



55TB Data Warehouse Fast Track Reference Architecture for Microsoft SQL Server 2014 using PowerEdge R730 and Dell Storage SC4020

Dell configuration and performance results

Dell Storage Engineering
March 2015

Revisions

Date	Description
March 2015	Initial release

THIS WHITE PAPER IS FOR INFORMATIONAL PURPOSES ONLY, AND MAY CONTAIN TYPOGRAPHICAL ERRORS AND TECHNICAL INACCURACIES. THE CONTENT IS PROVIDED AS IS, WITHOUT EXPRESS OR IMPLIED WARRANTIES OF ANY KIND.

© 2015 Dell Inc. All rights reserved. Reproduction of this material in any manner whatsoever without the express written permission of Dell Inc. is strictly forbidden. For more information, contact Dell.

PRODUCT WARRANTIES APPLICABLE TO THE DELL PRODUCTS DESCRIBED IN THIS DOCUMENT MAY BE FOUND AT:

<http://www.dell.com/learn/us/en/19/terms-of-sale-commercial-and-public-sector>. Performance of network reference architectures discussed in this document may vary with differing deployment conditions, network loads, and the like. Third party products may be included in reference architectures for the convenience of the reader. Inclusion of such third party products does not necessarily constitute Dell's recommendation of those products. Please consult your Dell representative for additional information.

Trademarks used in this text:

Dell™, the Dell logo, Dell Boomi™, Dell Precision™, OptiPlex™, Latitude™, PowerEdge™, PowerVault™, PowerConnect™, OpenManage™, EqualLogic™, Compellent™, KACE™, FlexAddress™ and Vostro™ are trademarks of Dell Inc. Other Dell trademarks may be used in this document. Cisco Nexus®, Cisco MDS®, Cisco NX-OS®, and other Cisco Catalyst® are registered trademarks of Cisco System Inc. EMC VNX®, and EMC Unisphere® are registered trademarks of EMC Corporation. Intel®, Pentium®, Xeon®, Core® and Celeron® are registered trademarks of Intel Corporation in the U.S. and other countries. AMD® is a registered trademark and AMD Opteron™, AMD Phenom™ and AMD Sempron™ are trademarks of Advanced Micro Devices, Inc. Microsoft®, Windows®, Windows Server®, Internet Explorer®, MS-DOS®, Windows Vista® and Active Directory® are either trademarks or registered trademarks of Microsoft Corporation in the United States and/or other countries. Red Hat® and Red Hat® Enterprise Linux® are registered trademarks of Red Hat, Inc. in the United States and/or other countries. Novell® and SUSE® are registered trademarks of Novell Inc. in the United States and other countries. Oracle® is a registered trademark of Oracle Corporation and/or its affiliates. Citrix®, Xen®, XenServer® and XenMotion® are either registered trademarks or trademarks of Citrix Systems, Inc. in the United States and/or other countries. VMware®, Virtual SMP®, vMotion®, vCenter® and vSphere® are registered trademarks or trademarks of VMware, Inc. in the United States or other countries. IBM® is a registered trademark of International Business Machines Corporation. Broadcom® and NetXtreme® are registered trademarks of Broadcom Corporation. Qlogic is a registered trademark of QLogic Corporation. Other trademarks and trade names may be used in this document to refer to either the entities claiming the marks and/or names or their products and are the property of their respective owners. Dell disclaims proprietary interest in the marks and names of others.



Table of Contents

1	Introduction to Data Warehouse Fast Track reference architectures for SQL Server 2014	6
1.1	Dell Data Warehouse Fast Track reference architectures for SQL Server 2014	6
2	Recommended reference architectures	8
2.1	Single server reference architecture	8
2.2	Highly available reference architecture	10
3	Hardware components	12
3.1	Dell PowerEdge R730 server	12
3.2	QLogic QLE2562 8 Gbps host bus adapter	12
3.3	Brocade 6505 SAN switch	12
3.4	Dell Storage SC4020 array	12
4	Storage configuration	14
4.1	Cabling	14
4.2	Local ports	15
4.3	Disk folder	15
4.4	Storage type	16
4.5	Storage profile	16
4.6	Storage Center server object	17
4.7	Storage Center volumes	18
5	Server configuration	21
5.1	System BIOS	21
5.2	Host bus adapters	21
6	Windows Server 2012 R2 configuration	22
6.1	Power plan	22
6.2	Lock pages in memory	22
6.3	Windows volumes	22
6.4	MPIO	23
7	SQL Server 2014 Enterprise Edition configuration	25
7.1	Startup parameters	25
7.2	SQL Server maximum memory	25
7.3	Max degree of parallelism (MAXDOP)	25
7.4	Resource Governor	25



7.5 Tempdb configuration25

8 Additional considerations for the Highly Available (HA) reference architecture.....26

9 DWFT for SQL Server 2014 certification.....27

10 Summary28

A Additional Resources.....29



Acknowledgements

Dell Storage Technical Solutions: Mike Matthews

Special thanks to Jamie Reding, Sadashivan Krishnamurthy and Jarupat Jisarajito at Microsoft.

Executive Summary

Dell and Microsoft, in cooperation, provide guidelines and principles to assist customers in designing and implementing a balanced configuration for Microsoft SQL Server data warehouse workloads to achieve out-of-the-box scalable performance. These database reference architectures enable each of the components in the database stack to provide optimal throughput to match the database capabilities of the specific setup. Innovative 13th generation Dell servers, along with robust and cutting edge Dell Storage SC4020 arrays, form efficient candidates for a high performing data warehouse solution.

This reference architecture describes the design principles and guidelines used to achieve an optimally balanced 55 TB Data Warehouse Fast Track reference architecture for SQL Server 2014 using Dell PowerEdge R730 and Dell Storage SC4020 arrays. The configuration used to achieve the performance numbers for the reference configuration is discussed in detail.

The target audience for this paper is database administrators, business intelligence architects, storage administrators, IT directors and data warehousing users seeking sizing and design guidance for their enterprise, business intelligence solutions with Microsoft SQL Server 2014.



1 Introduction to Data Warehouse Fast Track reference architectures for SQL Server 2014

Data Warehouse Fast Track (DWFT) reference architectures provide tested and validated configurations and associated resources to help customers identify the right environment for their data warehouse solutions. Tangible benefits of following these recommended configuration best practices and guidelines are:

- Accelerate data warehouse projects with pretested hardware and SQL Server configurations
- Reduce hardware and maintenance costs by purchasing a balanced hardware solution and optimizing it for a data warehouse workload
- Reduce planning and setup costs by leveraging the certified reference architecture configurations
- Ensure predictable performance by configuring the system correctly and taking advantage of the tuning directions

The DWFT reference architectures provide a balanced server, memory, network, and storage hardware configuration and avoid the risk of improperly designed and configured hardware systems. These guidelines ensure that the capability and throughput for the entire system is maximally utilized. Configurations are designed specifically for the data warehouse or Business Intelligence (BI) systems.

1.1 Dell Data Warehouse Fast Track reference architectures for SQL Server 2014

Dell and Microsoft have refreshed the DWFT reference architecture offerings with the latest technology advancements in database, server, and storage technology. Dell PowerEdge 13th generation servers, Dell Storage SC4020 arrays, and Microsoft SQL Server 2014 are the latest additions to the list of reference architecture components.

