



Intel® Select Solution for SAP HANA*

Improve infrastructure flexibility while ensuring business continuity with SAP HANA Tailored Datacenter Integration (TDI) Phase 5.



The SAP HANA* business data platform is a flexible, data source-agnostic platform that provides real-time analysis of large data volumes. New and existing SAP HANA users are looking for ways to process larger data volumes in real time so they can roll out services and apps quickly. Most SAP HANA customers run mission-critical solutions on SAP HANA, and ensuring business continuity is of the utmost importance. Because SAP HANA is an in-memory platform, memory technology plays an important role in providing an optimal solution.

SAP and Intel have collaborated on SAP HANA since its inception, resulting in one of the most efficient and highest-performing in-memory data platforms available. SAP HANA continues to evolve with features designed for greater privacy, availability, disaster recovery, advanced analytics, and application development.

The Intel® Select Solution for SAP HANA capitalizes on that long collaboration. It provides a pre-configured, validated solution combining SAP HANA with 2nd Generation Intel® Xeon® Scalable processors, Intel® Optane™ DC persistent memory, Intel® Solid State Drives (SSDs), and Intel® Ethernet Network Adapters. The solution is a simplified, optimized deployment of SAP HANA based on high-capacity, non-volatile memory for high availability and quick database restarts

Workload-Driven Hardware Configuration in SAP HANA

Enterprises running on SAP HANA can choose between two deployment models: the SAP HANA appliance-delivery model, in which they purchase a preconfigured hardware and software setup, and SAP HANA Tailored Datacenter Integration (TDI) Phase 5, in which they configure a system using components that integrate with their existing hardware. While the appliance-delivery model simplifies installation and reduces the number of decisions to make, some enterprises want additional flexibility when integrating SAP HANA into their data centers. SAP HANA TDI provides IT operations managers with that additional flexibility.

SAP HANA TDI Phase 5 is the latest step in opening up flexible deployment options. Formerly, the type and number of processors and the configuration of system memory in an SAP HANA TDI deployment were determined by the size of memory reserved by SAP HANA. With the changes in SAP HANA TDI Phase 5, those parameters are now determined in SAP HANA by specific workloads; for example, analytics, online transaction processing (OLTP), and hybrid transactional/analytical processing (HTAP).

Those changes mark the advent of workload-driven hardware configurations, with increased flexibility and cost savings. In SAP HANA TDI Phase 5, the enterprise customer works with a preferred hardware partner to jointly determine the processor type, the optimal number of cores, and the amount of memory needed to run a specific application workload on SAP HANA.

Enterprises that run databases in the hundreds of gigabytes or terabytes on SAP HANA face another inflection point, related to business continuity. It can take a long time to reload such a huge in-memory database into traditional, volatile memory after planned or unplanned downtime. Even in a high-availability configuration, where a secondary system takes over the workload from a primary system, extended restart times can lead to costly downtime because the primary system must still load all data back into memory before redundancy can be restored.

The Intel Select Solution for SAP HANA

To enable SAP HANA to retain its data on startup, the Intel Select Solution for SAP HANA offers multiple options for memory configuration. Combining 2nd Generation Intel Xeon Scalable processors and Intel Optane DC persistent memory, the Intel Select Solution for SAP HANA meets the exacting requirements of workload-driven hardware configurations in SAP HANA, including the requirements of SAP HANA TDI Phase 5. Besides combining a major database platform with high-capacity, persistent memory modules from Intel, the solution helps ensure business continuity by preserving data in-memory, which helps significantly reduce the time to load data on startup and dramatically simplifies high availability and disaster recovery.

The Intel Select Solution for SAP HANA includes 2nd Generation Intel Xeon Scalable processors, Intel Optane DC persistent memory, Intel SSDs, Intel® Ethernet Connections, and Intel® Ethernet Converged Network Adapters. It offers:

- **Accelerated time** to SAP HANA value through simplified deployment
- **Components optimized and validated** for SAP HANA TDI Phase 5
- **High availability and query performance** with the latest Intel processor and memory technologies
- **Business-continuity assurance** through data load on startup for in-memory business processing and analytics

The solution is designed for enterprises looking to upgrade their hardware and for those seeking a turnkey implementation of SAP HANA.

Hardware Selections

The Intel Select Solution for SAP HANA delivers the hardware flexibility enterprises need for varied workloads and business continuity.

