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TECHNICAL REPORT

70TB DWFT FOR MICROSOFT® SQL SERVER® 2016 USING SUPERMICRO® ULTRA 2028U WITH 24 NVME

EXECUTIVE SUMMARY

Supermicro® has collaborated with Microsoft® to develop a SuperServer® DWFT Reference Architecture, which utilizes high-performance and highly efficient 2U Ultra SuperServers, low latency and high throughput NVMe SSDs, the latest Intel® Xeon® processor E5-2600 v4 CPUs, as well as Microsoft® SQL Server® 2016.

By configuring 10 NVMe SSD drives out of the available 24 all-flash NVMe drive bays, this DWFT Reference Architecture is certified to be sufficient to host a 70TB data warehouse instance. For every data warehouse instance tested, the 2U Ultra system exhibits a great performance per dollar advantage.

Some of the key results are highlighted below:

- Rated User Data Capacity: 70TB
- Row Store Measured Throughput: 19,180 Queries/Hr (274 Queries/Hr/TB)
- Column Store Measured Throughput: 154,420 Queries/Hr (2,206 Queries/Hr/TB)

INTRODUCTION TO SUPERMICRO 2U ULTRA SOLUTION

What's New

- Support Dual Intel® Xeon® processor E5-2600 v4 product familly (Broadwell).
- Support up to 24x NVMe drives with industry's first-to-market true hot-swap capabilities.
- Scalable I/O expansion capabilities with support up to 6 PCI-E 3.0 x8 slots.
- Lowering OpEx with Redundant 1000W Titanium Level (96%) Digital Power Supplies.
- Supermicro Server Manager (SSM) provides a comprehensive solution to manage and maintain Supermicro servers in an IT data center from a single console view.

Microsoft SQL Server 2016 has made significant improvements in data warehousing performance compared to Microsoft SQL Server 2014. The improved Column Store index technologies offered up to 10x higher compression ratio in data size, which significantly reduced the number of I/O transactions and the amount of memory required, hence increased performance dramatically.

SQL Server 2016 also added additional (B-Tree) indices to column store-based tables, which enabled more efficient single-row lookup. Some of other performance improvements on column store include Operator Pushdown and Batch Mode Processing that further optimized the processing of column store-based queries.

Supermicro®, the leading innovator in high-performance, high-efficiency server technology is a premier provider of advanced Server Building Block Solutions® for HPC, Data Center, Cloud Computing, Enterprise IT and Embedded Systems worldwide. Supermicro's proven high level of quality and performance has become the platform of choice for supercomputer clusters and enterprise databases as well as mission-critical, front-end server applications.

The Supermicro® 2U Ultra SuperServer® DWFT Reference Architecture, which integrates low latency/ high speed NVMe (Non-Volatile Memory Express) SSDs with the latest Intel® Xeon® processor E5-2600 v4 Broadwell CPUs, has achieved excellent scores from DWFT benchmarks. With a total of 10 NVMe SSDs, the Reference Architecture is certified to be sufficient to host a 70TB Microsoft SQL Server 2016 data warehouse instance with measured CPU utilization rate up to 92/100% for row and column stores respectively.

