

Lenovo Database Configuration for Microsoft SQL Server 2016 – 145TB

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 x3850 X6 server combined with SanDisk IoMemory3 PCIe flash adapters to solve SQL database warehouse needs up to 145 TB in size.

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 x3850 X6 hardware configurations.

The configuration listed in this document has a Fast Track RowStore I/O throughput rating of 13,516 MB/s and ColumnStore throughput of 4,774 Queries/Hr/TB.

Enterprise data warehouse with faster time-to-value

DWFT for SQL Server 2016 for System x 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 192 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

- Advanced 145TB SQL DWFT solution from Lenovo
- Balanced and Optimized configuration
- Build, tune and deploy with confidence using established data warehouse best practices
- Eliminate bottlenecks with optimized rapid data reads and query aggregations
- Certified by Microsoft
- Reduced time to value



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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 x3850 X6
- Processors: Four Intel Xeon E7-8890 v4 24-core 2.2 GHz
- Memory: Ninety-six 32GB DDR4 DIMMs for a total 3,072 GB memory
- Storage: Eight SanDisk ioMemory3 6.4TB Enterprise Flash Adapters for data and tempdb
- OS Storage: Two 300 GB SAS HDDs
- Logging: Six 960 GB SSDs for log



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Powered by System x3850 X6 and SanDisk ioMemory3 6.4TB PCIe Enterprise Performance Flash Adapters

The X6 server features Intel Xeon processors. With more cores and more memory, the X6 family is designed to be fast from the ground up. Every subsystem is tuned to maximize performance.

- Harness greatly increased processing power, with Xeon processor E7-8800 v4
- Achieve three times the memory capacity of previous platform with 96 DIMM sockets and 6TB memory in the x3850 X6 with 64GB DIMMs.
- Proven storage technologies, such as the SanDisk ioMemory3 6.4TB PCIe Enterprise Flash Adapter for Lenovo System servers, which closely align the performance of storage with the power of the processors.

DWFT for SQL Server 2016 with System x3850 X6 features SanDisk ioMemory3 6.4TB PCIe Enterprise Flash Adapters designed to improve productivity through data consolidation, availability, performance and scalability. These solid-state devices simplify DWFT storage configuration and maintenance versus the use of a SAN, which has more parts to maintain and manage.

Lenovo X6 servers continue to lead the way as the shift toward mission-critical scalable databases, business analytics, virtualization, enterprise applications and cloud- computing applications accelerates.

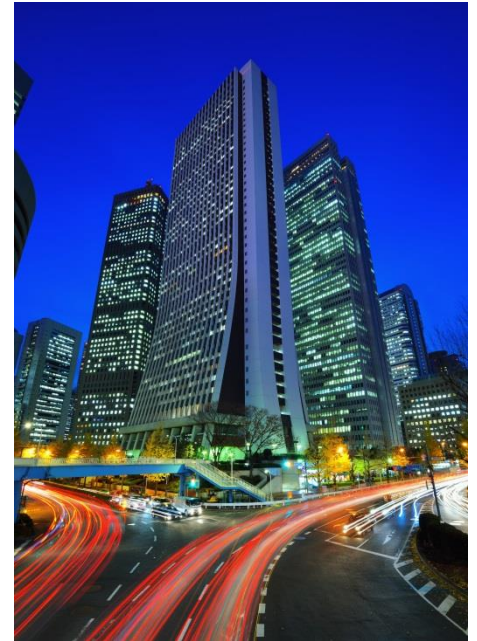
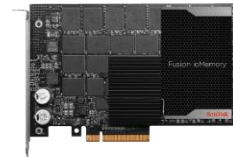
- Fast: x3850 X6 features outstanding compute performance and sophisticated memory technologies, providing lower latencies, faster response times and smarter data management in real time.
- Agile: Modular design for multiple generations of processors, providing a unique “pay-as-you-grow” capability and “fit-for-purpose” design for the lowest total cost of ownership.
- Resilient: X6 platforms maximize application uptime, provide fault tolerance and promote easy integration in virtual environments.

