

Lenovo Database Configuration for Microsoft SQL Server 2016 – 22TB

Data Warehouse Fast Track Solution

Data Warehouse problem and a solution

The rapid growth of technology means that the amount of available data and the ability to collect that data increased to a level unthinkable as little as five years ago. As the volume and velocity of data increased, however, extracting meaningful insight in a timely manner became more complex. Therefore, opportunities are being missed and effort is being wasted. To compete, businesses in the 21st century are demanding the tools to derive true value from their data.

This Microsoft Data Warehouse Fast Track (DWFT) configuration for SQL Server 2016 improves time-to-value for data warehousing needs with a new scalable architecture. This solution in the Lenovo portfolio uses the high performance System x3650 M5 server combined with NVMe Flash Adapter Storage to solve SQL database warehouse needs up to 22 TB in size.

The Microsoft Data Warehouse Fast Track program makes it easy to reduce costs, save time, and reduce risk with reliable, pretested hardware and best practices for data warehousing. This solution features the following highlights:

- Reduce time to value with pretested hardware configurations.
- Reduce hardware testing and reduce tuning immediately.
- Reduce total cost of ownership through better price and performance, rapid deployment, and advanced hardware.
- Optimize performance with pretested System x3650 M5 hardware configurations.
- Consolidate storage and match IT investment-to-information-value with NVMe Flash adapters.

The configuration listed in this document has a Fast Track RowStore rating of I/O: 8,305 MBps and ColumnStore throughput: of 1,851 Queries/Hr/TB.

Enterprise data warehouse with faster time-to-value

DWFT for SQL Server 2016 for Lenovo solution offerings are methodically tested and tuned to save you months of configuration, setup, testing, and tuning. With these offerings from Lenovo, you can now complete the following tasks:

- Buy all the hardware that you need from only one vendor including servers, storage, and networking.
- Build, tune, and deploy with confidence by using established data warehouse best practices.
- Select from different levels of performance, scalability, and price to suit your business needs.
- Choose from 4 to up to 120 Intel Xeon processor cores.
- Run targeted query workloads that are patterned for large sequential data sets rather than small random transactions.
- Eliminate bottlenecks with optimized rapid data reads and query aggregations

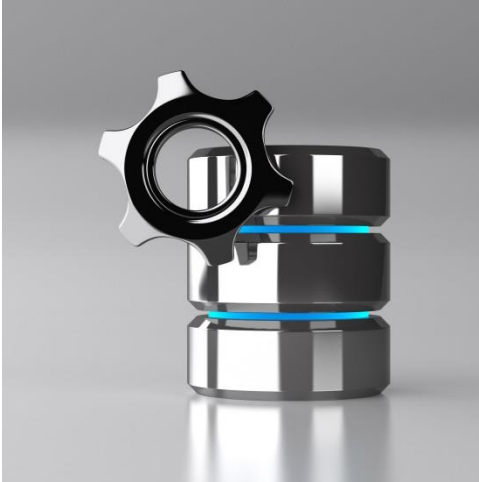
HIGHLIGHTS

- Standard 22 TB SQL DWFT solution from Lenovo
- Balanced and optimized configuration
- High performance NVMe storage solution
- Certified by Microsoft
- Reduced time to value



CONFIGURATION BRIEF

Lenovo Database Configuration for Microsoft SQL Server 2016 – 22TB



Microsoft SQL Server 2016

Microsoft® SQL Server 2016 has made significant improvements in data warehousing technologies and performance, including column-store features as well as many other improvements. Column-store indices offer great advantages over traditional row stores for analytics and data warehousing queries. They are ideally suited for the star schemas, and tables with billions of rows which are commonly seen. Among their advantages for analytics are:

- **Up to 10X compression in data size** - Data warehouses are very large by nature, and the compression offered by column store index technologies offers both space and cost savings, but also significantly increased performance, due to the dramatically reduced IO requirements given by the compression, coupled by the ability to only scan the specific columns required by each query. Compression also reduces the amount of memory required to hold a given number of rows from the source data warehouse.
- **Additional Indices** - SQL Server 2016 adds the capability to add additional (B-Tree) indices to column store-based tables, which enables efficient single-row lookup.