The Dell 13th generation server platforms, featuring enhanced onboard memory, storage, and processor speeds, have advanced features that boost data warehouse performance. The latest Intel Xeon E5 series processors, larger memory capacities, higher memory speed, and third generation PCI Express slots on the newer PowerEdge platforms ensure faster database throughput.

The SC4020 storage array is based on the flagship Dell SC8000 platform. Offering similar benefits, the mid-tier SC4020 begins with a rock-solid enterprise hardware architecture providing enterprise-class performance and reliability, intelligent automation, and simplified storage management. Dell Storage Center offers exceptional performance for both sequential and transactional applications with the ability to meet stringent mid-tier requirements at an unprecedented value.

Microsoft SQL Server 2014 Enterprise Edition comes with several exciting features that directly benefit data warehouse environments. One of these features is columnstore indexes. Introduced in SQL Server 2012, columnstore indexes enable storing data in columnar fashion, providing better query performance and better compression rates. This is very beneficial for data warehouse environments as they typically handle large amounts of data. In SQL Server 2014, columnstore indexes were enhanced to allow clustering and



updating, making them even easier to incorporate. For more information on columnstore indexes, visit msdn.microsoft.com/en-us/library/gg492088.aspx. Microsoft DWFT for SQL Server 2014 guidelines incorporate the benefit of columnstore indexes for improved query performance.

The Dell DWFT reference architectures for SQL Server 2014 are engineered jointly by Dell and Microsoft. The hardware and software optimizations are tested by Dell and the performance results are crosschecked by Microsoft. This approach presents a faster time-to-value using integrated, balanced, and verified architectures.



2 Recommended reference architectures

Two different DWFT reference architectures for SQL Server 2014 are comprised of PowerEdge R730 servers and Dell Storage SC4020 storage arrays. Each reference architecture is assigned a Solution ID, which can be used during the purchase process to identify the hardware components needed to implement the solution.

Table 1 Recommended reference architectures with Solution IDs

Reference Architecture	Solution ID
Single Server Reference Architecture	5413520
Highly Available Reference Architecture	5413522

2.1 Single server reference architecture

Figure 1 illustrates the single server reference architecture with the major elements and Table 2 lists the component details.

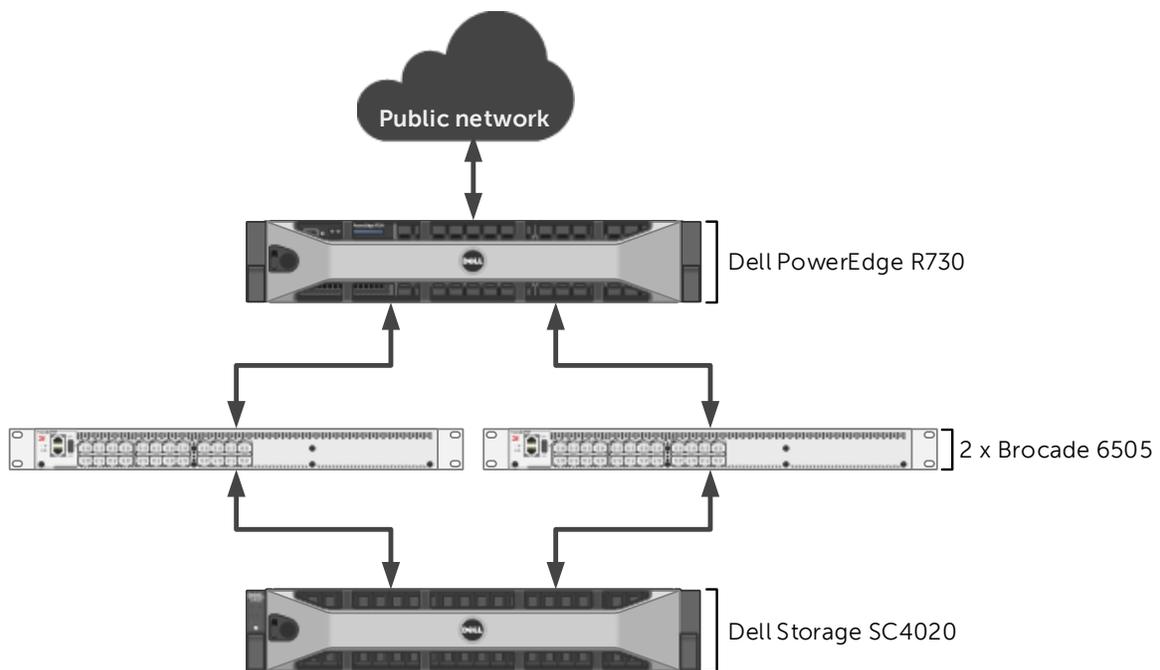


Figure 1 Single server reference architecture

Table 2 Single server reference architecture details

Component	Description	
Server	PowerEdge R730	
	Processors	2 x Intel Xeon E5-2697v3 (2.6Ghz, 14 cores, 28 threads)
	Total cores	28
	Total logical processors	56 (Hyper-Threading enabled)
	Total memory	768 GB
	Network adapters	Minimum of one network adapter (1 Gbps or 10 Gbps based on requirements) Recommended to have more than one network adapter with load balancing configured
	Host bus adapters	4 x QLogic QLE2562 dual port 8 Gbps FC HBA
Software	Operating system	Windows Server 2012 R2 Standard Edition
	Database software	SQL Server 2014 Enterprise Edition
Storage	Storage array	1 x Dell Storage SC4020 (SCOS v6.5.20)
	Disk drives	18 x 1.6 TB read intensive SSDs (2.5" SAS)
	SAN switches	2 x Brocade 6505 with 8 Gbps SFPs



2.2 Highly available reference architecture

For achieving high availability for the database, Microsoft Windows failover clustering is recommended. Using Microsoft clustering services, one database server is configured as the primary (active) server and the second server is configured as the secondary (passive) server. The secondary server should have exactly the same configuration as the primary server. Since the database is only active on a single server at any point of time, the performance of the database on the primary server (active) is comparable to the single server configuration (discussed earlier).

Figure 2 illustrates the highly available reference architecture with the major elements and Table 3 lists the component details.

