor cores	Optimized concurrent libraries and functional parallel programming features (Lambdas and Streams)
Intel® Advanced Vector Extensions 2 (Intel® AVX2)[2]	SIMD and three-operand code generation, for simplified code and optimized array and string methods
Bit Manipulation New Instructions (BMI)	Support for efficiently moving bits or other small data structures
CRC32 Checksum Acceleration	Use of carry-less multiply for checksum computation

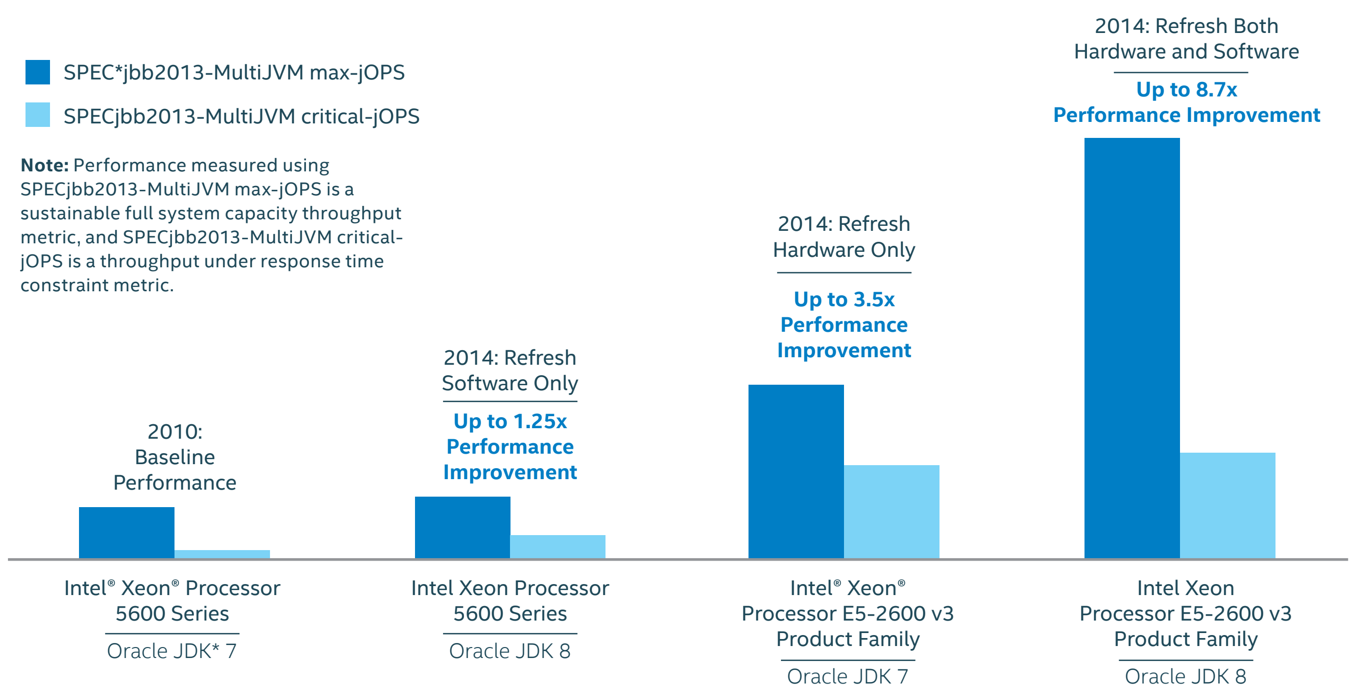

Figure 1. Better together: performance benefits of refreshing both hardware and software.[3,7]

Conclusion

Refreshing hardware and software together offers significant advantages for server-side Java applications. Co-engineering by Oracle and Intel throughout the stack can dramatically accelerate Java solutions as organizations strive to offer more sophisticated capabilities, based on more extensive data sets, for larger groups of users. Upgrading to Oracle JDK 8 on the Intel Xeon processor E5-2600 v3 product family plays a key role in driving up Java performance[3] and cost-effectiveness, helping data centers achieve competitive advantages.

To learn more, visit:

www.java.com

www.intel.com/xeon

[1] "Oracle Java 8 launch represents a major evolution of the platform" (2014). www.oracle.com/us/corporate/analystreports/enterprise-application/ovum-java8-launch-2181014.pdf

[2] Intel® Advanced Vector Extensions (Intel® AVX)* are designed to achieve higher throughput to certain integer and floating point operations. Due to varying processor power characteristics, utilizing AVX instructions may cause a) some parts to operate at less than the rated frequency and b) some parts with Intel® Turbo Boost Technology 2.0 to not achieve any or maximum turbo frequencies. Performance varies depending on hardware, software, and system configuration and you should consult your system manufacturer for more information. *Intel® Advanced Vector Extensions refers to Intel® AVX, Intel® AVX2 or Intel® AVX-512. For more information on Intel® Turbo Boost Technology 2.0, visit http://www.intel.com/go/turbo.

