

Accelerate OLTP and DSS with Microsoft SQL Server 2022 Running on 4th Gen Intel® Xeon® Scalable Processors

Business Challenge: Enterprises seek new scalable solutions that can help them quickly transform their data into insights, enhance security and governance, and drive digital transformation. These three goals can be met by investing in a security-enabled hardware/software platform that is preconfigured, validated, and tuned for specific workloads.



Up to
34.2%
More New Orders
Per Minute



Up to
28.1%
Faster Query
Response Times
Compared to Previous Generations

Solution Overview and Summary

Solution: For modern data professionals tasked with delivering business insights, Microsoft SQL Server 2022 is a high-performance data platform that is optimized for 4th Generation Intel® Xeon® Scalable processors and industry-leading storage, memory, and networking components. Intel has built a hardware and software stack that is based on its deep experience with industry solution providers and software vendors, as well as its collaboration with the world's leading data center service providers. Running on the latest Intel® technology, this solution for SQL Server 2022 on Windows Server offers the following benefits:

- Accelerate transaction processing and real-time insights in addition to reducing time to prediction using this solution, which is optimized for both online transaction processing (OLTP) and decision support systems (DSS). Decision support workloads are typically enabled by online analytical processing (OLAP).
- Mitigate data breach risk through extensive hardware- and software-based security features.
- Speed time to production deployment with this preconfigured, scalable, security-enabled solution.

Results: With this solution, organizations can perform faster transactions, queries, artificial intelligence (AI), and analytics. Running SQL Server 2022 on 4th Gen Intel Xeon Scalable processors results in up to 34.2% more new orders per minute (NOPM) and up to 28.1% faster query response times, compared to previous-generation processors.¹

OLTP Benchmarking Process

- Create the TPC-C database and populate it with the desired number of data warehouses using the schema build option of the HammerDB tool. We used 800 data warehouses and 150 virtual users for our tests.
- Run the TPROC-C benchmarking test from this tool by setting the ramp-up time and test duration.
- Once the test completes, the results will show up in both NOPM and TPM metrics.
- Ensure to refresh the TPC-C database before each iteration and test run.
- Final result has been derived from the average NOPM calculated from 5 such iterations.

DSS Benchmarking Process

- Create the TPC-H database and populate it with a desired scale factor using the schema build option of the HammerDB tool. We used a scale factor of 1 TB for our tests.
- Run a TPROC-H warm-up test from this tool, where a single user runs the select queries and provides the query times for 22 queries.
- Then, run a throughput test from this tool that allows 7 users to run the select queries.
- Calculate the average value of the response time in minutes for all 7 users.
- Final result has been derived from the average query response time calculated from 5 such iterations.

Test Methodology

Microsoft SQL Server 2022 on Windows Server is available in three editions: the Base Standard, the Base Enterprise Edition, and the Plus Enterprise Edition. We tested each edition, comparing OLTP and DSS performance of 3rd Gen Intel Xeon Scalable processors to 4th Gen Intel Xeon Scalable processors.

The benchmark for OLTP testing, HammerDB TPROC-C, is based on the TPC-C specification. This OLTP benchmark simulates a medium-to-large wholesale supplier with multiple warehouses, virtual users, and transactions. However, this supplier can represent any business in any industry that needs to manage, sell, or distribute products or services. For the OLTP benchmark, we populated an empty TPC-C database from the HammerDB build schema and prepared a full database backup. We then ran the HammerDB TPROC-C benchmarks.

Results

Microsoft and Intel collaborated on optimizing Microsoft SQL Server 2022 so it can deliver better OLTP and DSS performance on 4th Gen Intel Xeon Scalable processors, compared to previous-generation processors, for all three editions (see Figures 1 and 2).¹

- **Plus Enterprise Edition:** Up to 19.2% more NOPM for OLTP and up to 19.4% faster query response times in DSS.
- **Base Enterprise Edition:** Up to 17.7% more NOPM for OLTP and up to 11.6% faster query response times in DSS.
- **Base Standard Edition:** Up to 34.2% more NOPM in OLTP and up to 28.1% faster query response times in DSS.

Customers who choose the Plus Enterprise Edition can also take advantage of the high throughput and low latency of the Intel® Optane™ SSD P5800X—the world’s fastest data center SSD.²

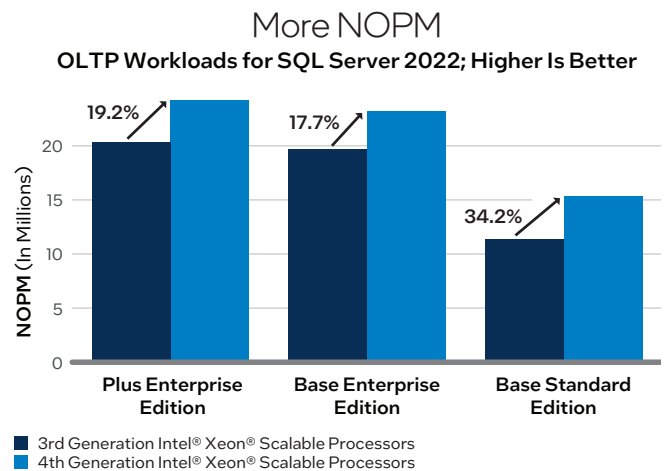


Figure 1. OLTP performance comparison of NOPM with the latest Intel® Xeon® Scalable processors.