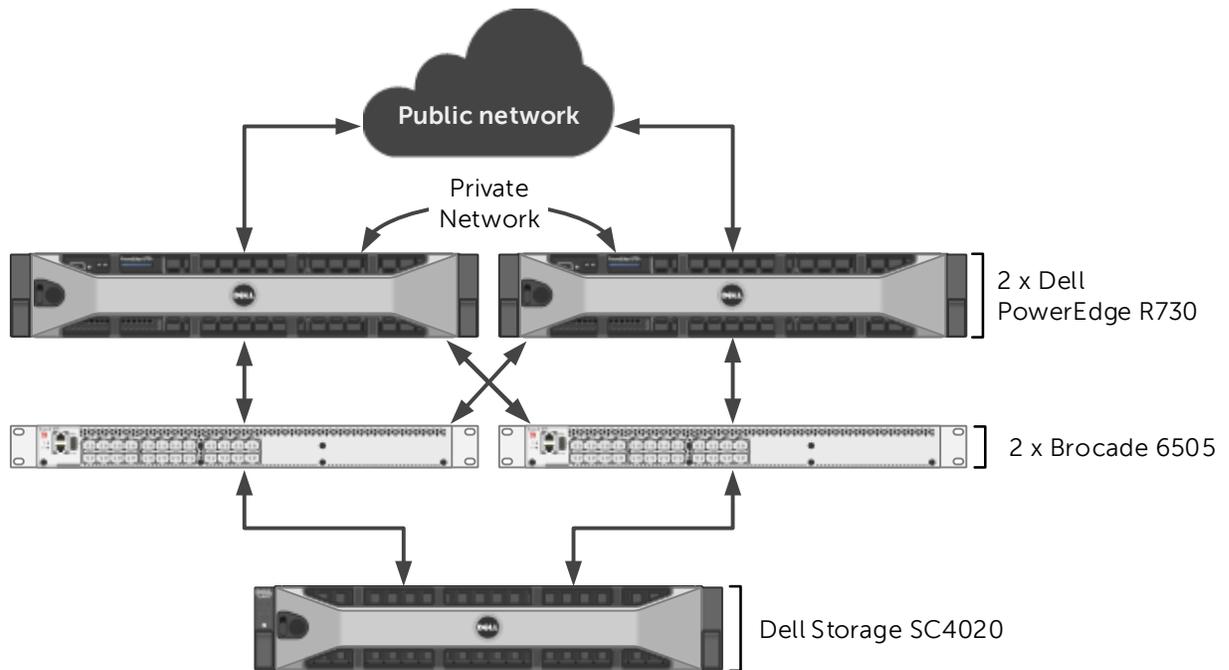


Figure 2 Highly available reference architecture

Table 3 Highly available reference architecture details

Component	Description	
Server	2 x PowerEdge R730	
	Processors	2 x Intel Xeon E5-2697v3 (2.6Ghz, 14 cores, 28 threads) per server
	Total cores	28 per server
	Total logical processors	56 per server (Hyper-Threading enabled)
	Total memory	768 GB per server
	Network adapters	Public Network: Minimum of two network adapters (1 Gbps or 10 Gbps based requirements) per server with load balancing configured Private Network (Cluster): Minimum of one network adapter with 1 Gbps (or more) connectivity per server
	Host bus adapters	4 x QLogic QLE2562 dual port 8 Gbps FC HBA per server
Software	Operating system	Windows Server 2012 R2 Standard Edition with Windows Failover Clustering
	Database software	SQL Server 2014 Enterprise Edition configured as a Failover Cluster Instance
Storage	Storage array	1 x Dell Storage SC4020 (SCOS v6.5.20)
	Disk drives	18 x 1.6 TB read intensive SSDs (2.5" SAS)
	SAN switches	2 x Brocade 6505 with 8 Gbps SFPs



3 Hardware components

3.1 Dell PowerEdge R730 server

The PowerEdge R730 is a highly versatile, two-socket 2U rack server with impressive processor performance, a large memory footprint, extensive I/O options and a choice of dense, high performance storage or low-cost, high-capacity storage. The R730 offers simplified management, purposeful design, and energy efficiency with support for Intel E5 series Haswell processors and ECC DDR4 memory with a maximum memory capacity of 768 GB. PowerEdge R730 provides up to seven Gen3 PCIe slots.

For more information on PowerEdge R730 Servers, visit <http://www.dell.com/us/business/p/poweredge-r730/pd>.

3.2 QLogic QLE2562 8 Gbps host bus adapter

The reference architecture makes use of four QLogic QLE2562 dual port 8 Gbps Fibre Channel (FC) to PCI Express host bus adapters.

For more information on QLogic QLE2562 FC adapters, visit <http://www.qlogic.com/Products/adapters/Pages/FibreChannelAdapters.aspx>.

3.3 Brocade 6505 SAN switch

The Brocade 6505 switch is a 1U, 24 port, rack-mountable Fibre Channel switch providing up to 16 Gbps of bandwidth per port. This switch enables organizations to simplify IT infrastructures, improve system performance, maximize the value of virtual server deployments, and reduce overall storage costs.

For more information on Brocade 6505 SAN switches, visit <http://www.brocade.com/products/all/switches/product-details/6505-switch/index.page>

3.4 Dell Storage SC4020 array

The SC4020 makes the business and technology benefits of true enterprise-class storage practical and affordable for mid-sized deployments. SC4020 offers the award-winning capabilities of the popular Dell Compellent SC8000 array in a compact, affordable, yet highly expandable format. This easy-to-manage solution will auto-tune your datacenter environment to meet both workload and budget requirements at the same time.

Dual redundant controllers, 24 internal drives, eight ports of 8 Gb Fibre Channel network access, plus four IP ports for management and replication are all delivered in a space-saving 2U chassis, making the SC4020 a true all-in-one solution. The SC4020 supports 16 GB of memory per module for a total of 32 GB of memory per array. By adding Dell SC200 or SC220 enclosures, the SC4020 can support a raw capacity greater than 400TB.



With the Fluid Data architecture, Dell Storage changes the way organizations manage data. Empowered by real-time system information about each block of data, Dell Storage Center optimizes data placement, management and protection throughout its lifecycle. This level of data awareness also enables Storage Center to virtualize the storage infrastructure, bringing new efficiency, flexibility and reliability to enterprise storage by creating a pool of high-performance storage shared by all servers and applications.

For more information on Dell Storage SC4020 arrays, visit <http://www.dell.com/us/business/p/dell-compellent-sc4020/pd>.



4 Storage configuration

4.1 Cabling

The hardware components were connected using Dell Storage best practices.

Port 1 on each HBA in the server and ports 1 and 2 on each module in the SC4020 were connected to the same Brocade 6505 switch. Port 2 on each HBA in the server and ports 3 and 4 on each module in the SC4020 were connect to the other Brocade 6505 switch.