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 x3850 X6 Mission Critical Rack Server with and SanDisk ioMemory3 6.4TB PCIe Flash Adapters



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Configuration certification

DWFT Certification #2016-007	Lenovo System x3850 X6 DWFT Reference Architecture		Report Date 09/7/2016		
DWFT Rev. 5.4					
System Provider	System Name	Processor Type	Memory		
	Lenovo System x3850 X6	Intel Xeon E7-8890 v4 2.2 GHz (4/96/192)	3072 GB		
Operating System		SQL Server Edition			
Windows Server 2016		SQL Server 2016 Enterprise Edition			
Storage Provider	Storage Information				
	2x 300 GB SAS HDDs for OS (RAID 1) 8x SanDisk ioMemory3 (6.4TB) Enterprise Flash adapters for data and tempdb 4x 960GB SSDs for log (RAID 10)				
Primary Metrics					
Rated User Data Capacity ¹	Row Store Relative Throughput ²	Column Store Relative Throughput ³	Maximum User Data Capacity ¹		
(TB)			(TB)		
145	459	734	187		
Row Store					
Relative Throughput ²	Measured Throughput	Measured Scan Rate Physical	Measured Scan Rate Logical	Measured I/O Throughput	Measured CPU (Avg.)
	(Queries/Hr/TB)	(MB/Sec)	(MB/Sec)	(MB/Sec)	(%)
459	486	12,200	14,832	13,516	87
Column Store					
Relative Throughput ²	Measured Throughput	Measured Scan Rate Physical	Measured Scan Rate Logical	Measured I/O Throughput	Measured CPU (Avg.)
	(Queries/Hr/TB)	(MB/Sec)	(MB/Sec)	(MB/Sec)	(%)
734	4,774	2,798	N/A	N/A	88
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.					

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Bill of Materials

Feature code	Description	Quantity
6241MC1	145TBDWFT : Lenovo System x3850 X6 for MS OS	1
ASMH	x3850 X6 4U Chassis	1
ATX9	X6 Compute Book Intel Xeon Processor E7-8890 v4 24C 2.2GHz 60M 165W	1
ATXZ	Addl X6 Compute Book Intel Xeon Processor E7-8890 v4 24C 2.2GHz 165W	3
ATCB	32GB TruDDR4 Memory (2Rx4, 1.2V) PC4-19200 CL17 2400MHz LP RDIMM	96
00YA809	SanDisk ioMemory3 6.4TB PCIe Enterprise Flash Adapter	8
A4A6	4x 2.5" HDD Riser	2
A3YZ	ServeRAID M5210 SAS/SATA Controller	1
AT89	300GB 10K 12Gbps SAS 2.5" G3HS HDD	2
AT8U	960GB Enterprise Entry SATA G3HS 2.5" SSD	6
A4A2	X6 Half-length I/O Book	2
A40R	Intel I350-T4 ML2 Quad Port GbE Adapter	1
A54D	1400W HE Redundant Power Supply for altitudes >5000 meters	4
6311	2.8m, 10A/100-250V, C13 to IEC 320-C14 Rack Power Cable	4
A4A1	X6 Storage Book	1
ATYH	x3850/x3950 X6 I/O Planar IV	1
A4AA	Rail Kit	1
A4A4	Midplane for 4U Chassis	1
5977	Select Storage devices - no configured RAID required	1
6134	Unique SBB for AC1/MC1 models	1
ASFA	System Documentation and Software-US English refresh	1
A4BP	Short SAS cable to planar	2
ASFD	Labels GBM	1
A2HP	Configuration ID 01	1
A4AB	System 4U Packaging - WW	1
A4VH	Lightpath LCD Op Panel	1
A4C1	2U bracket for low profile-internal-storage adapter	1
A4QX	Rating label for 1400W PS	4
5374CM1	HIPO : Configuration Instruction	1
A46P	ServeRAID M5210 SAS/SATA Controller Placement	1
A2HP	Configuration ID 01	1
A2JX	Controller 01	1



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Mission Critical support with the
Lenovo x3850 X6 server and SanDisk
ioMemory3 PCIe flash adapters



Why ioMemory3 PCIe solid state storage from SanDisk

Delivering high speed, low latency, and high efficiency, this new third-generation line of flash adapters brings scalable and optimized performance to distributed scale-out architectures at low cost. The SanDisk ioMemory3 PCIe Flash Adapters are designed primarily for servers and computing appliances to maximize compute efficiency while providing the added benefits of lower power and cooling costs, low management impact, and smaller storage footprints

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 – 145 TB solution, contact your Lenovo Business Partner or visit:

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



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