Intel® Xeon® Platinum Processors

2nd Generation Intel Xeon Platinum processors are designed to accelerate in-memory databases to harvest real-time insights from massive datasets, enabling in-the-moment decisions. Intel selected the Intel Xeon Platinum 8276 processor to power the Intel Select Solution for SAP HANA because of its compatibility with different ratios of persistent memory to DRAM, which translates to more cost-efficient handling of different workloads.

Intel® Optane™ DC Persistent Memory

Intel Optane DC persistent memory represents a new class of memory and storage technology that allows organizations to maintain larger amounts of data closer to the processor, with consistent, low latencies and near-DRAM performance. Organizations can use Intel Optane DC persistent memory to cost-effectively expand the capacity of memory available to support higher quantities of “hot” data available for processing with in-memory databases, analytics, and other demanding workloads.

Intel Optane DC persistent memory enables the Intel Select Solution for SAP HANA to handle large (from hundreds of megabytes to terabytes) databases under memory-intensive workloads. Persistent memory offers nearly the same performance as DRAM, but it can retain its contents through a power interruption or database restart. It enables configuration of four-socket systems with up to 18 TB of memory. As an example of the potential for extending this Intel Select Solution, a server with more powerful processors can reload in-memory data without the need to retrieve it from other persistent storage. For example, in an internal benchmark, SAP HANA 2.3 saw a 13-times-shorter start time when making use of persistent memory.¹

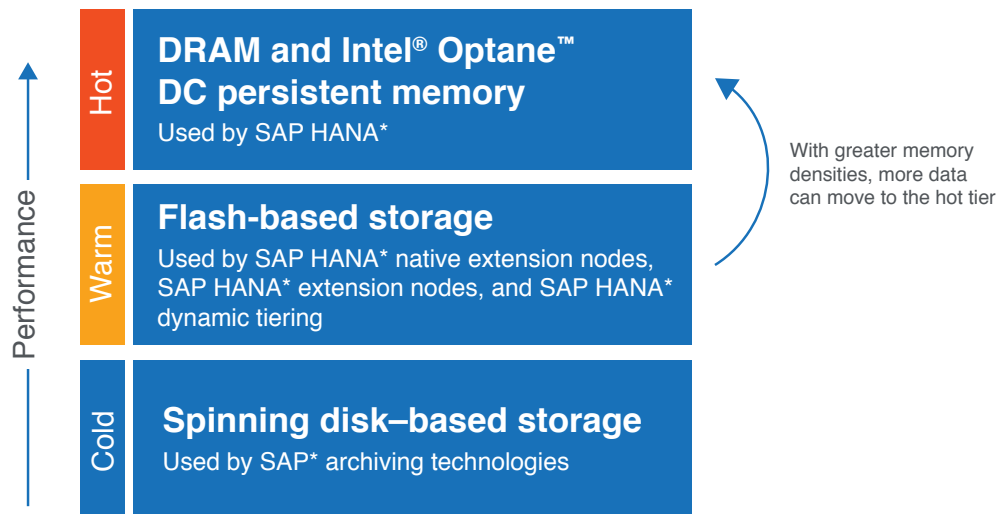


Figure 1. Intel® Optane™ DC persistent memory provides new opportunities to expand the performance capabilities of in-memory databases by providing near-DDR4 DRAM speeds with the same persistence as flash- and disk-based storage

Intel Optane DC SSDs

Intel Optane DC SSDs enable an entirely new storage tier between Intel Optane DC persistent memory and NAND SSDs that brings data closer to the processor for fast caching or fast storage of hot and warm data.

To boost database performance, the Intel Select Solution for SAP HANA uses the Intel® SSD DC S4610 and Intel SSD DC P4600 (NVM Express* [NVMe*]) drives, which are based on Intel® 3D NAND technology.

Intel® Ethernet Connections and Intel® Ethernet Adapters

The Intel Select Solution for SAP HANA features either the Intel Ethernet Connection X722 with the Intel® Ethernet Converged Network Connection OCP X527-DA2/DA4, or the 10Gb Intel Ethernet Converged Network Adapter X710.

The 10Gb Intel® Ethernet 700 Series Network Adapters accelerate the performance of the Intel Select Solution for SAP HANA. Paired with 2nd Generation Intel Xeon Platinum processors, they provide up to 1.6x performance compared to 1Gb Ethernet.^{2,3} The Intel Ethernet 700 Series delivers validated performance ready to meet high-quality thresholds for data resiliency and service reliability with broad interoperability.⁴ All Intel Ethernet products are backed by worldwide pre- and post-sales support and offer a limited lifetime warranty.