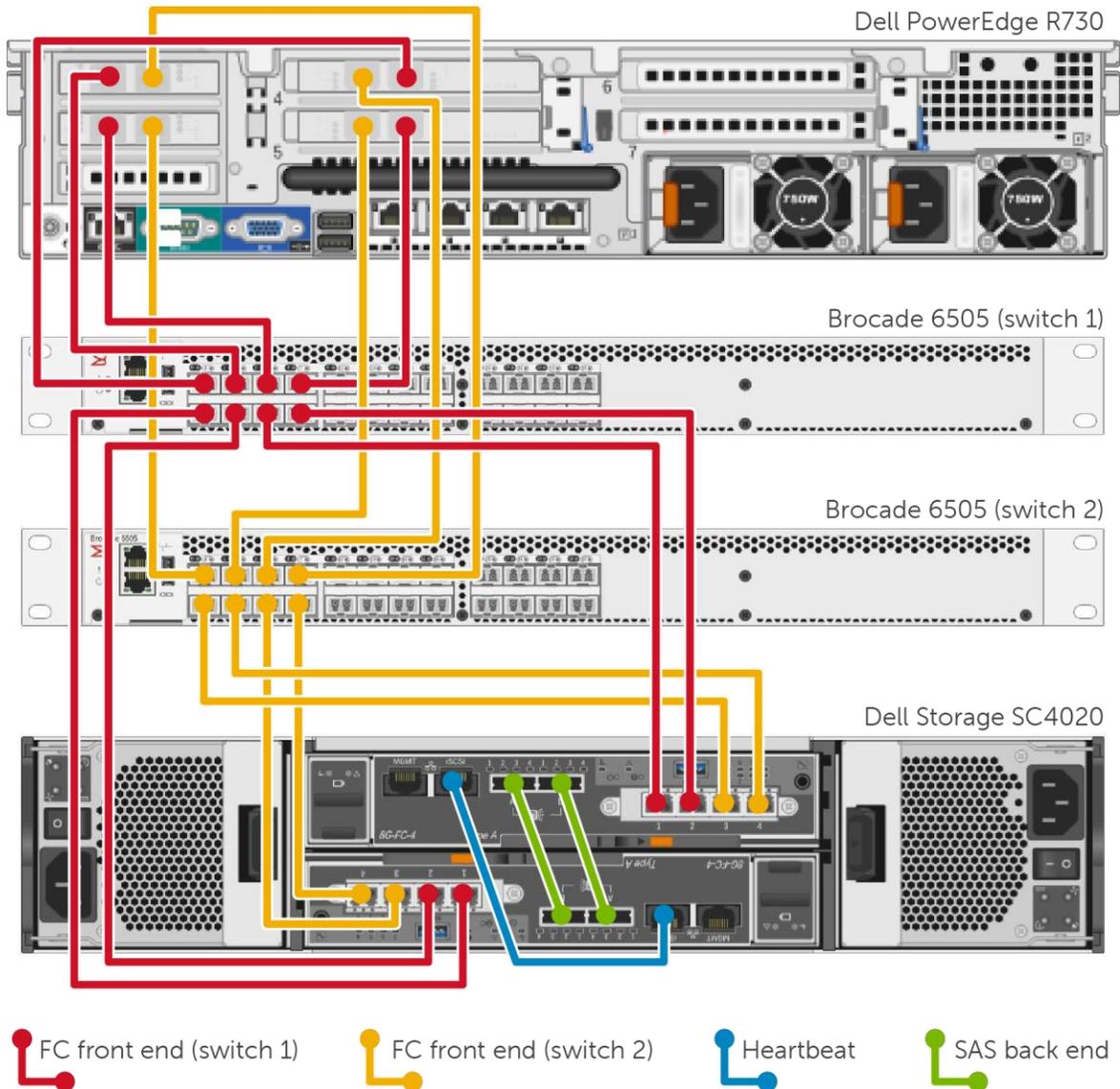


Figure 3 Single server configuration cabling diagram



4.2 Local ports

The front-end Fibre Channel (FC) ports and back-end SAS ports were configured using the Configure Local Ports wizard.

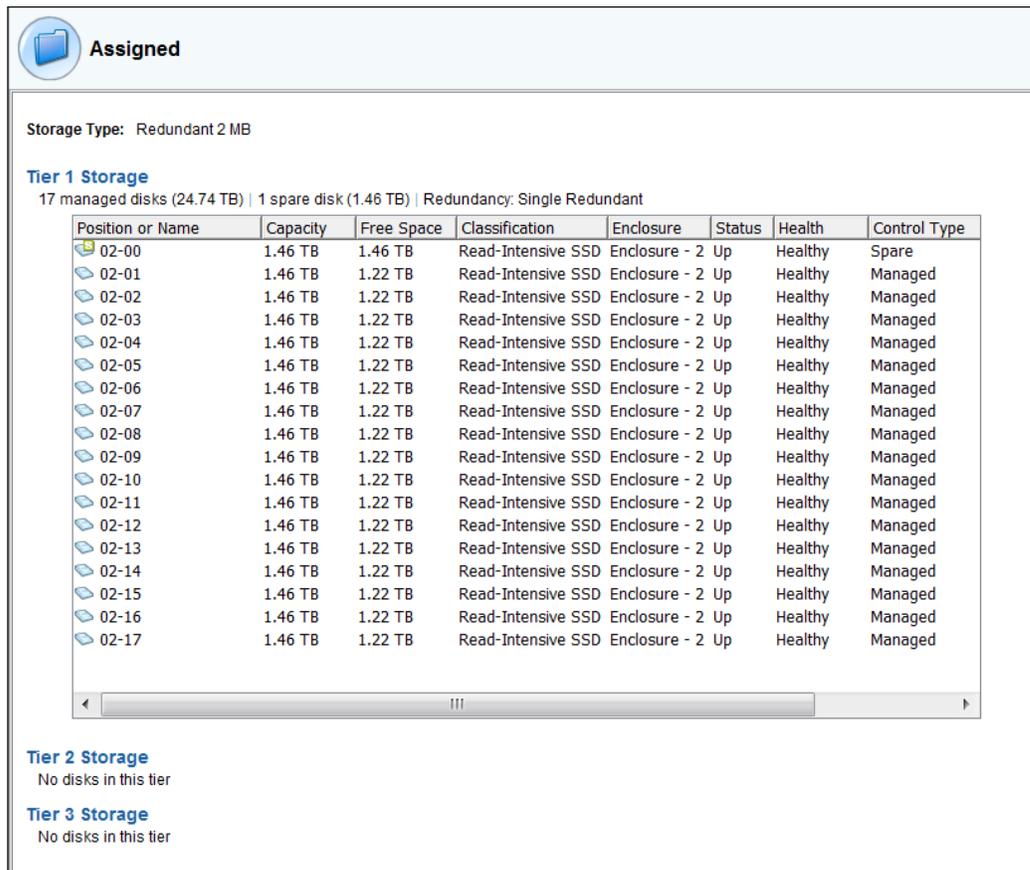
The FC ports were configured to use two fault domains in virtual port mode. Ports 1 and 2 from each controller were put into fault domain 0 and ports 3 and 4 from each controller were put into fault domain 1. In addition, all eight ports were configured as front-end ports by selecting **Front End** for the purpose.

All four SAS ports were configured as back end ports by selecting **Back End** for the purpose.

4.3 Disk folder

All 18 disks were put into the Assigned disk folder. One disk was defined as a hot spare, leaving 17 active disks. All volumes were created in the Assigned disk folder.

Figure 4 shows the disk configuration used in the reference architecture.



The screenshot shows a storage configuration window titled "Assigned". It displays the following information:

- Storage Type:** Redundant 2 MB
- Tier 1 Storage:** 17 managed disks (24.74 TB) | 1 spare disk (1.46 TB) | Redundancy: Single Redundant

Position or Name	Capacity	Free Space	Classification	Enclosure	Status	Health	Control Type
02-00	1.46 TB	1.46 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Spare
02-01	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-02	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-03	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-04	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-05	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-06	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-07	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-08	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-09	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-10	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-11	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-12	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-13	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-14	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-15	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-16	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed
02-17	1.46 TB	1.22 TB	Read-Intensive SSD	Enclosure - 2	Up	Healthy	Managed

Below the table, it indicates:

- Tier 2 Storage:** No disks in this tier
- Tier 3 Storage:** No disks in this tier

Figure 4 Disk configuration



4.4 Storage type

The disk folder storage type defines the page size on the Storage Center and whether the disks are configured for redundancy (single or dual). The disk folder can be configured to use a 512KB, 2MB (default) or 4MB page.

