PRODUCT BRIEF

The Engine for Digital Transformation in the Data Center

Intel® Xeon® Processor E5-2600 v4 Product Family

From individual servers and workstations to clusters, data centers, and clouds, IT organizations face increasing pressure to improve performance, security, agility, and utilization throughout their compute, storage, and network infrastructure—while minimizing their total cost of ownership. The Intel® Xeon® processor E5-2600 v4 product family addresses all these needs. These processors take performance and efficiency to new heights[1] across the widest range of workloads, while providing an array of new technologies for more efficient virtualization, smarter resource orchestration, and enhanced protection of systems and data. The Intel Xeon processor E5-2600 v4 product family can help businesses, cloud service providers and telecommunications companies get higher performance and value from every new server, while accelerating their move toward the next-generation efficiencies of software-defined infrastructure (SDI).

Up to 47% faster, 27% Average Generational Performance Gain Across Key Industry-Standard Workloads and Applications[2]

Designed specifically for two-socket servers, the Intel Xeon processor E5-2600 v4 product family provides over 20 percent more cores and cache[3] than the previous generation, supports faster memory, and includes integrated technologies for accelerating critical workloads, such as database transactions and vector operations. These processors include Intel® QuickPath Interconnect (QPI) Technology for fast, resilient system communications with up to 9.6 GT/s of QPI speed per channel. They also include key improvements in virtualization efficiency that can help to boost application performance and consolidation ratios throughout today's virtualized data centers and clouds.

- **More execution resources for higher overall performance.** With up to 22 cores per socket, up to 55 MB of last-level cache (LLC), and support for up to 12 percent faster DDR4 memory[4] versus previous-generation memory, the Intel Xeon processor E5-2600 v4 product family increases performance across a broad range of workloads[2], from business and technical computing applications to communications and storage solutions. These processors come in a wide variety of configurations, so core counts, frequencies, and power levels can be tailored for individual workloads to deliver optimal performance.

- **Higher performance for multi-threaded workloads.** Intel® Transactional Synchronization Extensions (Intel® TSX) exposes hidden parallelism to help boost performance for online transaction processing (OLTP) and other multi-threaded workloads that are currently slowed by memory locking.
- **Higher performance for mixed workloads.** Intel® Advanced Vector Extensions 2.0 doubles the number of floating point operations (flops) per clock cycle versus first generation Intel® AVX. New optimizations in the Intel Xeon processor E5-2600 v4 product family enable higher core frequencies for concurrent applications that don't use Intel AVX2, which helps to optimize overall performance for mixed workloads.
- **Faster access to critical data.** Enhanced Intel® Data Directed I/O allows direct data transfers to last level cache (LLC) with optimized LLC-to-core communications. Main memory is bypassed completely to provide high-speed, low-latency data access that is ideal for today's increasingly data-hungry applications.
- **Enhanced virtualization.** Intel® Virtual Machine Control Structure (VMCS) shadowing extends root virtual machine monitor (VMM)-like privileges to a guest VMM to provide more flexible support for legacy code and deep security monitoring. Additional virtualization enhancements in the Intel Xeon processor E5-2600 v4 product family enable fewer and faster transitions to the VMM through Posted Interrupts and other innovations, so more compute cycles can be devoted to virtual machine performance. Support for Page Modification Logging has also been added to enable high-end availability for virtual machines while reducing performance overhead.

Smarter Orchestration Through Built-In Instrumentation

With the growth of private and hybrid clouds in the enterprise, IT organizations are deploying powerful new tools for orchestrating and automating data center resource management. The Intel Xeon processor E5-2600 v4 product family includes Intel® Resource Director Technology, which provides deeper visibility and control over shared platform resources to enable smarter orchestration. This suite of technologies, which will continue to evolve in the future, can help IT organizations improve service levels and infrastructure utilization and accelerate their move toward fully-automated SDI.