Verified Performance through Benchmark Testing

All Intel Select Solutions are verified through benchmark testing to meet a specified, minimum level of workload-optimized performance. The Intel Select Solution for SAP HANA was run against the SAP Business Warehouse Edition for SAP HANA* Standard Application Benchmark.

Base Configuration

The Intel Select Solution for SAP HANA is available in a “Base” configuration, with three different ratios of Intel Optane DC persistent memory to DRAM: 2:1, 1:1, and 4:1, as detailed in Table 1.

Intel has worked closely with SAP to streamline processes for its valued partners and ensure the testing and benchmark thresholds required for SAP HANA certification meet the standards of the Intel Select Solutions program.

What Are Intel® Select Solutions?

Intel Select Solutions are pre-defined, workload-optimized solutions designed to minimize the challenges of infrastructure evaluation and deployment. Solutions are validated by OEMs/ODMs, certified by ISVs, and verified by Intel. Intel develops these solutions in extensive collaboration with hardware, software, and operating system vendor partners and with the world's leading data center and service providers. Every Intel Select Solution is a tailored combination of Intel® data center compute, memory, storage, and network technologies that delivers predictable, trusted, and compelling performance.

To refer to a solution as an Intel Select Solution, a vendor must:

1. Meet the software and hardware stack requirements outlined by the solution's reference-design specifications
2. Replicate or exceed established reference-benchmark test results
3. Publish a solution brief and a detailed implementation guide to facilitate customer deployment

Solution providers can also develop their own optimizations in order to give end customers a simpler, more consistent deployment experience.

2nd Generation Intel® Xeon® Scalable Processors

2nd Generation Intel Xeon Scalable processors:

- Offer high scalability that is cost-efficient and flexible, from the multi-cloud to the intelligent edge
- Establish a seamless performance foundation to help accelerate data's transformative impact
- Support breakthrough Intel® Optane™ DC persistent memory technology
- Accelerate artificial-intelligence (AI) performance and help deliver AI readiness across the data center
- Provide hardware-enhanced platform protection and threat monitoring

The Intel® Select Solution for SAP HANA* features 2nd Generation Intel Xeon Platinum processors.



Table 1. Configurations for the Intel® Select Solution for SAP HANA*

INGREDIENT	INTEL® SELECT SOLUTION FOR SAP HANA* 2:1 MEMORY RATIO, 4,608 GB	INTEL SELECT SOLUTION FOR SAP HANA 1:1 MEMORY RATIO, 6,144 GB	INTEL SELECT SOLUTION FOR SAP HANA 4:1 MEMORY RATIO, 7,680 GB
PROCESSOR	Minimum four sockets Intel® Xeon® Platinum 8276 processor (M or L memory tier capacity), or a higher number Intel Xeon Scalable processor		
MEMORY (MINIMUM)	3,072 GB (24 x 128 GB) Intel® Optane™ DC persistent memory + 1,536 GB (24 x 64 GB) DRAM	3,072 GB (24 x 128 GB) Intel Optane DC persistent memory + 3,072 GB (24 x 128 GB) DRAM	6,144 GB (24 x 256 GB) Intel Optane DC persistent memory + 1,536 GB (24 x 64 GB) DRAM
BOOT DRIVE**	1 x Intel® SSD DC S4610 (240 GB or larger)		
LOG DRIVE (MINIMUM)**	1 x Intel SSD DC P4600 or higher (2 TB) (NVM Express* [NVMe*])		
DATA NETWORK**	Intel® Ethernet Connection X722 with Intel® Ethernet Converged Network Connection OCP X527-DA2/DA4 or 10Gb Intel® Ethernet Converged Network Adapter X710		
MANAGEMENT NETWORK**	Integrated 1 gigabit Ethernet (GbE)		
SOFTWARE	SAP HANA 2.0 SPS 03 or later		
INTEL OPTANE DC PERSISTENT MEMORY MODE	App Direct Mode		
FIRMWARE AND SOFTWARE OPTIMIZATIONS	Intel® Advanced Vector Extensions 512 (Intel® AVX-512) enabled ⁵ Intel® Hyper-Threading Technology (Intel® HT Technology) enabled Intel® Turbo Boost Technology enabled Intel® Transactional Synchronization Extensions (Intel® TSX) enabled Intel® Deep Learning Boost (Intel® DL Boost) enabled Intel® Speed Shift technology, hardware P-states (HWP) native C-states disabled Operating system power management and plan set for performance		