[3] Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to www.intel.com/performance. Intel does not control or audit the design or implementation of third party benchmark data or Web sites referenced in this document. Intel encourages all of its customers to visit the referenced Web sites or others where similar performance benchmark data are reported and confirm whether the referenced benchmark data are accurate and reflect performance of systems available for purchase.

[4] Higher memory bandwidth: Source as of August 2014 TR#3044 on STREAM (triad): Intel® Server Board S2600CP with two Intel® Xeon® Processor E5-2697 v2, 24x16GB DDR3-1866 @1066MHz DR-RDIMM, score: 58.9 GB/sec. New Configuration: Intel® Server System R2208WTTYS with two Intel® Xeon® Processor E5-2699 v3, 24x16GB DDR4-2133 @ 1600MHz DR-RDIMM, score: 85.2 GB/sec.

Reduced power consumption: Results have been estimated based on internal Intel analysis and are provided for informational purposes. Any difference in system hardware or software design or configuration may affect actual performance. Source as of July 2014: Intel internal estimates on DIMM level power savings of 3 DIMM per channel 4GB DRx4 DDR3L RDIMM vs. 4GB DRx4 DDR4 RDIMM configurations

[5] Source as of June 2014: Intel internal measurements on Mayan City CRB with one Intel® Xeon® processor E5-26xx v3 (14 cores, 2.3 GHz, 145 W), 8x4GB DDR4-1600, Red Hat Enterprise Linux* kernel 3.10.18, PCPS on 110 W, PCPS off 70 W on an internal web workload.

[6] Intel Tick Tock Model. www.intel.com/content/www/us/en/silicon-innovations/intel-tick-tock-model-general.html.

[7] SPECjbb*2013 Multi-JVM workload results as of 8 September 2014.

Baseline configuration and score: Supermicro X8DTN+ with two Intel® Xeon® processors X5690 @ 3.46 GHz (six physical cores per socket), 48 GB RAM, Red Hat Enterprise Linux* 6.3, Oracle Java* SE Development Kit 7u11, 12 GB heap. Source: www.spec.org/jbb2013/results/res2013q1/jbb2013-20130205-00003.html. Score: 21,709 SPECjbb2013-MultiJVM max-jOPS and 3,587 SPECjbb2013-MultiJVM critical-jOPS.

Software-upgraded configuration and score: Supermicro 2026T URF with two Intel® Xeon® processors X5690 @ 3.46 GHz (six physical cores per socket), 48 GB RAM, Red Hat Enterprise Linux* 6.5, Oracle Java* SE Development Kit 8u5, 12 GB heap. Source: www.spec.org. Score: 27,199 SPECjbb2013-MultiJVM max-jOPS and 9,732 SPECjbb2013-MultiJVM critical-jOPS.

Hardware-upgraded configuration and score: Intel® Server Board S2600WTT with two Intel® Xeon® processors E5-2699 v3 @ 2.3 GHz (18 physical cores per socket), 512 GB RAM, Red Hat Enterprise Linux* 6.5, Oracle Java* SE Development Kit 7u11, 240 GB heap. Source: www.spec.org. Score: 77,303 SPECjbb2013-MultiJVM max-jOPS and 41,226 SPECjbb2013-MultiJVM critical-jOPS.

Hardware- and software-upgraded configuration and score: HP ProLiant ML350 Gen9 platform with two Intel Xeon Processor E5-2699 v3 @ 2.3GHz (18 physical cores per socket), 512GB RAM, SUSE, Oracle Java SE Development Kit 8u11, 236GB heap. Score: 190,674 SPECjbb2013-MultiJVM max-jOPs, 47,139 SPECjbb2013-MultiJVM critical-jOPs. Source: http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA5-4748ENW&cc=us&lc=en

[8] Intel estimates of maximum achievable I/O R/W bandwidth (512B transactions, 50% reads, 50% writes) comparing platform based on Intel® Xeon® processor E5-2680 with 64 lanes of PCIe* 3.0 (66 GB/s) versus platform based on Intel® Xeon® processor X5670 with 32 lanes of PCIe* 2.0 (18 GB/s). Baseline configuration: Platform with two Intel Xeon processor X5670 (2.93 GHz, 6C), 24 GB memory @ 1333, 4 x8 Intel internal PCIe* 2.0 test cards. New configuration: Platform with two Intel Xeon processor E5-2680 (2.7 GHz, 8 cores), 64 GB memory @1600 MHz, 2 x16 Intel internal PCIe 3.0 test cards on each node (all traffic sent to local nodes).

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