In addition to these architectural features, query processing in column-store indices is further optimized in the following ways:

- **Operator Pushdown** - Pushdown refers to moving both filter and aggregation query operations closer to the data, so that many of the filters and calculations can be done in the scan operators, dramatically reducing the volume of data which needs to be handled further on in query processing.
- **Batch Mode Processing** - SQL Server 2016 includes enhancements in batch-mode processing which processes many rows at a time rather than serially doing calculations on each individual row. These batch operations are further optimized by leveraging Single Instruction Multiple Data (SIMD) vector processing CPU instructions in the Intel® architectures.

Configuration tested and certified

This configuration features the following main components:

- Server: Lenovo System x3650 M5
- Processor: Two E5-2699 v4 22C 2.2 GHz
- Memory: 512 GB of DDR4 memory
- Storage: Four 2.0TB NVMe Flash Adapters for data and tempdb
- OS Storage: Two 300 GB SAS HDDs for the operating system (RAID 1)
- Logging: Two 480 GB SSDs for log (RAID 1)
- Software:
 - Microsoft Windows Server 2016 Standard Edition
 - Microsoft SQL Server 2016 Enterprise Edition

CONFIGURATION BRIEF

Lenovo Database Configuration for Microsoft SQL Server 2016 – 22TB

Powered by System x3650 M5 and 2.0TB NVMe Flash Adapters

Lenovo System servers, such as the System x3650 M5 server, feature the latest Intel Xeon E5-2600 v4 series processors. With more cores and more memory, the new M5 family is fast. The greatly increased processing power is provided by the latest Intel Xeon E5-2600 v4 processors. Lenovo System x3650 M5 servers include the following features:

- Two times the memory capacity of previous generation processors, with 24 DIMM sockets in the x3650 M5.
- Support for 64 GB TruDDR4 Memory LRDIMMs, up to 1.5 TB of memory in the x3650 M5.
- New storage technologies, such as the Intel P3700 2.0TB NVMe Enterprise Performance Flash Adapter for Lenovo System servers, which closely align the performance of storage with the power of the processors.
 - As an alternate to the Intel P3700 Flash Adapter, a quantity of four [Lenovo PX04PMC 1.92TB NVMe Mainstream Flash Adapters](#) may be employed in this configuration.

DWFT for SQL Server 2016 features the System x3650 M5 with 2.0TB NVMe Flash Adapters that improve productivity through data consolidation, availability performance, and scalability. These solid-state adapters simplify DWFT storage configuration and maintenance versus the use of a SAN, which has more parts to maintain and manage. The reference configuration is a 2-socket system that uses the DWFT V4 methodology.

Best practices for Data Warehouse Fast Track

For a balanced and optimized Data Warehouse configuration:

- Configure UEFI settings to set Memory mode to Independent.
- Configure UEFI settings to set Operating mode to Maximum performance.
- Configure high availability for the OS with 2-disk Raid-1.
- Configure high availability for the log drive with 2-disk Raid-1 or Raid-10 with more disks based on performance needs.
- Data files and tempdb can be on Raid 0 drives. Spread data and tempdb files evenly across all data drives for even performance.
- Configure more than one tempdb files; at least one file per data drive.
- Enable lock pages in memory option using Windows Group policy tool to prevent paging of data.
- If the server is dedicated to data warehousing,
 - Set processor affinity for SQL Server to use all the processors in the system.
 - Set SQL Server Maximum Server Memory to 90% of the total memory available on the server.
 - Add -E and optionally -T834 to SQL Server Startup parameters.

Lenovo System x3650 M5 High Performance Rack Server, Intel P3700 NVMe PCIe adapter and Lenovo NVMe Mainstream Flash Adapter