**Recommended, not required

Technology Selections for the Intel Select Solution for SAP HANA

In addition to the Intel hardware foundation used for the Intel Select Solution for SAP HANA, Intel technologies integrated in 2nd Generation Intel Xeon Scalable processors deliver further performance and reliability gains:

1. **Intel® Advanced Vector Extensions 512 (Intel® AVX-512)** is a set of new CPU instructions that impacts compute, storage, and network functions. The number 512 refers to the width, in bits, of the register file, which sets the parameters for how much data a set of instructions can operate upon at a time. Intel AVX-512 enables twice the number of floating point operations per second (FLOPS) per clock cycle compared to its predecessor, Intel AVX2.⁵
2. **Intel® Transactional Synchronization Extensions (Intel® TSX)** accelerates performance for business-critical workloads on SAP HANA by automatically executing in parallel all threads without data conflicts. Data flows freely because the processor determines whether threads need to serialize, then serializes them only when required.
3. **Intel® Deep Learning Boost (Intel DL Boost)**, available on 2nd Generation Intel Xeon Scalable processors, takes embedded artificial-intelligence (AI) performance to the next level. Intel Xeon Scalable processors are built specifically for the flexibility to run complex AI workloads on the same hardware as your existing workloads. Some enterprises have experienced 57 percent performance improvements.⁶
4. **Intel® Hyper-Threading Technology (Intel® HT Technology)** enables multiple threads to run on each core, which ensures that systems use processor resources more efficiently. Intel HT Technology also increases processor throughput, improving overall performance on threaded software.

5. **Intel® Turbo Boost Technology** accelerates processor and graphics performance for peak loads, automatically allowing processor cores to run faster than the rated operating frequency when operating below power, current, and temperature specification limits.
6. **Intel® Speed Shift technology** allows the processor to quickly select its best operating frequency and voltage for optimal performance and power efficiency without intervention from the operating system.
7. **Power-management settings** are tuned for performance in the Intel Select Solution for SAP HANA.

Enjoy Greater Flexibility in System Configuration when Implementing SAP HANA TDI

The Intel Select Solution for SAP HANA, optimized with Intel Optane DC persistent memory, is designed for IT organizations that rely on SAP HANA for business operations and real-time analytics on large data volumes. Proven to scale with 2nd Generation Intel Xeon Scalable processors, these pre-tuned and tested configurations are workload-optimized and allow organizations to deploy data center infrastructure quickly and efficiently with less tuning.

Visit intel.com/selectsolutions to learn more, and ask your infrastructure vendor for Intel Select Solutions.

Learn More

Intel Select Solutions: intel.com/selectsolutions

2nd Generation Intel Xeon Scalable processors: intel.com/xeonscalable

Intel SSD Data Center family:

intel.com/content/www/us/en/products/memory-storage/solid-state-drives/data-center-ssds.html

Intel Optane DC persistent memory: intel.com/optanememory

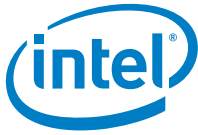
Intel Ethernet 700 Series: intel.com/ethernet

Intel Select Solutions are supported by Intel® Builders: <http://builders.intel.com>. Follow us on Twitter: [#IntelBuilders](https://twitter.com/IntelBuilders)

Intel Optane DC persistent memory for SAP HANA: sap.com/persistent-memory and intel.com/sap

“SAP HANA Real-Time Analytics Software and Intel® Technologies”:

