SOLUTION BRIEF

Intel® Select Solutions | Version 2
Enterprise Data Center Infrastructure
December 2019

Intel Select Solutions for Microsoft SQL Server on Linux

Extract powerful insights from big data using validated database-as-a-service (DBaaS) solutions.

Database-as-a-service (DBaaS) solutions play an increasingly important role in enterprise data center deployments, where scaling up and down quickly is a high priority. DBaaS offers the technical advantages of accommodating multiple tenants on a wide variety of concurrent workloads in databases ranging from hundreds of megabytes to terabytes in size. It also offers the financial advantages of tighter utilization of infrastructure, with IT paying only for resources actually used.

As of Microsoft SQL Server 2017, businesses can use containers to host SQL Server in multi-tenant environments on Linux. That capability allows IT organizations to capitalize on the efficiency and cost advantages of DBaaS, as long as the underlying hardware can meet the performance levels required by multiple SQL Server instances.

Intel Select Solutions are verified hardware and software stacks optimized across compute, storage, and networking resources for specific workloads, such as DBaaS. Built on Intel® Xeon® Scalable processors, Intel Select Solutions for SQL Server on Linux help ensure that enterprises get the performance, agility, and security they require for SQL Server, even when distributed in containers across demanding multi-tenant environments.

SQL Server as a Multi-Tenant DBaaS Offering

Many organizations extend their SQL Server deployments to use SQL Server as part of their DBaaS solutions. SQL Server provides the high performance, robust security, and flexibility in programming languages expected in a multi-tenant DBaaS environment. In addition to supporting in-memory database capabilities across all workloads, SQL Server offers in-database advanced analytics using SQL Server Machine Learning Services. SQL Server handles the workloads and user requirements in verticals as varied as IT services, manufacturing, retail and e-commerce, healthcare, education, energy, and infrastructure.

Under ordinary database workloads, the traditional way to scale up SQL Server is to add DRAM. However, simply adding more DRAM does not address all of the performance needs of container-based multi-tenancy and enterprise private cloud deployments, nor does it offer a solution when a legacy version of SQL Server falls out of support. To scale quickly and efficiently across a wider range of environments, organizations are turning to more flexible and efficient DBaaS solutions.

Intel Select Solutions for SQL Server on Linux

IT organizations are increasingly turning to lightweight, flexible containers for deploying and managing multi-tenant environments. Administrators can drive down costs for multi-tenant DBaaS offerings by deploying large numbers of SQL Server containers on a single hypervisor instance.

In 2019, Intel and Microsoft created a second version of the Intel Select Solutions for SQL Server on Linux that are built to support multi-tenancy. Intel Select Solutions for SQL Server on Linux are aligned with the building-block approach to scaling out a containerized DBaaS hosting environment. They are also designed to handle the concurrent, variable (for example, operational and analytical) workloads of business users running online transaction processing (OLTP), enterprise data warehousing (EDW), or both.

Intel Select Solutions for SQL Server on Linux combine Microsoft and Linux software with the Intel Xeon Scalable processor platform, Intel® Optane™ DC persistent memory, Intel® Solid State Drive (SSD) technology, Intel® Ethernet Connections, and Intel® Ethernet Converged Network Adapters. They offer:

- **Building blocks** for infrastructure that grows to meet the needs of containerized, multi-tenant environments offering DBaaS
- **Options for consolidating** older SQL Server environments
- **Benchmarked performance** that supports business operations and EDW workloads across a wide variety of verticals
- **Accelerated time to market** with a turnkey solution benchmarked to scale for a variety of workloads

A solid model for long-term compatibility, Intel Select Solutions for SQL Server on Linux can help simplify private and public cloud deployments. Intel's extensive benchmark testing (described below) validates the building-block model of adding and removing infrastructure for easy scaling.

Hardware Selections

Intel Select Solutions for SQL Server on Linux combine 2nd Generation Intel Xeon Scalable processors, Intel Optane DC persistent memory, and Intel SSDs for high performance, easy scalability, and suitability to varied workloads.