The Assigned disk folder was configured for single redundancy, using the default page size of 2MB.

4.5 Storage profile

The Storage Center uses storage profiles to define the RAID level and tiers on which data is stored for a given volume. By default, newly created volumes use the **Recommended (All Tiers)** storage profile. This storage profile uses RAID 10 for active (writeable) data and RAID 5 for Replays.

To increase capacity, the reference architecture uses RAID 5 for all data stored on the SQL Server data volumes. A custom storage profile named **RAID 5 All Tiers** was created. SQL Server data volumes on the storage array use this custom storage profile to ensure that RAID 5 is always used for those volumes. All other volumes use the **Recommended (All Tiers)** storage profile.

Figure 5 shows the creation of the custom storage profile.

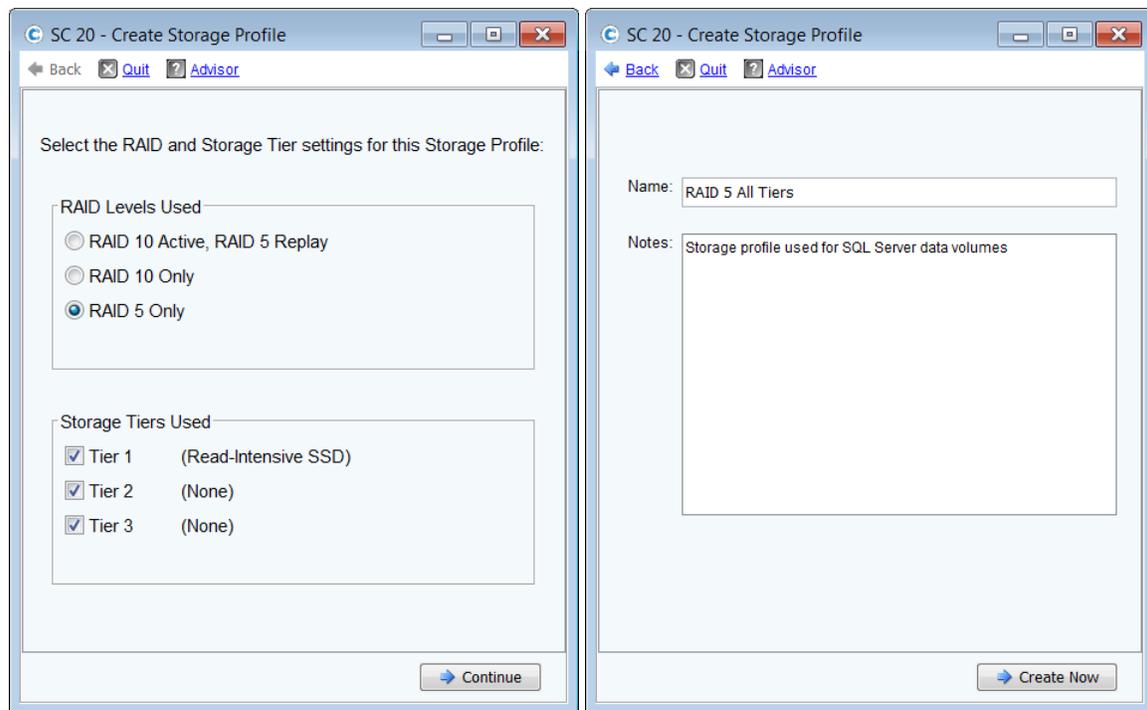


Figure 5 Creating the custom storage profile **RAID 5 All Tiers**

4.6 Storage Center server object

The process of mapping a volume to a server object creates the I/O path (or paths) between a volume and a server. When creating a server object, the operating system of the server is defined. The Storage Center includes both single path and multi-path definitions for each version of Windows.

In this configuration, the server object on the Storage Center was created using the **Windows 2012 MPIO** operating system definition. Since the MPIO version of the Windows 2012 definition was chosen, each volume mapping will contain 16 paths.

Figure 6 and Figure 7 show the creation of the server object.