intel.com/content/www/us/en/big-data/real-time-analysis-sap-product-brief.html



¹ Testing was conducted by Intel on January 30, 2019, with the following hardware and software configurations: **DRAM only configuration:** one-node, 4 x Intel® Xeon® Platinum 8280M processor; 1 x Intel® Lighting Ridge system; total memory of 6 TB that consists of 48 x 128 GB DDR4 RDIMM at 2,666 megatransfers per second (MT/s); storage: 60 x 480 GB Intel® SSD DC S4600 Serial ATA (SATA); network devices: 10Gb Intel® Ethernet Converged Network Adapter x520; ucode: 0x04000010; software: SUSE 15*; SAP HANA* database size of 3 TB; security mitigations: variants 1, 2, and 3 enabled. Restart time: 20 minutes. **Intel® Optane™ DC persistent memory + DRAM configuration:** one-node, 4 x Intel Xeon Platinum 8280L processor; 1 x Intel Lighting Ridge system; total memory of 9 TB that consists of 24 x 256 GB Intel Optane DC persistent memory and 24 x 128 GB DDR4 RDIMM at 2,666 MT/s; storage: 90 x 480 GB Intel SSD DC S4600 SATA; network devices: 10Gb Intel Ethernet Converged Network Adapter x520 NIC; ucode: 0x04000010; software: SUSE 15; SAP HANA database size of 6 TB; security mitigations; variants 1, 2, and 3 enabled. Restart time: 90 seconds..

² Testing based on the 2nd Generation Intel® Xeon® Platinum 8260 processor and upgrading from a 1GbE to a 10GbE Intel® Ethernet Network Adapter XXV710.

³ Performance results by HeadGear Strategic Communications are based on testing as of February 12, 2019. The comparative analysis in this document was done by HeadGear Strategic Communications and commissioned by Intel. Detailed configuration details: **VM Host Server:** Intel® Xeon® Platinum 8160 processor, Intel Xeon Platinum 8160F processor (CPUID 50654, microcode revision 0x200004D), and Intel Xeon Platinum 8260 processor (CPUID 50656, microcode revision 04000014); Intel® Server Board S2600WFT (board model number H48104-850, BIOS ID SE5C620.86B.0D.01.0299.122420180146, baseboard management controller [BMC] version 1.88.7a4eac9e; Intel® Management Engine [Intel® ME] version 04.01.03.239; SDR package revision 1.88); 576 GB DDR4 2,133 MHz registered memory, 1 x Intel® Ethernet Network Adapter XXV710-DA2, 1 x Intel® Ethernet Converged Network Adapter X710-DA2; operating system drive configuration: 2 x Intel® SSD DC S3500 in Intel® Rapid Storage Technology enterprise [Intel® RSTe] RAID1 configuration. Windows Server 2016* Datacenter edition 10.0.14393 build 14393, Hyper-V* version 10.0.14393.0, Hyper-V scheduler type 0x3, installed updates KB4457131, KB4091664, KB1322316, KB3211320, and KB3192137. **E-mail Virtual-Machine Configuration:** Windows Server 2012 Datacenter edition 6.2.9200 build 9200; 4 x vCPU; 12 GB system memory, BIOS version/date: Hyper-V release v1.0, 2012, 11/26), SMBIOS version 2.4; Microsoft Exchange Server 2013*, workload generation via VM clients running Microsoft Exchange Load Generator 2013*, application version 15.00.0805.000). **Database Virtual-Machine Configuration:** Windows Server 2016 Datacenter edition 10.0.14393 build 14393, 2 x vCPU 7.5 GB system memory; BIOS version/date: Hyper-V release v1.0, 2012, 11/26), SMBIOS version 2.4, Microsoft SQL Server 2016* workload generation DVD Store application* (dell.com/downloads/global/power/ps3q05-20050217-Jaffe-OE.pdf). **Storage Server:** Intel® Server System R2224WFTZS; Intel Server Board S2600WFT (board model number H48104-850, BIOS ID SE5C620.86B.0D.01.0014.070920180847, BMC version 1.60.56383bef; Intel ME version 04.00.04.340; SDR package revision 1.60); 96 GB DDR4 2,666 MHz registered memory, 1 x Intel Ethernet Network Adapter XXV710-DA2, 1 x Intel Ethernet Converged Network Adapter X710-DA2; operating system drive configuration: 2 x Intel SSD DC S3500 in Intel RSTe RAID1 configuration. **Storage Configuration:** 8 x Intel SSD DC P4600 (2.0 TB) configured as RAID 5 volume using Intel® Virtual RAID on CPU (Intel® VROC), 8 x Intel SSD DC S4500 (480 GB) in RAID5 configuration using Intel® RAID Module RMSP3AD160F, 8 x Intel SSD DC P4510 in RAID 5 configuration using Intel VROC for VM operating system store, Windows Server 2016 Datacenter edition 10.0.14393 build 14393, Hyper-V version 10.0.14393.0, Hyper-V scheduler type 0x3, installed updates KB4457131, KB4091664, KB1322316, KB3211320, and KB3192137. **Windows Server 2016 Datacenter and Windows Server 2012 Datacenter Configured with Intel Xeon Platinum 8160 and Intel Xeon Platinum 8160F Processors:** Speculation control settings for CVE-2017-5715 (branch target injection)—hardware support for branch target injection mitigation is present: true; Windows* operating system support for branch target injection mitigation is present: true; Windows operating system support for branch target injection mitigation is enabled: true; Windows operating system support for branch target injection mitigation is disabled by system policy: false; Windows operating system support for branch target injection mitigation is disabled by absence of hardware support: false. Speculation control settings for CVE-2017-5754 (rogue data cache load)—hardware requires kernel VA shadowing: true; Windows operating system support for kernel VA shadow is present: true; Windows operating system support for kernel VA shadow is enabled: true. Speculation control settings for CVE-2018-3639 (speculative store bypass)—hardware is vulnerable to speculative store bypass: true; hardware support for speculative store bypass disable is present: true; Windows operating system support for speculative store bypass disable is present: true; Windows operating system support for speculative store bypass disable is enabled system-wide: true. Speculation control settings for CVE-2018-3620 (L1 terminal fault)—hardware is vulnerable to L1 terminal fault: true; Windows operating system support for L1 terminal fault mitigation is present: true, Windows operating system support for L1 terminal fault mitigation is enabled: true. **Windows Server 2016 Datacenter and Windows Server 2012 Datacenter Configured with Intel Xeon Platinum 8160 and Intel Xeon 8160F Processors:** Speculation control settings for CVE-2017-5715 (branch target injection)—hardware support for branch target injection mitigation is present: true; Windows operating system support for branch target injection mitigation is present: true; Windows operating system support for branch target injection mitigation is enabled: true. Speculation control settings for CVE-2017-5754 (rogue data cache load)—hardware requires kernel VA shadowing: false. Speculation control settings for CVE-2018-3639 (speculative store bypass)—hardware is vulnerable to speculative store bypass: true; hardware support for speculative store bypass disable is present: true; Windows operating system support for speculative store bypass disable is present: true; Windows operating system support for speculative store bypass disable is enabled system-wide: true. Speculation control settings for CVE-2018-3620 (L1 terminal fault)—hardware is vulnerable to L1 terminal fault: false. **Network Switches:** 1/10GbE SuperMicro SSE-X3348S*, hardware version P4-01, firmware version 1.0.7.15; 10/25GbE Arista DCS-7160-48YC6*, EOS 4.18.2-REV2-FX.