- **Cache Monitoring and Allocation Technologies (CMT & CAT).** The ability to monitor and allocate LLC usage for individual applications and virtual machines can help IT provide more reliable performance guarantees for high priority applications and make better decisions regarding workload placement, load balancing, and consolidation ratios. The data can also be used to deliver tiered services with metered charge back.
- **Memory Bandwidth Monitoring (MBM).** With granular visibility into memory bandwidth usage, IT can balance workloads across sockets to avoid contention, improve utilization, and deliver higher service levels.
- **Code and Data Prioritization (CDP).** Code and data placement in the LLC can now be programmatically controlled to help optimize performance and code isolation for applications that have large code footprints or high sensitivity to code residency in the last-level cache.
- **End-to-end power management.** Intel® Node Manager 3.0 offers real-time telemetry data on server power, thermal, and utilization levels, so IT can implement policies for enhanced orchestration, improved data center efficiency, and more efficient power utilization.

A Better Foundation for Trust and Security

The volume and sophistication of digital threats continue to escalate. The Intel Xeon Processor E5-2600 v4 product family adds additional layers of hardware-assisted security to help protect data and platforms more effectively through enhanced workload isolation, improved security policy enforcement, and faster cryptography.

- **Up to 70 percent increased per-core performance on key encryption algorithms.**[5] New instructions (such as ADCX/ADOX and PCLMULQDQ micro-architecture) in the Intel Xeon processor E5-2600 v4 product family help to accelerate secure session initiation protocols based on RSA, ECC, and Secure Hash Algorithm (SHA). Intel® Data Protection Technology with Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI) has also been improved to enable even faster bulk data encryption. With these technologies, protecting data at rest and during transmission is practically transparent for many workloads.
- **Enhanced Key Security.** The Intel Xeon processor E5-2600 v4 family provides an integrated random number generator for creating security keys and a random bit generator for seeding software-based solutions. Both technologies help to provide high quality keys for enhanced security.
- **Strong protection against platform attacks.** Intel® Platform Protection Technology with OS Guard (Supervisor Mode Execution Protection) has been enhanced with new Supervisor Mode Access Prevention (SMAP). These technologies work together to prevent privileged code in the operating system from executing or even accessing data

from unauthorized user pages. New #VE (Virtualization Exception) provides hardware assists to reduce overhead for deep memory monitoring (below the OS), which can help organizations protect against new classes of stealthy malware and zero day attacks. Intel® Platform Protection Technology with BIOS Guard adds to these safeguards by protecting BIOS during FLASH updates via protected agent authentication.

- **Measured boot for trusted infrastructure.** Intel® Platform Protection Technology with Intel® Trusted Execution Technology (Intel® TXT) helps to protect platform firmware and the OS kernel from pre-boot attacks. It also supports Trusted Platform Module 2.0 (TPM 2.0), with its stronger cryptographic capabilities.

Intel® Xeon® Processor E5 v4 Product Family Overview

High Performance for the Broadest Range of Applications and Environments

Advanced multi-core, multi-threaded processing

- Up to 22 cores and 44 threads per socket

Larger cache and faster memory

- Up to 55 MB of last-level cache (LLC) for fast access to frequently used data
- Up to 24 DIMMs per two-socket server to support multiple data-hungry VMs
- Faster maximum memory speeds than the previous generation (DDR4 2400 MHz versus 2133 MHz)

Higher performance for diverse workloads

- Intel® Turbo Boost Technology takes advantage of power and thermal headroom to increase processor frequencies across a wide range of workloads

Higher performance for technical computing and multi-threaded applications

- Intel® TSX instructions take advantage of hidden parallelism to accelerate OLTP and other multi-threaded workloads
- Intel® AVX2 instructions accelerate floating point and integer computations with support for 256-bit vectors. This technology can increase peak floating point operations by up to 31%[6], and is now optimized for mixed workload environments

Industry-leading I/O performance

- Intel Integrated I/O provides up to 80 PCIe* lanes per two-socket server, and supports the PCIe 3.0 specification with atomic operations support for improved peer-to-peer (P2P) bandwidth
- The Non-Volatile Memory Express* (NVMe*) specification, supported by the Intel® Solid-State Drive Data Center Family for PCIe, overcomes SAS and SATA SSD performance limitations through an optimized register interface, command set, and feature set for PCI Express (PCIe*)-based Solid-State Drives (SSDs). For more information, visit NVMExpress[7]

