



Technical Report

Reference Architecture for Microsoft SQL Server 2017 Data Warehouse Fast Track: NetApp EF280

Pat Sinthusan, Mitch Blackburn, NetApp

May 2018 | TR-4687

Abstract

This technical report describes a Microsoft SQL Server 2017 Data Warehouse Fast Track reference architecture that was built with a NetApp® EF280 flash array (2U) and a Fujitsu Server PRIMERGY RX2540 M4 (2U). This report also presents the configuration and the performance results of the 4U solution.

TABLE OF CONTENTS

1	Solution Overview	3
1.1	Target Audience.....	3
2	EF280 DWFT Reference Architecture Design and Implementation.....	3
2.1	NetApp EF280 Flash Array	3
2.2	Fujitsu Server PRIMERGY RX2540 M4.....	3
2.3	Microsoft SQL Server 2017 Enterprise	4
2.4	Database and Storage Layout	4
3	EF280 DWFT Reference Architecture Certification.....	6
4	Bill of Materials	7
	Conclusion	8
	References.....	8

LIST OF TABLES

Table 1)	Bill of materials for the server.....	7
Table 2)	Bill of materials for the storage array.....	8

LIST OF FIGURES

Figure 1)	Database and storage layout details.....	5
Figure 2)	NetApp EF280 DWFT reference architecture certification.....	6

1 Solution Overview

Data Warehouse Fast Track (DWFT) for SQL Server 2017 is a program that Microsoft administers to produce efficient, purpose-built, and out-of-the-box balanced reference configurations for SQL Server data warehouse workloads. The DWFT validation kit for SQL Server 2017 is the fifth generation of the Microsoft DWFT validation kit. This latest DWFT validation kit (DWFT V5.4.5345) is comprehensive. It contains all the components that users need to build the database, populate the data, and run the queries.

The new DWFT V5.4.5345 includes a certification template. Section 3 of this report shows the certification template with the performance data of the reference architecture that is described in this report.

The DWFT V5.4.5345 test takes advantage of the performance improvement and flexibility of the columnstore index (CCI). For more information about the SQL Server 2017 columnstore index, see [Columnstore indexes—what's new](#). The query performance is also improved by the addition of a new batch-mode query execution mechanism, which is closely integrated with and optimized around the columnstore storage format.

This report was created to show NetApp EF-Series system interoperability with the data warehouse solution. No specific performance tuning was applied to this environment.

1.1 Target Audience

The target audience for the solution includes the following groups:

- Data warehouse architects
- Business intelligence (BI) users
- Database administrators
- IT planners

For more information about Microsoft SQL Server Data Warehouse Fast Track, go to [Data Warehouse Fast Track](#).

2 EF280 DWFT Reference Architecture Design and Implementation

The design of this DWFT reference architecture calls for a Fujitsu Server PRIMERGY RX2540 M4 that is directly attached to a NetApp EF280 flash array with four 12Gbps SAS links.

2.1 NetApp EF280 Flash Array

The NetApp EF280 is an all-flash entry-level storage array that brings together extreme performance and enterprise-grade reliability. The EF280 is a 2U dual-controller storage array. For this test, it was populated with 24 1.6TB solid-state drives (SSDs). The dual controllers were configured with SAS host interface cards (HICs) and 8GB of controller cache each. The EF280 runs on enterprise-proven NetApp SANtricity® OS 11.40.

For additional information about NetApp EF-Series solutions, visit [EF-Series Flash Storage Arrays](#).

2.2 Fujitsu Server PRIMERGY RX2540 M4

The Fujitsu PRIMERGY RX2540 M4 server was equipped with two of the Intel Xeon Processor Scalable Family CPUs with up to 48 cores relying on Intel UltraPath Interconnect for an increased data rate between the CPUs, along with new DDR4 memory technology of up to 3072GB. The modular design of the server offers excellent expandability with up to 24 drives, high storage density, DynamicLoM technology, and up to 8 Peripheral Component Interconnect Express (PCIe) Gen 3 I/O expansion slots.

The tested server was equipped with 1536GB of RAM and two internal SSDs for the operating system, and 2 of the 6 PCIe slots were occupied by LSI SAS 9300-8e host bus adapter (HBA) cards.