CONFIGURATION BRIEF

Lenovo Database Configuration for Microsoft SQL Server 2016 – 22TB

Reference Architecture Certification

DWFT Certification #2016-012	Lenovo 22TB (High Perf) System x3650 M5			Report Date:1/24/2017																			
DWFT Rev. 5.4	DWFT Reference Architecture																						
System Provider	System Name	Processor Type		Memory																			
Lenovo	x3650 M5	Intel Xeon E5-2699 v4 @2.20 GHz (2/44/88)		512 GB																			
Operating System		SQL Server Edition																					
Windows Server 2016 Standard Edition		SQL Server 2016 Enterprise Edition																					
Storage Provider	Storage Information																						
Lenovo	2x 300GB 10K rpm HDDs for OS (Raid 1) 4 x 2TB Intel P3700 NVMe adapters for data and tempdb 2 x 480GB Enterprise value SSDs for log (RAID 1)																						
<table><tr><th colspan="4">Primary Metrics</th></tr><tr><td>Rated User Data Capacity¹ (TB)</td><td>Row Store Relative Throughput²</td><td>Column Store Relative Throughput³</td><td>Maximum User Data Capacity¹ (TB)</td><td colspan="2"></td></tr><tr><td>22</td><td>282</td><td>285</td><td>25</td><td colspan="2"></td></tr></table>						Primary Metrics				Rated User Data Capacity ¹ (TB)	Row Store Relative Throughput ²	Column Store Relative Throughput ³	Maximum User Data Capacity ¹ (TB)			22	282	285	25				
Primary Metrics																							
Rated User Data Capacity ¹ (TB)	Row Store Relative Throughput ²	Column Store Relative Throughput ³	Maximum User Data Capacity ¹ (TB)																				
22	282	285	25																				
<table><tr><th colspan="6">Row Store</th></tr><tr><td>Relative Throughput²</td><td>Measured Throughput (Queries/Hr/TB)</td><td>Measured Scan Rate Physical (MB/Sec)</td><td>Measured Scan Rate Logical (MB/Sec)</td><td>Measured I/O Throughput (MB/Sec)</td><td>Measured CPU (Avg.) (%)</td></tr><tr><td>282</td><td>326</td><td>7,140</td><td>9,470</td><td>8,305</td><td>93</td></tr></table>						Row Store						Relative Throughput ²	Measured Throughput (Queries/Hr/TB)	Measured Scan Rate Physical (MB/Sec)	Measured Scan Rate Logical (MB/Sec)	Measured I/O Throughput (MB/Sec)	Measured CPU (Avg.) (%)	282	326	7,140	9,470	8,305	93
Row Store																							
Relative Throughput ²	Measured Throughput (Queries/Hr/TB)	Measured Scan Rate Physical (MB/Sec)	Measured Scan Rate Logical (MB/Sec)	Measured I/O Throughput (MB/Sec)	Measured CPU (Avg.) (%)																		
282	326	7,140	9,470	8,305	93																		
<table><tr><th colspan="6">Column Store</th></tr><tr><td>Relative Throughput²</td><td>Measured Throughput (Queries/Hr/TB)</td><td>Measured Scan Rate Physical (MB/Sec)</td><td>Measured Scan Rate Logical (MB/Sec)</td><td>Measured I/O Throughput (MB/Sec)</td><td>Measured CPU (Avg.) (%)</td></tr><tr><td>285</td><td>1,851</td><td>3,098</td><td>N/A</td><td>N/A</td><td>81</td></tr></table>						Column Store						Relative Throughput ²	Measured Throughput (Queries/Hr/TB)	Measured Scan Rate Physical (MB/Sec)	Measured Scan Rate Logical (MB/Sec)	Measured I/O Throughput (MB/Sec)	Measured CPU (Avg.) (%)	285	1,851	3,098	N/A	N/A	81
Column Store																							
Relative Throughput ²	Measured Throughput (Queries/Hr/TB)	Measured Scan Rate Physical (MB/Sec)	Measured Scan Rate Logical (MB/Sec)	Measured I/O Throughput (MB/Sec)	Measured CPU (Avg.) (%)																		
285	1,851	3,098	N/A	N/A	81																		
The reference configuration is a 2 socket system rated for 25TB using the DWFT V4 methodology																							
¹ Assumes a data compression ratio of 5:1																							
² Percent ratio of the throughput to the row store throughput of the reference configuration.																							
³ Percent ratio of the throughput to the column store throughput of the reference configuration.																							
* Reported metrics are based on the qualification configuration which specifies database size and SQL Server memory.																							

