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TECHNICAL REPORT

22TB DWFT FOR MICROSOFT® SQL SERVER® 2014 USING SUPERMICRO® ULTRA 2028U WITH HYBRID 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 Intel® NVMe SSDs, the latest Intel Xeon® E5-2600 v4 Broadwell CPUs, as well as Microsoft® SQL Server® 2014.

Supermicro SuperServer 2028U-TNR4T+ has achieved excellent scores for the DWFT benchmarks. With total 2x 4TB NVMe SSD drives, the Reference Architecture is certified to be sufficient to host a 22TB data warehouse instance.

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Supermicro Recommends Windows.

INTRODUCTION TO SUPERMICRO 2U ULTRA SOLUTION

Microsoft Data Warehouse Fast Track (DWFT) for SQL Server® 2014 is designed to provide customers optimized and validated system architectures for addressing data warehouse workload challenges. With the new "Clustered Column Store Index" feature, SQL Server 2014 is able to deliver higher data compression ratio to support the exponential growth of data, and to meet new demands for lower data latency and faster query response times.

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 Intel® NVMe (Non-Volatile Memory Express) SSDs with the latest Intel® Xeon® E5-2600 v4 Broadwell CPUs, has achieved excellent scores from DWFT benchmarks. With a total of 2x 4TB NVMe SSDs, the Reference Architecture is certified to be sufficient to host a 22TB Microsoft SQL Server 2014 data warehouse instance.
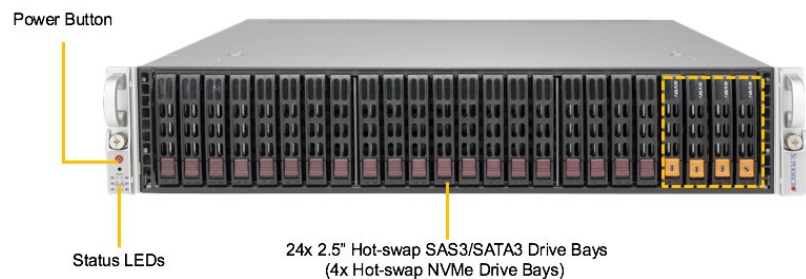
What's New

- Support up to 4x NVMe drives with industry's first-to-market true hot-swap capabilities. Deliver over 6x better IOPS performance, and 7x lower latency than SATA SSDs.

- Flexible drive deployment: users can freely combine and hot-swap SATA, SAS and NVMe drives for various usage scenarios within a single system with 26x 2.5" drive bays.

- 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.

Power Button

Status LEDs

24x 2.5" Hot-swap SAS3/SATA3 Drive Bays
(4x Hot-swap NVMe Drive Bays)

Figure 1. Supermicro 2U Ultra SuperServer 2028U-TNR4T+

2U ULTRA 22TB DWFT REFERENCE ARCHITECTURE

The Supermicro 2U Ultra SYS-2028U-TNR4T+ 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® E5-2690 v4 family processors (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.

- 8x 32GB DDR4-2133MHz memory DIMMs for a total of 256GB RAM. The system can support up to 24 DIMMs for up to 3TB DDR4 memory.

- 4 Intel DC P3500 2TB NVMe drives for SQL data storage.

- 2x 480GB SATA3 SSDs and 8x 300GB SAS3 HDDs for OS and SQL Server logs.

- 4x 10GBase-T LAN Ports.