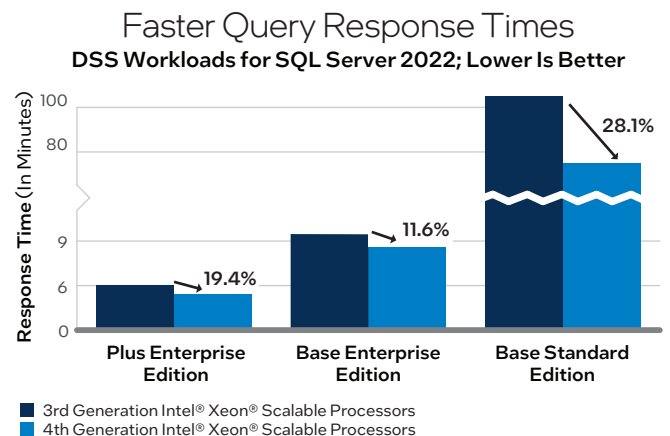


Figure 2. DSS performance comparison of query response times with the latest Intel® Xeon® Scalable processors.

Hardware Configuration Details

The following tables provide information about components and settings of the 4th Gen Intel Xeon Scalable processor infrastructure used for performance analysis and characterization testing. See the endnotes at end of the brief for 3rd Gen Intel Xeon Scalable processor configurations.

	Base Standard	Base Enterprise	Plus Enterprise
Processor	2x Intel® Xeon® Gold 6444Y+ processor (16 cores, 3.6 GHz, 270W) Intel® SST option: 12 cores/24 threads @ 3.6 GHz, 225W	2x Intel Xeon Gold 6438Y+ processor (32 cores, 2.0 GHz, 205W) Intel SST option: 24 cores/48 threads @ 2.1 GHz, 185W	2x Intel Xeon Gold 8460Y+ processor (40 cores, 2.0 GHz, 300W) Intel SST option: 32 cores/64 threads @ 2.3 GHz, 300W
Memory	256 GB (16x 16 GB 4800 MHz DDR5 RDIMM)	256 GB (16x 16 GB 4800 MHz DDR5 RDIMM)	512 GB (16x 32 GB 4800 MHz DDR5 RDIMM)
Boot Drive	1x Solidigm D3-S4610 960GB, 2.5"	1x Solidigm D3-S4610 960GB, 2.5"	1x Solidigm D3-S4610 960GB, 2.5"
Storage (Log Drive)	2x Solidigm D7-P5510 3.84 TB, 2.5"	2x Solidigm D7-P5510 3.84 TB, 2.5"	2x Intel® Optane™ SSD P5800X 400 GB
Storage (Data Drive)	6x Solidigm D3-S4500 Series 3.84 TB, 2.5"	6x Solidigm D7-P5510 3.84 TB, 2.5"	6x Solidigm D7-P5510 3.84 TB, 2.5"
Network	1x 25 GbE Intel® Ethernet Network Adapter E810-CAQ2	1x 25 GbE Intel Ethernet Network Adapter E810-CAQ2	1x 25 GbE Intel Ethernet Network Adapter E810-CAQ2
Management Network	Integrated 1GbE	Integrated 1GbE	Integrated 1GbE

Other Configuration Details

Important System Settings	
Power Plan	High performance
Firewall	Disabled
Control Panel: System and Security-Advanced System Settings	Adjust for best performance of programs
Control Panel: System and Security-Advanced System Settings – Virtual Memory	Custom Size: 4096 initial and maximum (not system managed)
Hardware Prefetcher	Disabled
Last-Level Cache (LLC) Prefetcher	Disabled (enabled by default)
DCU IP Prefetcher	Disabled
CPU PnP Policy	Performance
Workload Configuration	Balanced
Uncore Frequency Scaling	Disabled
Performance P-Limit	Disabled
CPU P-State Control	Boot performance mode
CPU State (C-State) Control > Package C-State	C0/C1 state
CPU C-State Control > Processor C6	Disabled
CPU Performance State (P-State) Control > Energy-Efficient Turbo	Enabled
Power Management Settings	Performance

Software Versions (same for all configurations)	
Microsoft Windows Server 2022 Standard Edition or higher	10.0.20348 or latest
Microsoft SQL Server 2022 Enterprise Edition or Microsoft SQL Server 2022 Standard Edition	16.0.1000.6 (x64) or latest
HammerDB	4.0/4.5/latest
Windows Patches	Updated to the latest

Accelerator Technologies Enabled	
Intel® Turbo Boost Technology	
Intel® Hyper-Threading Technology	

Profiles and Workloads

HammerDB is the benchmark tool used to optimize the SQL Server solutions. The following tables describe the SQL HammerDB workloads and settings used in OLTP and DSS testing.