For additional information about Fujitsu Primergy server solutions, visit [Fujitsu Server PRIMERGY](#).

2.3 Microsoft SQL Server 2017 Enterprise

Microsoft SQL Server 2017 Enterprise was installed and was configured with the following settings.

For startup options:

- `-E` was added to the startup options to increase the contiguous extents in database files and to enable large transfer sizes in sequential disk access.
- `-T1117` was also added to the startup options to facilitate even growth of all the files in a file group if autogrow is enabled.

SQL Server Maximum Memory

For ease of benchmarking, SQL Server 2017 maximum memory was set based on the number of sockets of the reference architecture implementation. Because the Fujitsu PRIMERGY RX2540 M4 server under testing had two sockets, the SQL Server maximum memory was set to 118GB.

MAXDOP

MAXDOP, or maximum degree of parallelism, is a tuning option that controls how many SQL Server schedulers a SQL Server query can use per query step. The following settings were used:

- MAXDOP = 48, for row store testing
- MAXDOP = 96 (that is, the system's logical processor count), for columnstore testing

Resource Governor

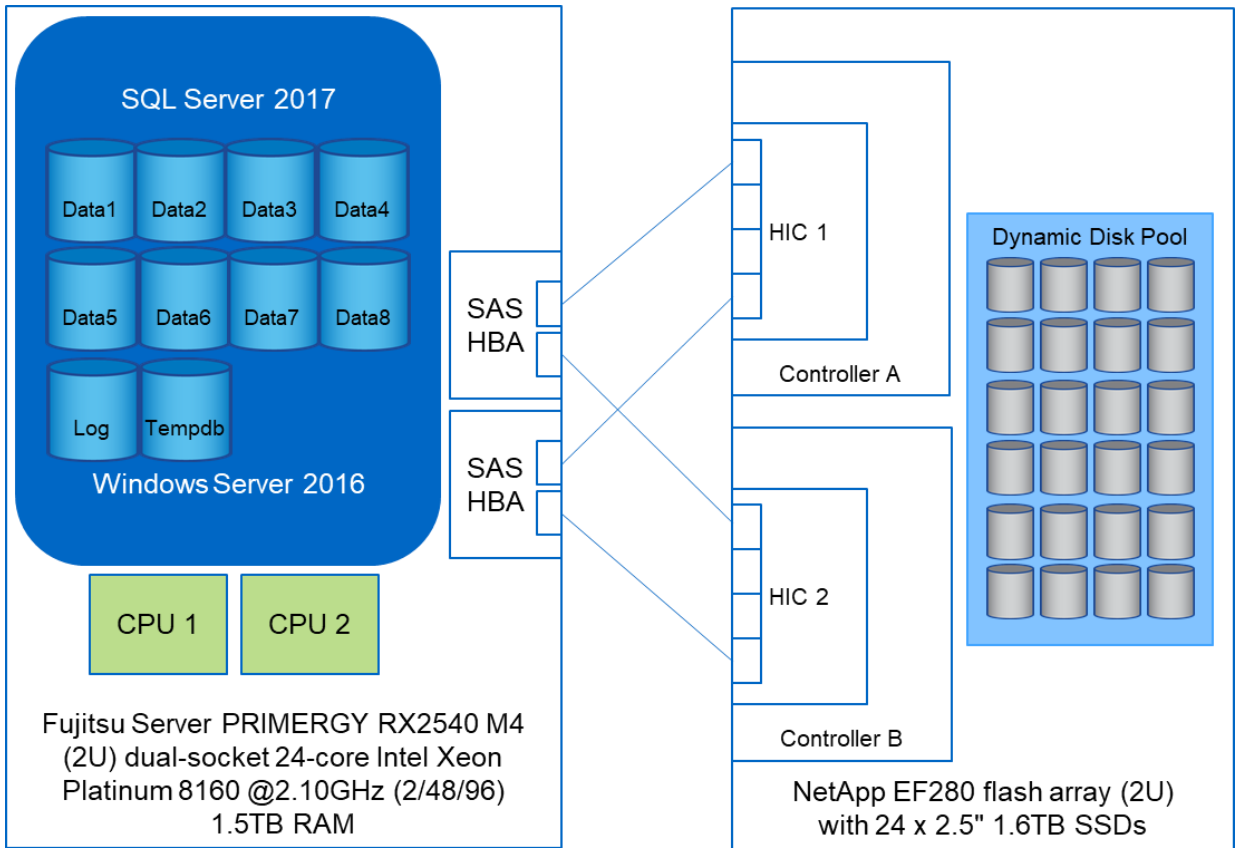
The SQL Server 2017 Resource Governor was enabled and was set to 12%.