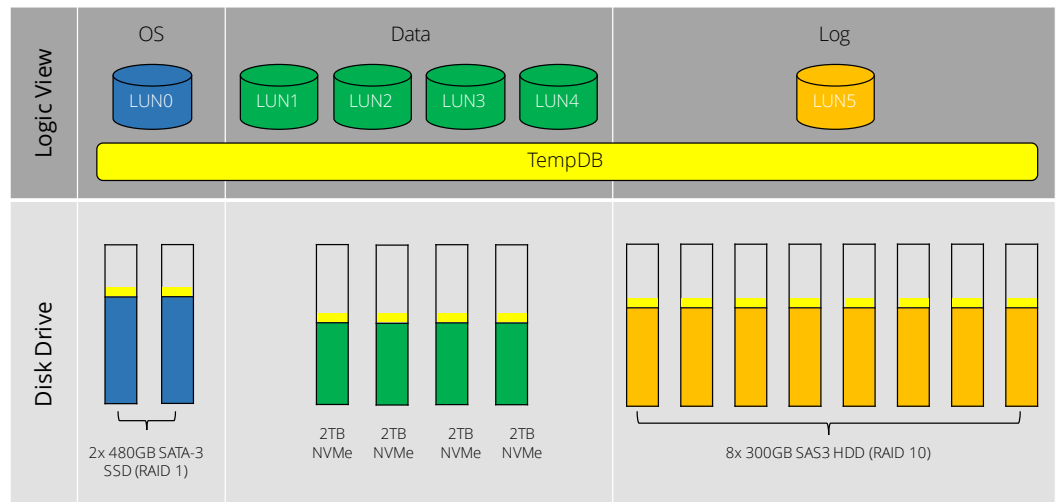- 2x Redundant 1000W Titanium Level Digital Power Supplies.

Figure 2. 22TB 2U Ultra DWFT Reference Architecture Storage Layout.

Storage Configuration

The Ultra SYS-2028U-TNR4T+ DWFT is configured to use 4 NVMe 2TB JBOD as the main storage for database, as shown in Figure 2 (LUN1 through LUN4).The system is also configured with a LUN0 volume, which consists of 2x 480GB SATA3 SSDs in RAID 1 for the operating system; and LUN5, a 8x 300GB HDDs RAID 10 volume for SQL Server logs. TempDB is distributed evenly throughout the 6 LUNs.

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	1 on LUN1, 1 on LUN2, 1 on LUN3, 1 on LUN4
Part_ci1FG	1 on LUN1, 1 on LUN2, 1 on LUN3, 1 on LUN4
Part_ci2FG	1 on LUN1, 1 on LUN2, 1 on LUN3, 1 on LUN4
Part_ci3FG	1 on LUN1, 1 on LUN2, 1 on LUN3, 1 on LUN4
Part_ci4FG	1 on LUN1, 1 on LUN2, 1 on LUN3, 1 on LUN4
Part_ci5FG	1 on LUN1, 1 on LUN2, 1 on LUN3, 1 on LUN4
Part_ci6FG	1 on LUN1, 1 on LUN2, 1 on LUN3, 1 on LUN4
Part_ci7FG	1 on LUN1, 1 on LUN2, 1 on LUN3, 1 on LUN4
FT_Demo_LOG	1 on LUN5

Tempdb Configuration

The tempdb database is configured to utilize 30 data files for the 2 socket 28 core CPU configuration. A total of 150GB of tempdb data files are evenly distributed on each LUN. The tempdb log file is placed on the log volume, which is LUN5. "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.

- –T1117
  When a file in the filegroup meets the autogrow threshold, all files in the filegroup grow to balance the data allocation.

- –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 3.