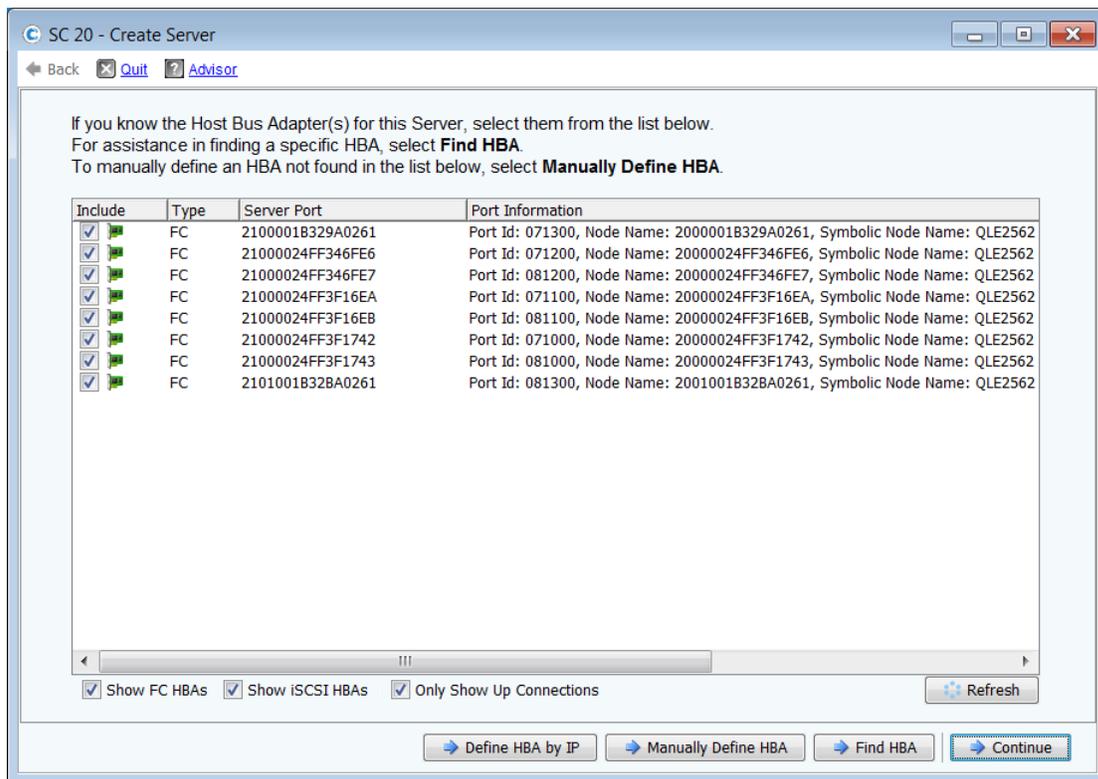


Figure 6 Creating a server object, part 1: Select the HBAs



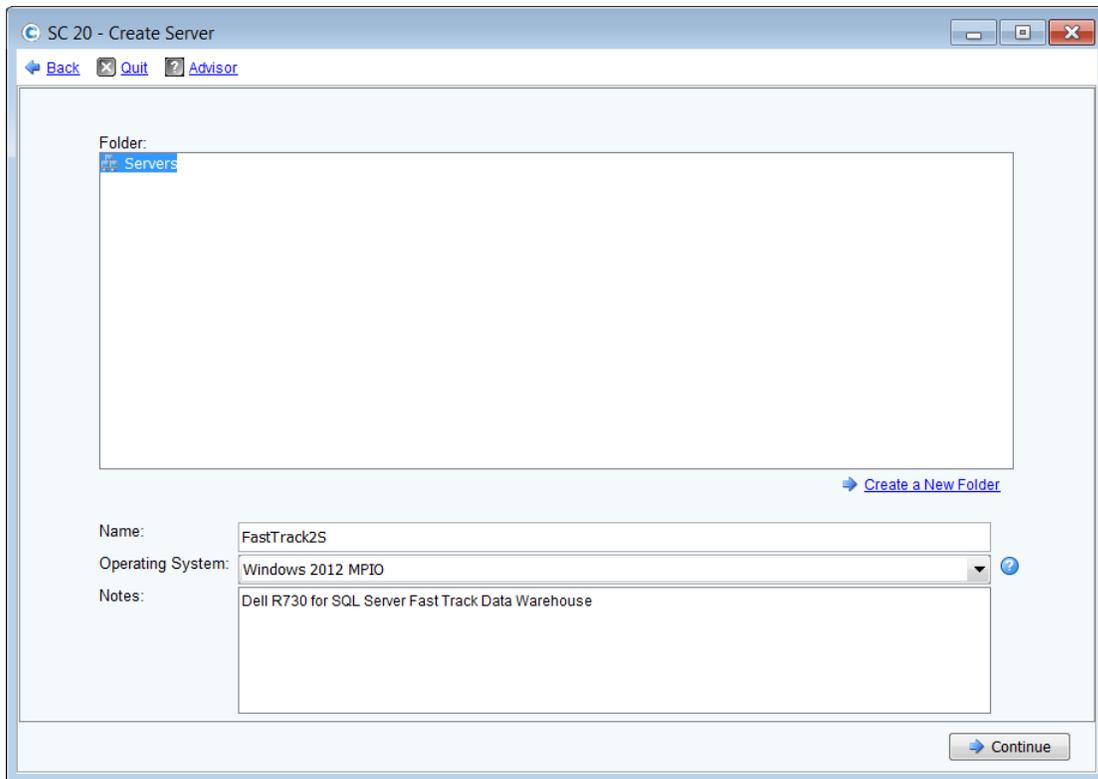


Figure 7 Creating a server object, part 2: Enter the name and select the operating system

4.7 Storage Center volumes

The **Recommended (All Tiers)** storage profile is assigned to all volumes, with the exception of the SQL Server data volumes. The SQL Server data volumes use the **RAID 5 All Tiers** custom storage profile. This tells the Storage Center to use RAID 5 for the SQL Server data volumes and RAID 10 for all other volumes.

None of the volumes were configured to use Replays. The reference architecture does not include hardware resources to support the use of Replays.

The server is configured to boot from the Storage Center. When mapping the boot volume to the server, select **Map volume using LUN 0** in the advanced dialog box. To simplify installation, create the boot volume, map it to the server and configure the HBAs before mapping any other volumes to the server.

Figure 8 shows the advanced dialog box that is used when mapping the boot volume.

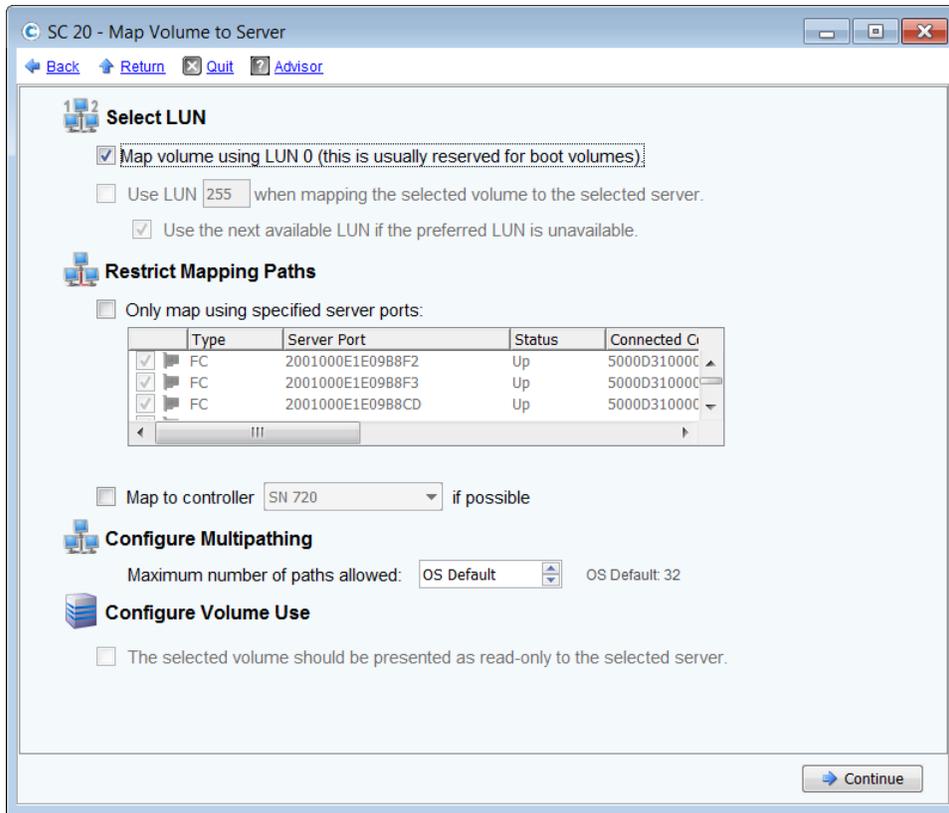


Figure 8 Advanced options for mapping the boot volume

Eight volumes (LUNs) were created to store the SQL Server data files for the data warehouse, with four volumes assigned to each controller. Two volumes were created to store the tempdb data files, with one volume assigned to each controller. If the volumes are created and mapped to the server at the same time, one after the other, the Storage Center should automatically distribute the volumes evenly across the controllers. Otherwise, the controller can be manually selected in the advanced dialog box when mapping the volume to the server. To achieve optimal results, the SQL Server data volumes must be evenly distributed across the controllers.