2.4 Database and Storage Layout

The combination of NetApp SANtricity Dynamic Disk Pools (DDP) technology and NetApp EF-Series storage is optimal for high-performance computing (HPC). DDP technology distributes data, parity information, and spare capacity across a pool of drives. To promote full data protection, its intelligent algorithm (seven patents pending) defines which drives are used for segment placement. The dynamic rebuild technology of DDP uses every drive in the pool to rebuild a failed drive, enabling exceptional performance under failure. Flexible disk pool sizing optimizes utilization of any configuration for maximum performance, protection, and efficiency.

Therefore, a single DDP pool was created on the EF280 system by using 24 SSDs for the SQL Server database data, log, and tempdb files. Figure 1 shows the detailed storage layout and database layout for the reference configuration.



Figure 1) Database and storage layout details.



3 EF280 DWFT Reference Architecture Certification

Figure 2 shows a DWFT reference architecture certification.

Figure 2) NetApp EF280 DWFT reference architecture certification.

DWFT Certification #2017-014	NetApp EF280 with Fujitsu RX2540 M4 DWFT Reference Architecture			Report Date: 4/19/2018	
DWFT Rev. 5.4					
System Provider	System Name	Processor Type		Memory	
	PRIMERGY RX2540 M4	Intel Xeon Platinum 2.1 GHz (2/48/96)		1536 GB	
Operating System			SQL Server Edition		
Windows Server 2016			SQL Server 2017 Enterprise Edition		
Storage Provider	Storage Information				
	24x 1.6TB SSD for data, log, and tempdb (Dynamic Disk Pool) 2x 480 GB SSD for OS (RAID 1)				
Primary Metrics					
Rated User Data Capacity ¹ (TB)	Row Store Relative Throughput ²	Column Store Relative Throughput ³	Maximum User Data Capacity ¹ (TB)		
95	263	527			
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.) (%)
263	366	6,525	8,996	7,760	70
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.) (%)
527	4,159	2,966	N/A	N/A	93
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.					

4 Bill of Materials

Table 1 and Table 2 list the bills of materials for this reference architecture, including server and storage components, respectively.

Table 1) Bill of materials for the server.

Part Number	Description	Quantity
S26361-K1567-V408	PY RX2540 M4 8x 2.5` (S26361-K1567-V408)	1
S26361-F4051-E160	Intel Xeon Platinum 8160 24C 2.10 GHz(S26361-F4051-E160)	2
S26361-F3849-E100	Cooler Kit 2nd CPU(S26361-F3849-E100)	1
S26361-F3694-E10	Independent Mode Installation(S26361-F3694-E10)	2
S26361-F4026-E464	64GB (1x64GB) 4Rx4 DDR4-2666 LR ECC(S26361-F4026-E464)	24
S26361-F3778-E1	DVD-RW supermulti ultraslim SATA(S26361-F3778-E1)	1
S26361-F5675-E480	SSD SATA 6G 480GB Mixed-Use 2.5` H-P EP(S26361-F5675-E480)	2
S26361-F3846-E31	Risercard PCIe 2 FH slots x16/x8 right(S26361-F3846-E31)	1
S26361-F3846-E32	Risercard PCIe 2 FH slots x16/x8 left(S26361-F3846-E32)	1
S26361-F3953-E401	PLAN EM 4x 1Gb T OCP interface(S26361-F3953-E401)	1
S26361-F2735-E175	Rack Mount Kit F1 CMA QRL LV(S26361-F2735-E175)	1
S26361-F4530-E10	Mounting of RMK in symmetrical racks(S26361-F4530-E10)	1
S26361-F2735-E82	Rack Cable Arm 2U(S26361-F2735-E82)	1
S26361-F1452-E130	region-kit America(S26361-F1452-E130)	1
S26361-F1790-E243	iRMC advanced pack(S26361-F1790-E243)	1
S26361-F1790-E311	eLCM Activation License(S26361-F1790-E311)	1
S26361-F2036-E100	ServerView Suite DVDs(S26361-F2036-E100)	1
S26113-F574-E13	Modular PSU 800W platinum hp(S26113-F574-E13)	2
T26139-Y1968-E100	Cable powercord rack, 4m, black(T26139-Y1968-E100)	2
S26361-F1420-E130	opt. front VGA(S26361-F1420-E130)	1
S26361-F3120-E50	serial port option(S26361-F3120-E50)	1