Server Configuration

Power settings

The power plan is set to High performance plan to reduce CPU throttling as shown in Figure 4.
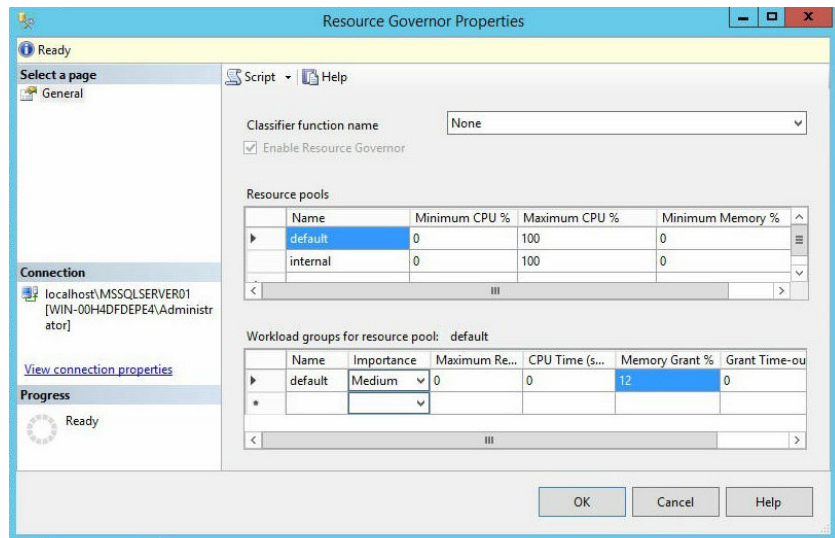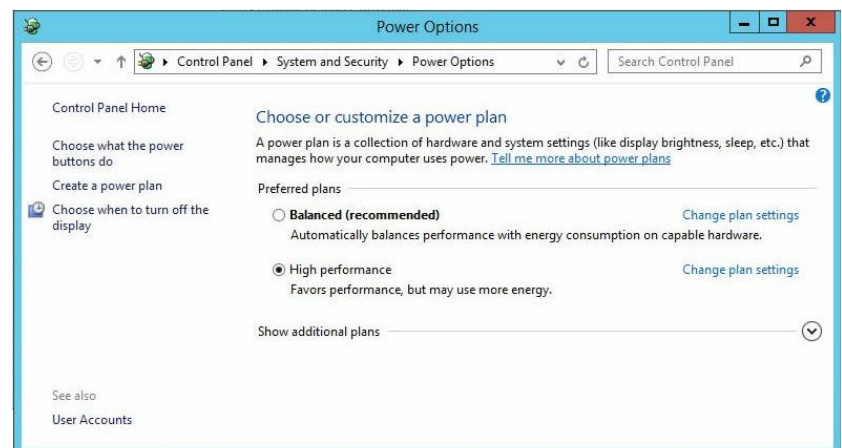

Figure 3. Resource Governor Settings

Figure 4. Server Power Settings

DWFT Certification #2014-055	Supermicro 2028U-TNR4T+	Report Date: 5/23/2016
DWFT Rev. 5.4	DWFT Reference Architecture	

System Provider	System Name	Processor Type	Memory
SUPERMICRO	Supermicro 2028U-TNR4T+	Intel Xeon E5-2690 v4 2.6 GHz (2S/28C/56T)	256 GB

Operating System	SQL Server Edition
Windows Server 2012 R2	SQL Server 2014 Enterprise Edition

Storage Provider	Storage Information
SUPERMICRO	4x 2 TB NVMe for data and tempdb 2x 480 GB SATA-3 SSD for OS (RAID 1) 8x 300 GB SAS3 HDD 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)
22	166	196	25

Row Store

Relative Throughput[2] (Queries/Hr/TB)	Measured Throughput (MB/Sec)	Measured Scan Rate Physical (MB/Sec)	Measured Scan Rate Logical (MB/Sec)	Measured I/O Throughput (MB/Sec)	Measured CPU (Avg.) (%)
166	202	4,348	5,436	4,892	64

Column Store

Relative Throughput[2] (Queries/Hr/TB)	Measured Throughput (MB/Sec)	Measured Scan Rate Physical (MB/Sec)	Measured Scan Rate Logical (MB/Sec)	Measured I/O Throughput (MB/Sec)	Measured CPU (Avg.) (%)
196	1,272	1,378	N/A	N/A	72

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.

Figure 5. 2U Ultra 22TB DWFT Reference Architecture Certification Results.

*Measured CPU utilization between 64/72%

Note: different MS SQL 2014 versions have huge impacts for overall CPU utilizations. The MS SQL 2014 Enterprise supports up to 20 physical cores/40 logic cores, which is inadequate for the 28 physical cores in our Reference Architecture. With SQL server 2014 Enterprise Core edition that supports unlimited cores, the CPU utilization jumped to 94/99% for row and column respectively.

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
  **www.microsoft.com/en-us/cloud-
  platform/data-warehouse-fast-track**

- Microsoft SQL Server 2016
  **www.microsoft.com/en-us/cloud-
  platform/sql-server**

- Microsoft Windows Server 2016
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- 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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