⁴ The Intel® Ethernet 700 Series includes extensively tested network adapters, accessories (optics and cables), hardware, and software, in addition to broad operating system support. A full list of the product portfolio's solutions is available at intel.com/ethernet. Hardware and software is thoroughly validated across Intel® Xeon® Scalable processors and the networking ecosystem. The products are optimized for Intel® architecture and a broad operating system ecosystem: Windows®, Linux® kernel, FreeBSD®, Red Hat® Enterprise Linux (RHEL®), SUSE®, Ubuntu®, Oracle Solaris®, and VMware ESXi®. Supported connections and media types for the Intel Ethernet 700 Series are: direct-attach copper and fiber SR/LR (QSFP+, SFP+, SFP28, XLPPI/CR4, 25G-CA/25G-SR/25G-LR), twisted-pair copper (100GBASE-T/10GBASE-T), backplane (XLAUI/XAUI/SFI/KR/KR4/KX/SGMII). Note that Intel is the only vendor offering the QSFP+ media type. The Intel Ethernet 700 Series supported speeds include 10GbE, 25GbE, 40GbE.

⁵ To learn more about Intel® Advanced Vector Extensions 512 (Intel® AVX-512), visit intel.com/content/www/us/en/architecture-and-technology/avx-512-animation.html.

⁶ To learn more about Intel® Deep Learning Boost, visit intel.ai/intel-deep-learning-boost/. For details on performance improvements from Intel Deep Learning Boost, visit intel.ai/mlperf-results-validate-cpus-for-dl-training/.

Performance results are based on testing as of the date set forth in the configurations and may not reflect all publicly available security updates. See configuration disclosure for details. No product or component can be absolutely secure.

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 complete information visit intel.com/benchmarks.

Cost reduction scenarios described are intended as examples of how a given Intel- based product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Intel does not guarantee any costs or cost reduction.

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