Part Number	Description	Quantity
S26361-F3552-E101	TPM 1.2 Module(S26361-F3552-E101)	1
H3-25460-01	SAS9300-8e dual-port 12GB (8 Phy) PCIe SAS 3 adapt	2

Table 2) Bill of materials for the storage array.

Part Number	Description	Quantity
EF280A-16GB-FC-0E-C	EF280A,16GB Cntrlr,No HIC,16Gb FC,2-pt,-C	2
X-56033-00-0E-C	HIC,E2800/EF280,12Gb SAS,4-ports	2
E-X5721A-QS	DE224C Exp Shelf,EF280 Attached,Model,eCTO	1
X-26004-00	Cable, miniSAS HD-miniSAS HD, SAS3, 1m	4
E-X4092A-0E-C	SSD,1.6TB,12Gb,DE224C,0E,-C	24
X-52197-00-0E-C	Power cord, in cabinet, 2m, C14-C13, E-Series	1

Conclusion

The NetApp reference architecture for Microsoft SQL Server 2017 DWFT that is presented in this report was designed to show the ease of configuring the EF-Series array by using Dynamic Disk Pools technology. It was also designed to provide a level of confidence in implementing the solution. The EF-Series all-flash array is built to deliver high performance with exceptionally low latency.

The EF280 can deliver 300,000 IOPS and 10GBps throughput. In this test with a single 2U server, the 4U solution (server and storage) delivered 8996MBps row-store measured I/O throughput and 4,159 queries/hr/TB columnstore measured throughput.

References

The following references were used in this TR:

- Columnstore indexes—what's new
<https://docs.microsoft.com/en-us/sql/relational-databases/indexes/columnstore-indexes-what-s-new>
- Data Warehouse Fast Track
<https://www.microsoft.com/en-us/cloud-platform/data-warehouse-fast-track>
- EF-Series Flash Storage Arrays
<http://www.netapp.com/us/products/storage-systems/all-flash-array/ef-series.aspx>

Refer to the [Interoperability Matrix Tool \(IMT\)](#) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

Copyright Information

Copyright © 2018 NetApp, Inc. All rights reserved. Printed in the U.S. No part of this document covered by copyright may be reproduced in any form or by any means—graphic, electronic, or mechanical, including photocopying, recording, taping, or storage in an electronic retrieval system—without prior written permission of the copyright owner.

Software derived from copyrighted NetApp material is subject to the following license and disclaimer:

THIS SOFTWARE IS PROVIDED BY NETAPP "AS IS" AND WITHOUT ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY DISCLAIMED. IN NO EVENT SHALL NETAPP BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

NetApp reserves the right to change any products described herein at any time, and without notice. NetApp assumes no responsibility or liability arising from the use of products described herein, except as expressly agreed to in writing by NetApp. The use or purchase of this product does not convey a license under any patent rights, trademark rights, or any other intellectual property rights of NetApp.

The product described in this manual may be protected by one or more U.S. patents, foreign patents, or pending applications.

RESTRICTED RIGHTS LEGEND: Use, duplication, or disclosure by the government is subject to restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.277-7103 (October 1988) and FAR 52-227-19 (June 1987).

Trademark Information

NETAPP, the NETAPP logo, and the marks listed at <http://www.netapp.com/TM> are trademarks of NetApp, Inc. Other company and product names may be trademarks of their respective owners.

TR-4687-0518