SQL Settings for OLTP and DSS Workloads		
	Base Standard/ Base Enterprise	Plus Enterprise
Maximum Server Memory (MB)	209,920	501,760
Minimum Server Memory (MB)	10,240	10,240
Lightweight Pooling	1 (Enabled)	1 (Enabled)
Maximum Worker Threads	3,000	3,000
Priority Boost	1 (Enabled)	1 (Enabled)
Recovery Interval (Minimum)	32,767 mins.	32,767 mins.
Lock Pages in Memory	Enabled	Enabled

HammerDB Settings for OLTP Workload	
Database Schema (Schema Build)	800 warehouses
Ramp Time	2 minutes
Test Time	5 minutes
Use the "All Warehouses" Option	Enabled
Checkpoint on End of Test	Enabled
Virtual Users	Enabled
Number of Virtual Users	150
User Delay	1 ms

HammerDB Settings for DSS Workload	
Total Query Sets Per User	1
Refresh Function	Disabled
Number of Update Sets	1
Trickle Refresh Delay	1,000 ms
Scale Factor	1TB
Number of Virtual Users	7
User Delay	500 ms
Repeat Delay	500 ms
Maxdop	Set to 2 for Base Standard Edition Set to 0 for Base & Plus Enterprise Editions
Iterations	1

Conclusion

With this Microsoft SQL solution, customers can deploy data center infrastructure quickly and efficiently to help achieve reliable, security-enabled, and workload-optimized performance on a balanced platform. Customers can spend less time, effort, and expense evaluating hardware and software options. This solution helps customers simplify design choices by bundling hardware and software elements together while maximizing performance.

Further Information

- 4th Gen Intel® Xeon® Scalable processors
- Intel® Optane™ SSDs
- Microsoft SQL Server 2022

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3rd Gen configuration details:

Common configuration: Intel® Hyper-Threading Technology = ON, Intel® Turbo Boost Technology = ON, Benchmark tool = HammerDB 4.0 for Base designs & HammerDB 4.5 for Plus Design. **Base Standard edition:** Testing by Intel as of March 2021. Single node, 2x Intel® Xeon® Silver 4310 processor (12 cores), Memory: 256 GB (16x 16 GB 3200 MHz DDR4 RDIMM), BIOS = SE5C6200.86B.0022.D27.2104140041, microcode = 0D000280, Storage (boot): 1x Solidigm D3-S4510 Series (240 GB), Storage (data drive): 6x Solidigm D3-S4610 Series (960 GB), Storage (log drive): 2x Solidigm D3-P4610 (1.6 TB, RAID 1), network devices: 1x Intel® Ethernet Converged Network Adapter X550, network speed: 10 GbE. OS/Software: Windows Server 2019 Data Center Edition Build 17763, with SQL Server 2019 Standard Edition RTM CU10 (Base designs) or CU9 (Plus design). Throughput for OLTP workloads = 1.14M NOPM; average query response time @ scale factor 1,000 and 7 users for DSS workloads = 105.24 minutes. **Base Enterprise edition:** Testing by Intel as of May 2023. Single node, 2x Intel® Xeon® Gold 5318S processor (24 cores), Memory: 256 GB (16x 16 GB 3200 MHz DDR4 RDIMM), BIOS = SE5C620.86B.01.01.0007.2210270543, microcode = 0D00037B, Storage (boot): 1x Solidigm D3-S4610, 960 GB SSD, 3D NAND, TLC, Storage (data drive): 6x Solidigm D3-P4510 (2 TB), Storage (log drive): 2x Solidigm D3-P4610 (1.6 TB), network devices: 1x Intel® Ethernet Converged Network Adapter X550, network speed: 10 GbE. OS/Software: Windows Server 2022 Standard Edition Build 20348, with SQL Server 2019 Enterprise Edition RTM CU20. Throughput for OLTP workloads = 1.97M NOPM; average query response time @ scale factor 1,000 and 7 users for DSS workloads = 9.37 minutes. **Plus Enterprise edition:** Testing by Intel as of March 2023. Single node, 2x Intel® Xeon® Gold 6348 processor (28 cores), Memory: 512 GB (16x 32 GB 3200 MHz DDR4 RDIMM), BIOS = SE5C620.86B.01.01.0007.2210270543, microcode = 0D00037B, Storage (boot): 1x Solidigm DC S4610, 960 GB M.2 NVMe PCIe3x4, 3D NAND, TLC, Storage (data drive): 6x Solidigm D7-P5510 (3.8 TB), Storage (log drive): 2x Intel® Optane™ SSD DC P5800X (400 GB, RAID 1), network devices: 1x Intel® Ethernet Converged Network Adapter X550, network speed: 10 GbE. OS/Software: Windows Server 2022 Standard Edition Build 20348, with SQL Server 2022 Enterprise Edition RTM 16.0.1000.6 (X64). Throughput for OLTP workloads = 2.03M NOPM; average query response time @ scale factor 1,000 and 7 users for DSS workloads = 6.23 minutes.