Intel Xeon Gold Processors

Intel Xeon Gold processors provide an excellent price/performance ratio for both business operations and EDW. Specifically, Intel selected the Intel Xeon Gold 5218 processor and the Intel Xeon Gold 6248 processor to power Intel Select Solutions for SQL Server on Linux. The processors optimize cost and performance for representative database workloads while taking into consideration speed and number of cores.

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.

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.

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

SOLUTION POWERED BY:

Intel SSD Data Center Family

For more-reliable database performance in the enterprise data center, Intel Select Solutions for SQL Server on Linux use Intel Optane SSD DC P4800X drives. They also use the Intel SSD DC S4510 and Intel SSD DC P4610, which provide a 3.2x lower annualized failure rate (AFR) than traditional hard-disk drives (HDDs).[1]

Intel Ethernet Connections and Intel Ethernet Adapters

Intel Select Solutions for SQL Server on Linux feature the Intel® C620 Series Chipset with Intel Ethernet Connection X722 for 10GBASE-T.

The 25Gb Intel® Ethernet 700 Series Network Adapters accelerate the performance of Intel Select Solutions for SQL Server on Linux. The Intel Ethernet 700 Series delivers validated performance ready to meet high-quality thresholds for data resiliency and service reliability with broad interoperability.[2] 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 to meet a specified minimum level of workload-optimized performance capabilities. For Intel Select Solutions for SQL Server on Linux, Intel and Microsoft chose the HammerDB 3.1 benchmark running an OLTP workload and a decision support system (DSS) workload to validate the solutions' performance.

- The HammerDB benchmark for OLTP testing is based on the TPC-C specification. This OLTP benchmark simulates a medium-to-large wholesale supplier with multiple warehouses and a large number of users and transactions, but it can represent any business in any industry that needs to manage, sell, or distribute products or services.
- The HammerDB tool with a TPC-H workload is employed to perform data collection for EDW or DSS systems. TPC-H workloads run complex queries scanning large volumes of data. This benchmark illustrates decision support systems that examine large volumes of data while multiple users issue a set of 22 queries, and the response times are captured in a calculator template to arrive at a throughput metric.

Intel Select Solutions for SQL Server on Linux are verified to meet minimum levels of workload-optimized performance capabilities for two deployment scenarios: single-tenant and multi-tenant (using containers). Key performance indicators (KPIs) for the multi-tenant scenario are measured in OLTP transactions per minute (TPM) per container. KPIs for single tenancy are measured in OLTP TPM, in addition to average query set response time per user with a DSS workload, as shown in Table 1.

Base and Plus Configurations

Intel Select Solutions for SQL Server on Linux are available in two configurations: "Base" and "Plus," as shown in Table 1. The Base configuration specifies the minimum required performance capability for Intel Select Solutions for SQL Server on Linux, and the Plus configuration provides one example of how system builders, system integrators, and solution and service providers can further optimize to achieve higher performance and capabilities. For example, businesses can realize up to 22.6 percent faster DSS query performance and up to 8.9 percent more TPM when using the Plus configuration compared to using the Base configuration for single-tenant scenarios.[3] For multi-tenant scenarios, the Plus configuration accommodates twice as many containers and double the minimum capacity for database files (24 TB) at a minimum throughput per container of 100,000 TPM.

Table 1. The Base and Plus configurations for version 2 of Intel Select Solutions for Microsoft SQL Server on Linux, optimized for HTAP