Table 4 Storage Center volumes created for the reference architecture

Volume name	Storage profile	Volume purpose
FastTrack2S - Boot	Recommended (All Tiers)	Windows boot volume
FastTrack2S - MPHost	Recommended (All Tiers)	Mount point host
FastTrack2S - SQLSystem	Recommended (All Tiers)	SQL Server system databases and files
FastTrack2S - SQLLog	Recommended (All Tiers)	Transaction log files for tempdb and the data warehouse
FastTrack2S - SQLData01	RAID 5 All Tiers	Data files for the data warehouse



Volume name	Storage profile	Volume purpose
FastTrack2S - SQLData02	RAID 5 All Tiers	Data files for the data warehouse
FastTrack2S - SQLData03	RAID 5 All Tiers	Data files for the data warehouse
FastTrack2S - SQLData04	RAID 5 All Tiers	Data files for the data warehouse
FastTrack2S - SQLData05	RAID 5 All Tiers	Data files for the data warehouse
FastTrack2S - SQLData06	RAID 5 All Tiers	Data files for the data warehouse
FastTrack2S - SQLData07	RAID 5 All Tiers	Data files for the data warehouse
FastTrack2S - SQLData08	RAID 5 All Tiers	Data files for the data warehouse
FastTrack2S - TempdbData01	Recommended (All Tiers)	Data files for tempdb
FastTrack2S - TempdbData02	Recommended (All Tiers)	Data files for tempdb



5 Server configuration

5.1 System BIOS

The system profile is set to **Performance**. All other options, outside of iDRAC configuration, were left at their factory default settings. The logical processor option, under processor settings, is left at its default setting of **Enabled**. This enables hyper-threading, which maximizes the number of logical processors available to SQL Server.

5.2 Host bus adapters

After each HBA port was reset to the factory defaults, several parameters were changed in accordance with Dell Storage best practices. Those changes are detailed in Table 5.

Table 5 HBA parameter changes

Parameter Menu	Parameter	Setting
Adapter Settings	Host Adapter BIOS	Enabled
	Connection Options	1 (Point to Point only)
Advanced Adapter Settings	Enable LIP Reset	Yes
	Login Retry Count	60
	Port Down Retry Count	60
	Link Down Timeout	30
	Execution Throttle	256
Selectable Boot Settings (Each HBA port has two paths to the boot volume. The WWN for each path should be selected.)	Selectable Boot	Enabled
	Boot Port Name, Lun	WWN for the 1 st boot volume path
	Boot Port Name, Lun	WWN for the 2 nd boot volume path



6 Windows Server 2012 R2 configuration

6.1 Power plan

To maximize performance, the server was configured to use the **High performance** power plan as shown in Figure 9.

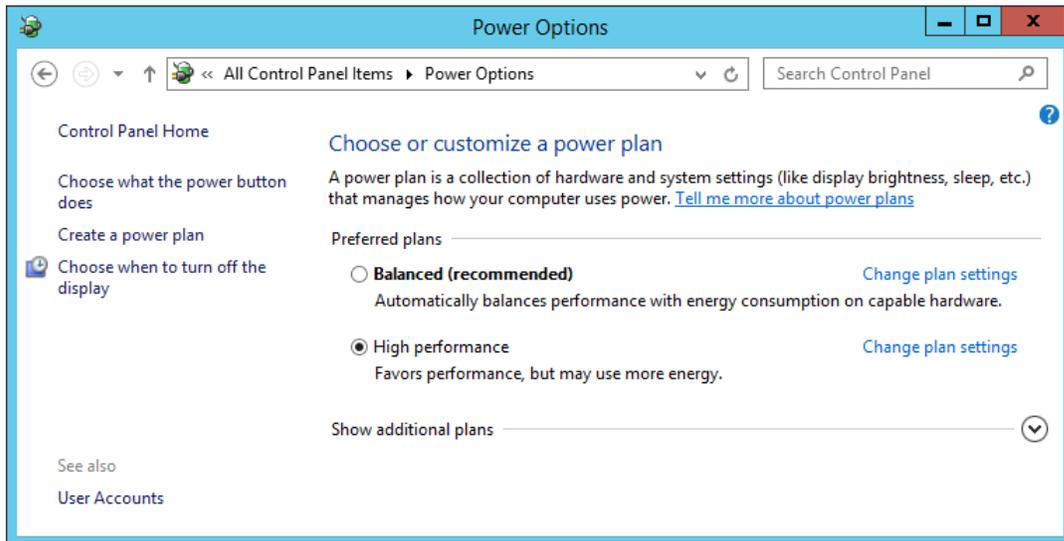


Figure 9 Windows power plan

6.2 Lock pages in memory

To prevent Windows from paging SQL Server memory to disk, the **Lock pages in memory** option was enabled for the SQL Server service account.

For information on enabling this option, visit <https://msdn.microsoft.com/en-IN/library/ms190730.aspx>.

6.3 Windows volumes

A single Windows volume was created on each Storage Center volume. All volumes were formatted with the NTFS file system. The boot volume and the mount point host volume used the default allocation unit. All other volumes used an allocation unit of 64KB.

For DWFT reference architectures, Dell recommends using mount points for the volumes instead of drive letters. It is highly recommended to assign appropriate volume and mount point names in order to simplify troubleshooting and performance analysis. Ideally, the mount point names should be assigned in such a way that makes it easy to identify the Storage Center volume for a given Windows volume.

Table 6 shows the volume labels and access paths used for the reference configuration.

Table 6 Windows volume details

Storage Center volume name	Windows volume label	Access path
FastTrack2S - Boot	Boot	C:\
FastTrack2S - MPHost	MPHost	M:\
FastTrack2S - SQLSystem	SQLSystem	M:\ft\SQLSystem
FastTrack2S - SQLLog	SQLLog	M:\ft\SQLLog
FastTrack2S - SQLData01	SQLData01	M:\ft\SQLData01
FastTrack2S - SQLData02	SQLData02	M:\ft\SQLData02
FastTrack2S - SQLData03	SQLData03	M:\ft\SQLData03
FastTrack2S - SQLData04	SQLData04	M:\ft\SQLData04
FastTrack2S - SQLData05	SQLData05	M:\ft\SQLData05
FastTrack2S - SQLData06	SQLData06	M:\ft\SQLData06
FastTrack2S - SQLData07	SQLData07	M:\ft\SQLData07
FastTrack2S - SQLData08	SQLData08	M:\ft\SQLData08
FastTrack2S - TempdbData01	TempdbData01	M:\ft\TempdbData01
FastTrack2S - TempdbData02	TempdbData02	M:\ft\TempdbData02

6.4 MPIO

MPIO was configured using Dell Storage best practices. MPIO best practices for the Storage Center are documented in *Dell Storage Center - Microsoft Multipath I/O Best Practices* on Dell TechCenter at http://en.community.dell.com/techcenter/extras/m/white_papers/20437917/download.

To improve throughput, each SQL Server data volume on the server is configured to use a single unique path between the Storage Center and the server. To ensure that only one path is used for each data volume, the MPIO policy is set to **Fail Over Only**. The MPIO policy for all other volumes is set to **Round Robin**, allowing those volumes to use all paths.

Figure 10 shows the MPIO policy used for each SQL Server data volume. Figure 11 shows the MPIO policy for all other volumes.