4th Gen configuration details:

Testing by Intel as of March-May 2023. Common configuration: OS/Software: Windows 2022 Standard Edition with SQL Server 2022 Enterprise Edition (RTM) – 16.0.1000.6 (x64) (Base & Plus Enterprise designs), Windows 2022 Standard Edition with SQL Server 2022 Standard Edition (RTM) – 16.0.1000.6 (x64) (Base Standard design), Intel® Hyper-Threading Technology = ON, Intel® Turbo Boost Technology = ON, Benchmark tool = HammerDB 4.0 for Base designs & HammerDB 4.5 for Plus Design, benchmark for OLTP testing = HammerDB TPROC-C, benchmark for DSS testing = HammerDB TPROC-H. **Base Standard edition:** Single node, 2x Intel® Xeon® Gold 6444Y+ processor (12 cores), Memory: 256 GB (16x 16 GB 4800 MHz DDR5 RDIMM), BIOS = American Megatrends International LLC 3A11.uh12/02/2022, microcode = 2B000111, Storage (boot): 1x Solidigm D3-S4610 (960 GB, 2.5in PCIe 4.0 x4, TLC), Storage (data drive): 6x Solidigm D3-S4500 Series (3.84 TB, 2.5in PCIe 4.0 x4, TLC), Storage (log drive): 2x Solidigm D7-P5510 Series (3.84 TB, 2.5in PCIe 4.0 x4, TLC), Network devices: 1x 25 GbE Intel® Ethernet Network Adapter E810-C-Q2, Network speed: 25 GbE, 1x 10 GbE Intel Ethernet Converged Network Adapter X550-T2, Network Speed: 1 GbE. Throughput for OLTP workloads = 1.53M NOPM; average query response time @ scale factor 1,000 and 7 users for DSS workloads = 75.68 minutes. **Base Enterprise edition:** Single node, 2x Intel® Xeon® Gold 6438Y+ processor (24 cores), Memory: 256 GB (16x 16 GB 3200 MHz DDR4 RDIMM), BIOS = American Megatrends International LLC 3A11.uh12/02/2022, microcode = 2B000111, Storage (boot): 1x Solidigm D3-S4610 (960 GB, 2.5in PCIe 4.0 x4, TLC), Storage (data drive): 6x Solidigm D7-P5510 3.84 TB (NVMe), Storage (log drive): 2x Solidigm D7-P5510 3.84 TB (NVMe), Network devices: 1x 25 GbE Intel Ethernet Network Adapter E810-C-Q2, Network speed: 25 GbE, 1x 10 GbE Intel Ethernet Converged Network Adapter X550-T2, Network Speed: 1 GbE. Throughput for OLTP workloads = 2.32M NOPM; average query response time @ scale factor 1,000 and 7 users for DSS workloads = 8.28 minutes. **Plus Enterprise edition:** Single node, 2x Intel® Xeon® Platinum 8460Y+ processor (32 cores), Memory: 512 GB (16x 32 GB 4800 MHz DDR5 DIMM), BIOS = American Megatrends International LLC 3A11.uh12/02/2022, microcode = 2B000111, Storage (boot): 1x Solidigm D3-S4610 (960 GB, 2.5in PCIe 4.0 x4, TLC), Storage (data drive): 6x Solidigm D7-P5510 Series (3.84 TB) (NVMe), Storage (log drive): 2x Intel® Optane™ SSD DC P5800X 400 GB (NVMe), Network devices: 1x 25 GbE Intel Ethernet Network Adapter E810-C-Q2, Network speed: 25 GbE, 1x 10 GbE Intel Ethernet Converged Network Adapter X550-T2. Throughput for OLTP workloads = 2.42M NOPM; average query response time @ scale factor 1,000 and 7 users for DSS workloads = 5.02 minutes.

² Claim [14] at <https://edc.intel.com/content/www/us/en/products/performance/benchmarks/intel-optane-ssd-p5800x-series/>