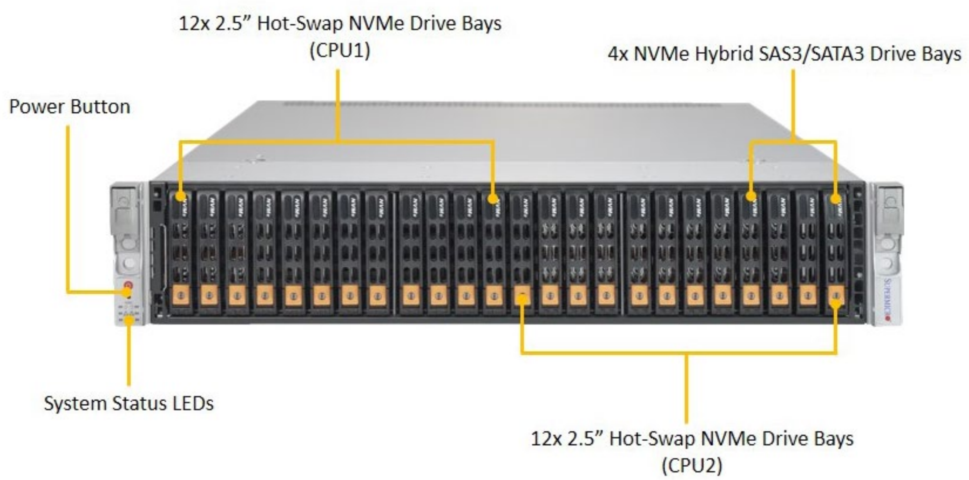

Figure 1. Supermicro 2U Ultra SuperServer 2028U-TN24R4T+ Front View

2U ULTRA 70TB DWFT REFERENCE ARCHITECTURE

The Supermicro 2U Ultra SYS-2028U-TN24R4T+ based DWFT reference architecture shown in Figure 1 offers numerous best-in-class advantages including performance, power efficiency, platform security and storage/IO scalability in the industry.

Key Features

- Dual Intel® Xeon® processor E5-2690 v4 (14 cores, 35 MB Smart Cache, 2.6 GHz, 9.6 GT/s Intel® QPI), which leverages the latest 14nm process technology that enables greater functionality, high density, and lower power consumption than previous generations.
- 24x 32GB DDR4-2133MHz memory DIMMs for a total of 768GB RAM. The system can support up to 24 DIMMs for up to 3TB DDR4 memory.
- 10x 3.2TB NVMe SSDs are used for SQL database storage. The system can support up to 24 NVMe SSD drives.
- 4x RJ45 10 Gigabit Ethernet LAN Ports.
- 2x Redundant 1000W Titanium Level Digital Power Supplies.

Storage Configuration

On the Ultra SYS-2028U-TN24R4T+ Reference Architecture, 24 drive bays are partitioned into 3 storage pools as shown in Figure 2.

The first 5 drive bays from left (see Figure 1) are allocated for 5 x 3.2TB NVMe drives to form LUN1 through LUN5. The 11th through 15th drive bays are allocated for the rest to form LUN11 through LUN15. The 10 NVMe are distributed this way to fully utilize the available PCI-E lanes provided by each CPU. In addition, drive bay 20 to 23 are populated with 4x 2TB SAS3 SSDs for the SQL Server log.

The system also includes 2 additional drive bays in the back of the chassis with RAID support as shown in Figure 3. 2x 400GB SATA3 SSDs in RAID 1 are deployed for hosting Windows Server 2012 R2.

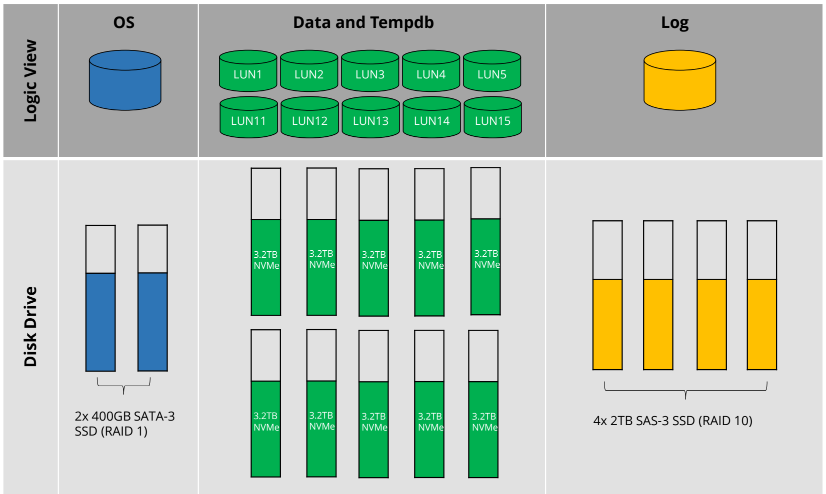

Figure 2. 70TB 2U Ultra DWFT Reference Architecture Storage Layout.