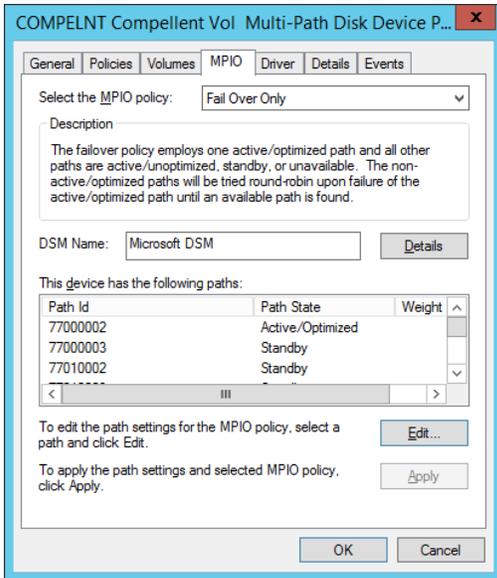


Figure 10 MPIO policy for data volumes

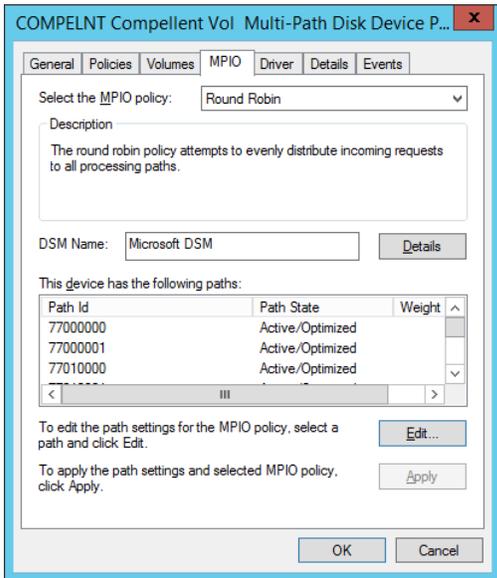


Figure 11 MPIO policy for other volumes

7 SQL Server 2014 Enterprise Edition configuration

7.1 Startup parameters

The following options were added to the SQL Server startup parameters:

-E

This parameter increases the number of contiguous extents in each file that are allocated to a database table as it grows. This option is beneficial because it improves sequential access.

-T1117

This trace flag ensures the even growth of all files in a file group when auto growth is enabled. Note that it is recommend to expand the data files to their appropriate size rather than to depend on auto grow.

7.2 SQL Server maximum memory

SQL Server was configured to use 92% of the memory on the server. Maximum server memory for this reference architecture was set to 706 GB. If additional applications share the server, adjust the amount of memory left available to the operating system accordingly.

7.3 Max degree of parallelism (MAXDOP)

The max degree of parallelism was set to 28 for the row store tests and 56 for the column store tests.

For information on configuring the max degree of parallelism, visit <https://msdn.microsoft.com/en-us/library/ms189094.aspx>.

7.4 Resource Governor

The resource governor was used to limit the maximum memory grant to 12 percent for the row store and column store tests.

For information about the Resource Governor, visit <https://msdn.microsoft.com/en-us/library/bb933866.aspx>.

7.5 Tempdb configuration

The tempdb database was configured to use eight data files of equal size. The data files were evenly distributed across the two tempdb data volumes, with four files stored on each volume. The tempdb transaction log file was placed on the log volume. All files were expanded to the appropriate size and auto grow was enabled.



8 Additional considerations for the Highly Available (HA) reference architecture

The HA reference architecture leverages Windows Failover Clustering to achieve high availability. When configuring a Windows failover cluster, there are additional storage considerations:

- The recommended quorum model is **Node majority with witness (disk or file share)** using a disk witness. An additional volume needs to be created and configured as the disk witness. Dell recommends using a 2 GB volume for the disk witness. For more information on quorum configurations in a failover cluster, visit <https://technet.microsoft.com/en-us/library/jj612870.aspx>.
- All volumes need to be mapped to each node of the cluster. It is recommended to use a cluster server object in the Storage Center when mapping volumes to the cluster.
- All volumes need to be configured as a cluster resource and added to the SQL Server cluster resource group.



9 DWFT for SQL Server 2014 certification

DWFT Certification #2014-019	Dell R730 with SC4020 - 55 TB DWFT Reference Architecture			Report Date: 1/22/2015	
DWFT Rev. 5.4					
System Provider	System Name	Processor Type		Memory	
	Dell PowerEdge R730	Intel Xeon E5-2697v3 2.6 GHz (2S/28C/56T)		768 GB	
Operating System			SQL Server Edition		
Windows Server 2012 R2			SQL Server 2014 Enterprise Edition		
Storage Provider	Storage Information				
	Dell Storage SC4020 18 x 1.6TB SSD for OS, data, log and tempdb RAID 10 for OS, log and tempdb, RAID 5-9 for data				
Primary Metrics					
Rated User Data Capacity ¹ (TB)	Row Store Relative Throughput ²	Column Store Relative Throughput ³	Maximum User Data Capacity ¹ (TB)		
55	178	291	66		
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.) (%)
178	218	4,451	6,046	5,248	80
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.) (%)
291	1,895	1,784	N/A	N/A	97
<p>The reference configuration is a 2 socket system rated for 25TB using the DWFT V4 methodology</p> <p>¹ Assumes a data compression ratio of 5:1</p> <p>² Percent ratio of the throughput to the row store throughput of the reference configuration.</p> <p>³ Percent ratio of the throughput to the column store throughput of the reference configuration.</p> <p>⁴ Reported metrics are based on the qualification configuration which specifies database size and SQL Server memory.</p>					



10 Summary

Dell, in partnership with Microsoft, enables customers to deploy tested and validated data warehouse solutions using Data Warehouse Fast Track reference architectures for SQL Server 2014. These uniquely designed architectures ensure optimal Business Intelligence (BI) solutions. The end-to-end best practices and recommendations enable the customer to achieve enhanced return-on-investment (ROI) and faster time-to-value with a balanced, better performing data warehouse environment than traditional data warehouse systems.

The Dell Microsoft DWFT reference architecture provides the following benefits to customers:

- Delivers a tested and validated configuration with proven methodology and performance behavior
- Delivers outstanding performance on the Dell 13G server platform with blazing processor speeds and leading edge flash-based Dell storage arrays
- Achieves a balanced and optimized solution at all the levels of the stack by following the best practices for both hardware and software components, achieving faster time-to-value and lower total-cost-of-ownership (TCO)
- Avoids over-provisioning of hardware resources
- Offers high availability at all levels of setup (host, switches, and storage)
- Offers single point of contact/accountability for purchases, services, and support; SQL Server is available to purchase from Dell worldwide
- Helps customers avoid the pitfalls of an improperly designed and configured system
- Reduces future support costs by limiting solution re-architect efforts because of scalability challenges

This paper describes a reference architecture using an R730 server with an SC4020 storage array. By implementing Data Warehouse Fast Track for SQL Server 2014 design principles, this configuration achieved a 55TB rating.



A Additional Resources

Dell Products:

<http://www.dell.com>

Dell Services:

<http://www.dell.com/services>

Dell Support:

<http://www.dell.com/support>

Dell SQL Server Solutions:

<http://www.dell.com/sql>

Dell Data Warehouse Fast Track for SQL Server Advisor:

http://www.dell.com/solutions/advisors/us/en/g_5/SQLFastTrack/4/Start?s=biz#212418

Dell Storage technical content on Dell TechCenter:

<http://en.community.dell.com/techcenter/storage/w/wiki/2631.storage-infrastructure-and-solutions-team>