Smarter resource orchestration

Intel® Resource Director Technology with:

- Cache Monitoring and Allocation Technologies enables IT to make smarter scheduling and load balancing decisions, implement a new class of tiered services, and provide guaranteed cache for high priority applications
- Memory Bandwidth Monitoring helps IT balance workloads across sockets for optimized performance with enhanced utilization and improved service levels
- Intel® Node Manager complements Intel® Resource Director Technology by monitoring and controlling server power, thermals, and utilization. In combination with Intel® Data Center Manager, it enables IT to dynamically optimize energy consumption at every level, from individual servers, racks, and rows to entire data centers

Integrated storage features

- Advanced storage processor features include x16 non-transparent bridging (vs. x8 NTB) for enhanced scalability, and accelerated RAID for implementing RAID 5 and RAID 6 without a custom ASIC

Strong, high-speed encryption for data and communications

Intel Data Protection Technology with:

- Intel® AES-NI and new crypto acceleration for RSA, ECC, and SHA help to accelerate bulk data encryption and secure session initiation protocols, enabling encryption to be used more pervasively without slowing applications
- Secure Key provides high-quality security keys, as well as random bits (seeds) for software-based key generation solutions

An excellent foundation for secure multi-tenancy

Intel® Platform Protection Technology with:

- Intel® Trusted Execution Technology (TXT) enables IT to establish trusted pools of virtualized resources for stronger security and compliance in multi-tenant virtual and cloud environments
- OS Guard (Supervisor Mode Execution Protection) and new Supervisor Mode Access Prevention (SMAP) protects against escalation of privilege attacks that attempt to gain control of the platform, execute malware, or otherwise compromise privileged OS components

Industry-leading energy-efficiency

- Intel's industry-leading 14 nm process technology supports greater functionality, higher density, and lower power consumption than the prior manufacturing process[8]
- Intel® Intelligent Power technology dynamically manages CPU and memory energy states to minimize power consumption without slowing performance
- Per-core P states dynamically and independently regulate power in each core for energy-efficient processing

Data center extended ingredients

With increasing demands on IT to support a broader range of workloads and address emerging constraints in the data center, Intel offers a range of products designed to provide greater performance and flexibility with improved density and utilization.

- **Intel® Xeon Phi™ Coprocessor.** Based on Intel® Many Integrated Core (Intel® MIC) architecture, the Intel Xeon Phi coprocessor delivers leading performance for highly parallel workloads and is fully compatible with applications that are written for Intel Xeon processors.
- **The Intel® Ethernet Controller XL710 Series.** These high-performance network adapters provide proven 40 and 10 Gigabit Ethernet connectivity for Intel Xeon processor-based platforms. They also extend Intel® Virtualization technologies to support next-generation network virtualization.
- **Intel® QuickAssist Adapter 8950:** These PCI-e Gen3 adapters provide customers with a scalable, flexible, and extendable way to offer Intel® QuickAssist Technology capabilities to their existing product lines. Intel QuickAssist Technology provides hardware acceleration and offload to assist with the performance demands of compute-intensive security and compression operations, thereby reserving processor cycles for application and control processing.
- **Intel® Solid-State Drive Data Center Family for PCIe*.** Built on the NVMe* specification, this comprehensive product family of 2.5-inch and add-in-card form-factors delivers breakthrough storage performance optimized for real-world applications. For more information, visit Intel® SSD.[9]