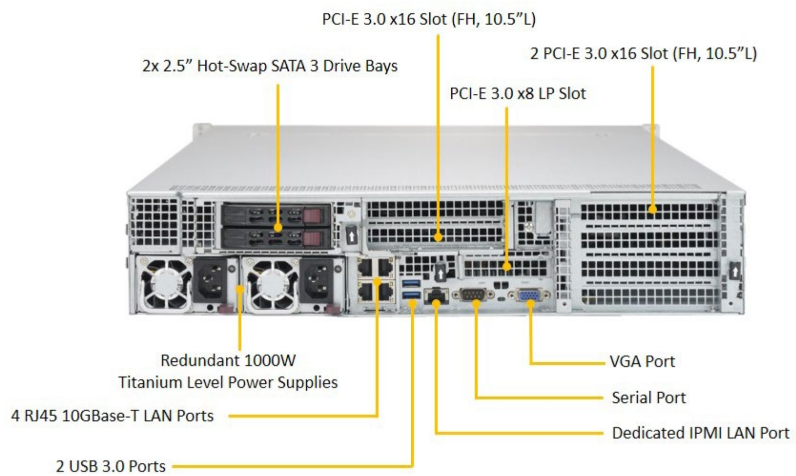

Figure 3. Supermicro 2U Ultra SuperServer 2028U-TN24R4T+ Rear View

Database Configuration

The table below show the configuration for data and log files of FT_Demo database that is used for this benchmark.

FILE GROUP	# OF DATA FILES
Base	10 data files, 1 data file on each data LUN
Part_ci1FG	10 data files, 1 data file on each data LUN
Part_ci2FG	10 data files, 1 data file on each data LUN
Part_ci3FG	10 data files, 1 data file on each data LUN
Part_ci4FG	10 data files, 1 data file on each data LUN
Part_ci5FG	10 data files, 1 data file on each data LUN
Part_ci6FG	10 data files, 1 data file on each data LUN
Part_ci7FG	10 data files, 1 data file on each data LUN
FT_Demo_LOG	1 transaction log on log LUN

Tempdb Configuration

The TempDB database is configured to utilize 10 data files for the 2 socket 28 core CPU configuration. A total of 7450GB of TempDB data files are evenly distributed on each LUN. The TempDB log file is placed on the log volume. "autogrow" is enabled for each data file.

SQL Server Settings

Trace Flags

Below trace flags were added to startup parameters:

- –E
  The -E parameter increases the number of extents that are allocated for each file in a filegroup so as to improve the data sequence and the performance of sequential I/O.

- –T834
  When this trace flag is set, SQL Server uses Windows large-page memory for the buffer pool. This setting improves performance by increasing the efficiency of the translation look-aside buffer (TLB) in the CPU.

Memory Settings

- Maximum server memory for this reference architecture was set to 118GB.

- The SQL server service account was assigned the Lock Pages in Memory policy.

Thread Mode

Configured SQL server to be running in thread mode.

```
sp_configure 'show advanced options', 1;
go
sp_configure 'lightweight pooling', 0;
go
reconfigure
go
```

Max Degree of Parallelism

Max degree of Parallelism (MDOP) was set to 28 for both row store and column store.

Resource Governor

The Memory Grant percentage value was set to 12% of the memory allocated. The setting is changed in the default resource pool as shown in Figure 4.

Server Configuration

Power settings

The power plan is set to High performance plan to reduce CPU throttling as shown in Figure 5.