CONFIGURATION BRIEF

Lenovo Database Configuration for Microsoft SQL Server 2016 – 22TB

Bill of materials

Feature code	Description	Quantity
8871-AC1	22TBDWFT: Lenovo System x3650 M5	1
A5G6	x3650 M5 8x 2.5" HS HDD Assembly Kit (Single RAID)	1
5977	Select Storage devices; no IBM configured RAID required	1
ATDY	System x3650 M5 24x 2.5" Base without Power Supply BDW	2
A5EW	System x 900W High Efficiency Platinum AC Power Supply	2
9206	No Preload Specify	1
ATCA	16 GB TruDDR4 Memory (2Rx4, 1.2 V) PC4-19200 CL17 2400 MHz LP RDIMM	24
AT7M	Intel P3700 2.0TB NVMe Enterprise Performance Flash Adapter	4
ATL3	System Documentation and Software-US English	1
ATF2	Intel Xeon Processor E5-2699 v4 22C 2.2 GHz 25 MB Cache 2133 MHz 135 W	1
ATFT	Addl Intel Xeon Processor E5-2699 v4 22C 2.2GHz 25MB 2133MHz 135W	1
AT89	300 GB 10K 12 Gbps SAS 2.5" G3HS HDD	2
AT8T	480 GB SATA 2.5-inch MLC G3HS Enterprise Value SSD	2
6311	2.8 m, 10A/100-250V, C13 to IEC 320-C14 Rack Power Cable	1
A3YZ	ServeRAID M5210 SAS/SATA Controller	1
A5FW	Lenovo System Gen-II Universal Slides Kit	1
ATG5	Lenovo System x3650 M5 WW Packaging	1
A5R6	System x3650 M5 PCIe Riser 2 (2 x8 FH/FL + 1 x8 FH/HL Slots)	1
ATE4	System x3650 M5 Planar BDW	1
A59E	Lenovo System x3550 M5 Label GMB	1
A5FP	System x3650 M5 PCIe Riser 1 (2 x8 FH/FL + 1 x8 FH/HL Slots)	1
01GX-366	3YR Tech Install Parts 24x7x4	1
Alternate 1	The following NVMe Flash Adapter may be used in place of the Intel P3700 Flash Adapter (feature code AT7M)	
AUUP	ThinkSystem HHHL PX04PMC 1.92TB Mainstream NVMe PCIe 3.0 x4 Flash Adapter	4



CONFIGURATION BRIEF

Lenovo Database Configuration for Microsoft SQL Server 2016 – 22TB

High Performance at low cost with Lenovo x3650 M5 servers and NVMe PCIe adapters



Why Lenovo System servers for Microsoft SQL DWFT

Lenovo offers a wide range of servers and options. The Lenovo reference configurations for DWFT for SQL Server bring together the right mix of technology and software. The configurations integrate the latest powerful Lenovo System rack and enterprise servers, robust Lenovo Storage options, and the data warehouse capabilities of SQL Server 2016 Enterprise Edition.

Why Lenovo

Lenovo is a leading provider of x86 servers for the data center. Featuring rack, tower, blade, dense and converged systems, the Lenovo server portfolio provides excellent performance, reliability and security. Lenovo also offers a full range of networking, storage, software, solutions, and comprehensive services supporting business needs throughout the IT lifecycle. With options for planning, deployment, and support, Lenovo offers expertise and services needed to deliver better service-level agreements and generate greater end-user satisfaction.

For More Information

To learn more about the Lenovo Database Configuration for Microsoft SQL Server 2016 – 22 TB solution, contact your Lenovo Business Partner or visit:

<http://shop.lenovo.com/us/en/systems/solutions/database/>

For more information on the Lenovo NVMe Mainstream Flash Adapters, visit:

<https://lenovopress.com/lp0627.pdf>



© 2017 Lenovo. All rights reserved.

Availability: Offers, prices, specifications and availability may change without notice. Lenovo is not responsible for photographic or typographical errors. **Warranty:** For a copy of applicable warranties, write to: Lenovo Warranty Information, 1009 Think Place, Morrisville, NC, 27560, Lenovo makes no representation or warranty regarding third-party products or services. **Trademarks:** Lenovo, the Lenovo logo, System x, ThinkServer are trademarks or registered trademarks of Lenovo. Microsoft and Windows are registered trademarks of Microsoft Corporation. Intel, the Intel logo, Xeon and Xeon Inside are registered trademarks of Intel Corporation in the U.S. and other countries. Other company, product, and service names may be trademarks or service marks of others. **CRN: DBSSQLM2262**

10/2017