INGREDIENT	INTEL SELECT SOLUTIONS FOR MICROSOFT SQL SERVER ON LINUX **BASE CONFIGURATION**	INTEL SELECT SOLUTIONS FOR MICROSOFT SQL SERVER ON LINUX **PLUS CONFIGURATION**
PROCESSOR	2 x Intel Xeon Gold 5218 processor at 2.30 GHz, 16 cores, 32 threads, or a higher number 2nd Generation Intel Xeon Scalable processor	2 x Intel Xeon Gold 6248 processor at 2.60 GHz, 20 cores, 40 threads, or a higher number 2nd Generation Intel Xeon Scalable processor
MEMORY	384 GB (12 x 32 GB 2,933 MHz 288-pin DDR4 RDIMM)	1,024 GB 2LM/memory mode (8 x 128 GB, 288-pin Intel Optane DC persistent memory + 384 GB (12 x 32 GB 2,933 MHz 288-pin DDR4 RDIMM) or 768 GB DRAM (24 x 32 GB 2,933 MHz 288-pin DDR4 RDIMM)
BOOT DRIVE	1 x Intel SSD D3-S4510 (greater than or equal to 240 GB, 2.5 in Serial ATA [SATA] 6 gigabits per second [Gbps], 3D2, triple-level cell [TLC])*	2 x Intel SSD D3-S4510 (greater than or equal to 240 GB, 2.5 in SATA 6 Gbps, 3D2, TLC) (mirrored)*
LOG DRIVE	2 x 1.6 TB Intel SSD DC P4610, NVM Express (NVMe)	2 x 750 GB Intel Optane SSD DC P4800X, NVMe
DATA DRIVE	6 x 2 TB Intel SSD DC P4510, NVMe	6 x 4 TB Intel SSD DC P4510, NVMe

DATA NETWORK	10Gb Intel C620 Series Chipset with integrated Intel Ethernet Network Connection X722 and Intel Ethernet Network Connection OCP X527-DA2 or 10Gb dual-port Intel Ethernet Converged Network Adapter X710*	10Gb Intel C620 Series Chipset with integrated Intel Ethernet Network Connection X722 and Intel Ethernet Network Connection OCP X527-DA2 or 25Gb dual-port Intel Ethernet Converged Network Adapter XXV710 or 40Gb dual-port Intel Ethernet Converged Network Adapter XL710*
MANAGEMENT NETWORK	Integrated 1 gigabit Ethernet (GbE)	Integrated 1 GbE
SOFTWARE	Red Hat Enterprise Linux 7.6 or later SQL Server 2017 Enterprise Edition, version 14.0.3192.2 or later	Red Hat Enterprise Linux 7.6 or later SQL Server 2017 Enterprise Edition, version 14.0.3192.2 or later
TRUSTED PLATFORM MODULE (TPM)	TPM 2.0 or Intel® Platform Trust Technology (Intel® PTT)	TPM 2.0 or Intel PTT
FIRMWARE AND SOFTWARE OPTIMIZATIONS	Intel® Hyper-Threading Technology (Intel® HT Technology) enabled Intel® Turbo Boost Technology enabled Intel® Speed Shift technology, hardware P-states (HWP) native CPU C-state control > package C-state: C0/C1 state CPU C-state control > processor C6 disabled Operating system power-management plan set for performance LLC prefetcher enabled MLC spatial prefetcher enabled CPU power and performance policy set to performance Workload configuration balanced Uncore frequency scaling disabled Performance P-limit disabled	Intel HT Technology enabled Intel Turbo Boost Technology enabled Intel Speed Shift technology, HWP native CPU C-state control > package C-state: C0/C1 state CPU C-state control > processor C6 disabled Operating system power-management plan set for performance LLC prefetcher enabled MLC spatial prefetcher enabled CPU power and performance policy set to performance Workload configuration balanced Uncore frequency scaling disabled Performance P-limit disabled
MINIMUM PERFORMANCE STANDARDS FOR SINGLE-TENANT SCENARIOS	OLTP workload: 4,500,000 throughput in TPM[3] DSS workload: 814 seconds average query set response time per user at 1 TB database size, 7 users, and a minimum capacity for database files of 12 TB[3]	OLTP workload: 4,900,000 throughput in TPM[3] DSS workload: 664 seconds average query set response time per user at 1 TB database size, 7 users, and a minimum capacity for database files of 24 TB[3]
MINIMUM PERFORMANCE STANDARDS FOR MULTI-TENANT SCENARIOS	OLTP workload: Minimum throughput per container (TPM): 100,000 with 6 or more containers and a minimum capacity for database files of 12 TB[3]	OLTP workload: Minimum throughput per container (TPM): 100,000 with 12 or more containers and a minimum capacity for database files of 24 TB[3]
BUSINESS VALUE OF CHOOSING A PLUS CONFIGURATION INSTEAD OF A BASE CONFIGURATION	For single-tenant scenarios: Compared to the Base configuration, the Plus configuration delivers up to 22.6 percent faster DSS query performance and up to 8.9 percent more TPM[3] For multi-tenant scenarios: Compared to the Base configuration, the Plus configuration delivers twice the number of containers at the same TPM and double the minimum capacity for database files[3]	

*Recommended, not required

Technology Selections for Intel Select Solutions for SQL Server on Linux

In addition to the Intel hardware foundation, additional technologies provide further performance and security gains:

- **Intel PTT or a discrete TPM 2.0:** Protects the system start-up process by ensuring that the boot hardware is tamper-free before releasing system control to the operating system. TPM 2.0 also provides secured storage for sensitive data, such as security keys and passwords, and it performs encryption and hash functions.