PROCESSOR NUMBER	CPU FREQUENCY (GHZ)	INTEL® TURBO BOOST 2.0 TECHNOLOGY	INTEL® HT TECHNOLOGY	LLC CACHE (MB)	NUMBER OF CORES	POWER (W)	INTEL® QPI LINK SPEED (GT/S)	DDR4 MEMORY
FOR 2-SOCKET SERVERS								
Intel® Xeon® Processor E5-2699 v4	2.2	*	*	55	22	145	9.6	2400
Intel® Xeon® Processor E5-2698 v4	2.2	*	*	50	20	135	9.6	2400
Intel® Xeon® Processor E5-2697A v4	2.6	*	*	40	16	145	9.6	2400
Intel® Xeon® Processor E5-2697 v4	2.3	*	*	45	18	145	9.6	2400
Intel® Xeon® Processor E5-2695 v4	2.1	*	*	45	18	120	9.6	2400
Intel® Xeon® Processor E5-2690 v4	2.6	*	*	35	14	135	9.6	2400
Intel® Xeon® Processor E5-2683 v4	2.1	*	*	40	16	120	9.6	2400
Intel® Xeon® Processor E5-2680 v4	2.4	*	*	35	14	120	9.6	2400
Intel® Xeon® Processor E5-2660 v4	2.0	*	*	35	14	105	9.6	2400
Intel® Xeon® Processor E5-2650 v4	2.2	*	*	30	12	105	9.6	2400
Intel® Xeon® Processor E5-2640 v4	2.4	*	*	25	10	90	8.0	2133
Intel® Xeon® Processor E5-2630 v4	2.2	*	*	25	10	85	8.0	2133
Intel® Xeon® Processor E5-2620 v4	2.1	*	*	20	8	85	8.0	2133
Intel® Xeon® Processor E5-2609 v4	1.7	-	-	20	8	85	6.4	1866
Intel® Xeon® Processor E5-2603 v4	1.7	-	-	15	6	85	6.4	1866
FOR 2-SOCKET SERVERS – FREQUENCY OPTIMIZED								
Intel® Xeon® Processor E5-2667 v4	3.2	*	*	25	8	135	9.6	2400
Intel® Xeon® Processor E5-2643 v4	3.4	*	*	20	6	135	9.6	2400
Intel® Xeon® Processor E5-2637 v4	3.5	*	*	15	4	135	9.6	2400
Intel® Xeon® Processor E5-2623 v4	2.6	*	*	10	4	85	8.0	2133
FOR 2-SOCKET SERVERS – LOW POWER								
Intel® Xeon® Processor E5-2650L v4	1.7	*	*	35	14	65	9.6	2400
Intel® Xeon® Processor E5-2630L v4	1.8	*	*	25	10	55	8.0	2133
FOR 2-SOCKET WORKSTATIONS								
Intel® Xeon® Processor E5-2687W v4	3.0	*	*	30	12	160	9.6	2400
FOR STORAGE AND COMMUNICATIONS[1,2]								
Intel® Xeon® Processor E5-2658 v4	2.3	*	*	35	14	105	9.6	2400
Intel® Xeon® Processor E5-2648L v4	1.8	*	*	35	14	75	9.6	2400
Intel® Xeon® Processor E5-2628L v4	1.9	*	*	30	12	75	8.0	2133
Intel® Xeon® Processor E5-2618L v4	2.2	*	*	25	10	75	8.0	2133
Intel® Xeon® Processor E5-2608L v4	1.6	-	*	20	8	50	6.4	1866

* supported
- not supported
[1] SKUs are available for long life (7-years) and extended reliability (10 years)
[2] Support higher Tcase for Embedded/Comms usage

LEARN MORE about the Intel® Xeon® processor E5-2600 v4 product family.
www.intel.com/content/www/us/en/processors/xeon/xeon-processor-e5-family.html

[1] E5 v4 up to 50% vs. previous-generation E5 v3 average performance per watt improvement based on key industry-standard benchmarks calculations submitted by OEMs as of 16 March 2016) comparing 2-socket Intel® Xeon® processor E5 v3 to v4 family. Key industry benchmarks include: SPECvirt_sc*2013_Server PPW, SPECvirt_sc*2013_PPW, SPEC power_ ssj*2008 and VMmark 2.5 server power. See http://www.intel.com/performance/datacenter for full configuration details.