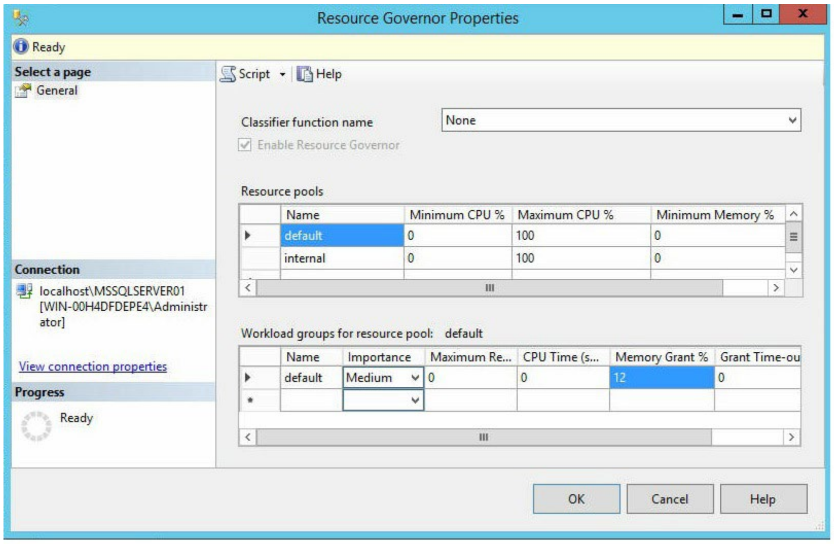

Figure 4. Resource Governor Settings

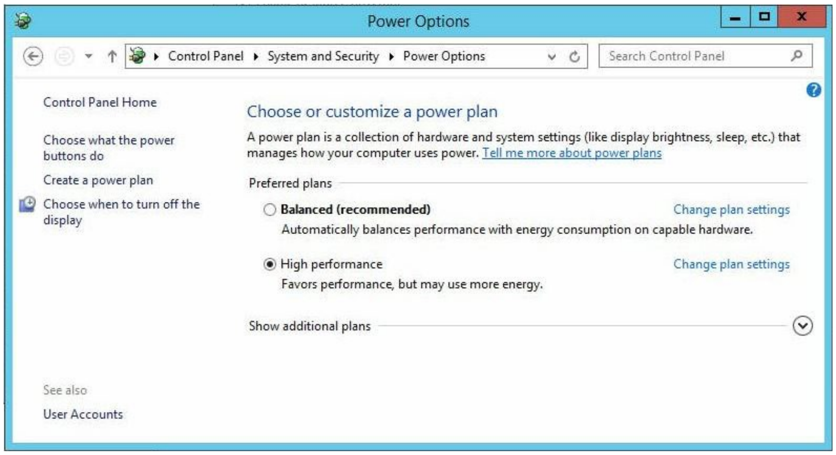

Figure 5. Server Power Settings

DWFT Certification #2016-006	Supermicro 2028U-TN24R4T+		Report Date: 8/10/2016
DWFT Rev. 5.4	DWFT Reference Architecture		
System Provider	**System Name**	**Processor Type**	**Memory**
SUPERMICRO	Supermicro 2028U-TN24R4T+	Intel Xeon E5-2690 v4 2.6 GHz (2S/28C/56T)	1024 GB
Operating System		**SQL Server Edition**	
Windows Server 2012 R2		SQL Server 2016 Enterprise Edition	
Storage Provider	**Storage Information**		
SUPERMICRO	10x 3.2TB NVMe for data and tempdb 2x 400 GB SATA-3 SSD for OS (RAID 1) 4x 2 TB SAS3 SSD for log (RAID 10)		

Primary Metrics

Rated User Data Capacity[1] (TB)	Row Store Relative Throughput[2]	Column Store Relative Throughput[3]	Maximum User Data Capacity[1] (TB)
70	225	339	103

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.) (%)
225	274	5,820	7,409	6,614	92

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.) (%)
339	2,206	3,033	N/A	N/A	100

The reference configuration is a 2 socket system rated for 25TB using SQL Server 2014 and 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.