- **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.
- **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.
- **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.
- **Power-management settings:** Operating system power-management settings are tuned for performance in Intel Select Solutions for SQL Server on Linux.

Scale Your DBaaS Infrastructure with Intel Select Solutions for SQL Server on Linux

Intel Select Solutions for SQL Server on Linux are designed to help IT organizations simplify scaling and management of SQL Server workloads in single-tenant or containerized multi-tenant environments. Proven to scale with Intel Xeon Scalable processors, these pre-tuned and tested configurations are workload-optimized and let organizations deploy and configure their DBaaS infrastructure quickly and with less tuning.

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

Learn More

SQL Server on Linux: **microsoft.com/en-US/sql-server/sql-server-2017-linux**

Data warehousing with SQL Server: **microsoft.com/en-us/sql-server/data-warehousing**

Intel Select Solutions: **intel.com/selectsolutions**

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 Ethernet 700 Series: **intel.com/ethernet**

Intel and Microsoft alliance: **intel.com/content/www/us/en/big-data/intel-microsoft-partnership.html**

Discover how advanced analytics can help transform your business: **intel.com/analytics**

Intel Select Solutions are supported by Intel® Builders: **http://builders.intel.com**. Follow us on Twitter: **#IntelBuilders**

1 Based on initial product AFR of 0.66 percent vs. industry AFR average (2.11%). Source: Backblaze. "Hard Drive Stats for Q1 2017." May 2017. backblaze.com/blog/hard-drive-failure-rates-q1-2017/.

2 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 (1000BASE-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.

3 Intel internal testing as of July 31, 2019. **Base configuration:** one node, 2 x Intel Xeon Gold 5218 processor, Intel® Server Board S2600WFT, total memory: 12 x 32 GB 2,933 MHz 288-pin DDR4 RDIMM, Intel HT Technology enabled, Intel Turbo Boost Technology enabled; storage (boot): 1 x Intel SSD D3-S4510 (greater than or equal to 240 GB, 2.5 in Serial ATA [SATA] 6 gigabits per second [Gbps], 3D2, triple-level cell [TLC]), storage (data drive): 6 x Intel SSD DC P4510 (2 TB) with NVMe, storage (log drive): 2 x 1.6 TB Intel SSD DC P4610 PCIe with NVMe; network devices: 10Gb Intel C620 Series Chipset with integrated Intel Ethernet Network Connection X722 and Intel Ethernet Network Connection OCP X527-DA2, OS/software: Red Hat Enterprise Linux 7.6 with Microsoft SQL Server 2017 Enterprise edition. **Plus configuration:** one node, 2 x Intel Xeon Gold 6248 processor, total memory: 1,024 GB 2LM/memory mode (8 x 128 GB, 288-pin Intel Optane DC persistent memory + 384 GB (12 x 32 GB 2933 MHz 288-pin DDR4 RDIMM), Intel HT Technology enabled, Intel Turbo Boost Technology enabled; storage (boot): 2 x Intel SSD D3-S4510 (240 GB, 2.5 in SATA 6 Gbps, 3D2, TLC) (mirrored), storage (data drive): 6 x Intel SSD DC P4510 (4 TB) with NVMe, storage (log drive): 2 x 750 GB Intel Optane SSD DC P4800X PCIe with NVMe; network devices: 10Gb Intel C620 Series Chipset with integrated Intel Ethernet Network Connection X722 and Intel Ethernet Network Connection OCP X527-DA2, OS/software: Red Hat Enterprise Linux 7.6 with SQL Server 2017 Enterprise edition.

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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