[2] E5 v4 up to 47% vs. previous-generation E5 v3 performance based on binomialcpu v3.0_AVX2 financial services workload results as of 16 March 2016) comparing 1-Node, 2 x Intel® Xeon® Processor E5-2699 v3 on Grantley-EP (Wellsburg) with 128 GB Total Memory on Red Hat Enterprise Linux* 6.4 kernel 2.6.32-358, Options per second Score: 106025 vs. 2 x Intel® Xeon® Processor E5-2699 v4 on Grantley-EP (Wellsburg) with 128 GB Total Memory on Red Hat Enterprise Linux* 6.4 kernel 2.6.32-358, Options per second Score: 156141 Higher is better. Data Source: Request Number: 1871

E5 v4 up to 27% vs. previous-generation E5 v3 average performance based on key industry-standard benchmarks calculations submitted by OEMs as of 16 March 2016) comparing 2-socket Intel® Xeon® processor E5 v3 to v4 family. Key industry benchmarks include: SPECint*_rate_base2006, SPECint*_base 2006 (Speed), SPECfp*_rate_base 2006, SPECfp*_base2006 (Speed), SPECmpiL*_base2007, SPECmpiM*_base2007, SPECompG*_base2012, SPECvirt_sc*2013, VMmark* 2.5 performance (matched pairs), TPC-E*, SPECjEnterprise*2010, Two-tier SAP SD* Windows*/Linux, 1-Node TPC-H* 1TB, TPCx-BB* and SPECjbb*2015 MultiJVM. See http://www.intel.com/performance/datacenter for full configuration details.

[3] Intel® Xeon® Processor E5-2600 v4 product family (22C, 55M Cache) compared to Intel® Xeon® Processor E5-2600 v3 product family (18C, 45M Cache).

[4] The Intel® Xeon® processor E5-2600 v4 product family supports memory speeds up to 2400 MT/s versus maximum memory speeds of 2133 MT/s for the Intel® Xeon® processor E5-2600 v3 product family.

[5] 1-Node, 2 x Intel® Xeon® Processor E5-2697 v3 @ 2.1GHz on Grantley-EP with 64 GB Total Memory on SUSE Linux Enterprise Server* 12 using haproxy* 1.6.3 and OpenSSL 1.0.2f versus 1-Node, 2 x Intel® Xeon® Processor E5-2699 v4 @ 2.1 GHz on Grantley-EP with 64 GB Total Memory on SUSE Linux Enterprise Server* 12 using haproxy* 1.6.3 and OpenSSL 1.0.2f

[6] LINPACK: 1-Node, 2 x Intel® Xeon® Processor E5-2699 v3 on Grantley-EP (Wellsburg) with 64 GB Total Memory on CentOS* using MP_LINPACK 11.3.1 (Composer XE 2016 U1) @ 80,000 problem size. Data Source: Request Number: 1636, Benchmark: Intel® Optimized MP LINPACK, Score: 1096 vs.1-Node, 2 x Intel® Xeon® Processor E5-2699 v4 on Grantley-EP (Wellsburg) with 64 GB Total Memory on Red Hat Enterprise Linux* 7.0 kernel 3.10.0-123 using MP_LINPACK 11.3.1 (Composer XE 2016 U1). Data Source: Request Number: 1636, Benchmark: Intel® Optimized MP LINPACK, Score: 1446 Higher is better

[7] Go to http://www.nvmexpress.org for details.

[8] Compared to previous generation 22 nm processor technology. Source: Intel internal testing.

[9] See https://www-ssl.intel.com/content/www/us/en/solid-state-drives/intel-ssd-dc-family-for-pcie.html

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 http://www.intel.com/performance

Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families.
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Intel technologies' features and benefits depend on system configuration and may require enabled hardware, software or service activation. Performance varies depending on system configuration. No computer system can provide absolute security.

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Relative performance for each benchmark is calculated by taking the actual benchmark result for the first platform tested and assigning it a value of 1.0 as a baseline. Relative performance for the remaining platforms tested was calculated by dividing the actual benchmark result for the baseline platform into each of the specific benchmark results of each of the other platforms and assigning them a relative performance number that correlates with the performance improvements reported.

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