Figure 6. 2U Ultra 70TB DWFT Reference Architecture Certification Results.

FOR MORE INFORMATION

- 2U Ultra SuperServers
  www.supermicro.com/Ultra
- All-Flash NVMe SuperStorage Solutions
  www.supermicro.com/NVMe
- 2U Simply Double SuperStorage
  supermicro.com/products/nfo/Simply_Double.cfm
- Supermicro® SuperServer® SYS-2028U-TNR4T+ Hybrid Datasheet
  www.supermicro.com/products/system/2u/2028/sys-2028u-tnr4t_.cfm
- Supermicro® SuperServer® SYS-2028U-TN24R4T+ All-Flash Datasheet
  www.supermicro.com/products/system/2u/2028/SYS-2028U-TN24R4T.cfm
- Microsoft Data Warehouse FastTrack
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- Microsoft SQL Server 2016
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- Microsoft Windows Server 2016
  www.microsoft.com/en-us/cloud-platform/windows-server
- Intel® Xeon® Processor E5-2600 v4 Product Family
  www.intel.com/content/www/us/en/processors/xeon/xeon-e5-solutions.html
- Intel® NVMe SSDs
  www.intel.com/content/www/us/en/solid-state-drives/solid-state-drives-ssd.html

SUPERMICRO MICROSOFT CERTIFIED SOLUTIONS

Supermicro and Microsoft have partnered together to deliver industry leading "fully certified solutions" on highly optimized and flexible Supermicro server and storage Systems. Supermicro systems are designed to provide significant advantage in the areas of power efficiency, performance and overall system optimization. These design principles coupled with bringing innovative technologies at an accelerated pace drives time to market value for Microsoft Solutions. In case of some of these disruptive technologies like NVMe, Supermicro is an established leader with the broadest range of products that customers can choose from.

Microsoft Certified Solutions running on Supermicro hardware include Windows Server, SQL Server Data Warehouse, Exchange Server, Hyper converged solutions like Storage Spaces Direct, Storage Server and Azure Stack. These solutions are optimized for Enterprise, Hybrid Cloud, Private and Public Cloud markets. We also deliver the Windows operating system software preloaded for fast growing SMB and Enterprise customers.

Supermicro has consistently innovated in the areas of designing server boards, chassis, highly efficient power supplies, networking equipments and storage systems. The building block approach is one of the key innovations to server system architecture. This vertically integrated design approach accelerates the delivery of application optimized Microsoft Solutions based on customer requirements.

SUPERMICRO SQL DWFT CERTIFIED REFERENCE ARCHITECTURES

Drive impact in your business using the power of a robust, cloud-enabled SQL Server 2016 database solution that offers enhanced performance, robust security, cloud enablement, and deeper insights across multiple types of data.

- 70TB DWFT For Microsoft SQL Server 2016 Using 2U Ultra 2028U All NVMe
  www.supermicro.com/white_paper/70TB_DWFT.pdf
- 40TB DWFT For Microsoft SQL Server 2014 Using 2U Ultra 2028U All NVMe
  www.supermicro.com/white_paper/40TB_DWFT.pdf
- 22TB DWFT For Microsoft SQL Server 2014 Using 2U Ultra 2028U Hybrid NVMe/SAS
  www.supermicro.com/white_paper/22TB_DWFT.pdf

About Super Micro Computer, Inc.

Supermicro® (NASDAQ: SMCI), the leading innovator in high-performance, high-efficiency server technology is a premier provider of advanced server Building Block Solutions® for Data Center, Cloud Computing, Enterprise IT, Hadoop/Big Data, HPC and Embedded Systems worldwide. Supermicro is committed to protecting the environment through its "We Keep IT Green®" initiative and provides customers with the most energy-efficient, environmentally-friendly solutions available on the market.

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